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Build our VLF transmitter/receiver pair and explore the fascinating world at the bottom of the RF spectrum.

Build An Ultrasonic Morse-Code Transceiver

Learning the code is lots of fun with these no-license-needed "transceivers."

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JULY 1990, VOLUME 7, NO. 7

Popular Electronics®

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Editorial

A LOYAL COMPANION

In this age of super computers, super conductors, compact discs, and high-definition TV, radio doesn't seem to get a lot of attention, or respect. But if you think to your earliest experiences in this wonderful hobby of ours, it's likely that radio played a big part.

It may have been that crystal radio that you built as your first project. Or maybe it was the sound of far-away places on a friend's or relative's shortwave receiver. Whatever it was, radio served as the spark that got many of us involved in electronics.

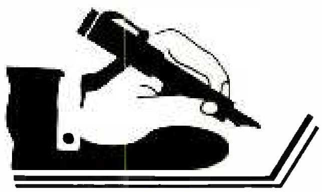
Despite all of the razzle-dazzle that makes up electronics today, we at Popular Electronics have never, and will never forget the importance of radio. Each month we feature several columns that concentrate on various aspects of that part of our hobby.

This month, though, we have something extra. Our VLF Transmitter/Receiver pair open up a window to the world below *10 kHz.* Exploring and experimenting with those frequencies is a fascinating pastime; once you've tried them you may be hooked for good.

But what's even more fascinating is the excitement of world-wide communications that's yours when you possess a ham license. One of the milestones in many of our "electronics lives" comes on the day that we finally earn our treasured "ticket." Of course, before we earn that ticket we need to clear a very difficult hurdle—learning the Morse code. That's where our Ultrasonic Morse Code Transceiver comes in; by simulating the operation of a ham station, it turns a sometimes dreaded task into hours of communications fun.

Radio put many of us on the road to our hobby and our careers, and in Popular Electronics it will always be one of our traveling companions.

Carl Laron
Editor



Letters

STALLED TRAINS

Your staff did a remarkable job copying my schematic for my article, "Model Train and Slot-Car Controller" (**Popular Electronics**, March 1990). Unfortunately, when I prepared the article for submission, switches S2 and S3 were drawn incorrectly; the correct wiring is shown here in Fig. 1. Also, the power side of those switches should not be connected to +9V as shown in the schematic but to +18V as described in the text; make the connection to the junction of the positive terminal of capacitor C6 (1000 µF) and the output of bridge-rectifier BR1. This correction also applies to the parts-placement diagram.

Also, a couple of errors crept into the text: On page 70, center column, the text should read, "... R13 to **R16**, and transistors Q3 and Q4 for ..." and in the right-hand column on page 70, the text should read, "Resistors R14/R15 and R18/R19 turn on Q4 and **Q6**, respectively ...".

Finally, there is a discrepancy between the schematic diagram and the Part List concerning Q4 and Q6; either the IRF521 given in the schematic or the IRF523 listed in the Parts List will work satisfactorily in this circuit.

There've been some questions about how the output circuits work, so here's a more detailed description: Each output consists of a 2N3904 NPN transistor and an IRF523 hexFET. Op-amp U2-a sends pulses to Q4 forty times per second. The duty cycle of the pulses is varied from nearly always low to always high. When the voltage to the gate of Q4 is high, Q4 turns on and conducts. If the current through R16 is greater than three amps, Q3 turns on and lowers the gate voltage to Q4 to limit the output current to three amps per channel. The power transformer is rated for 3A at 12.6 VAC, or about 38 watts. The filter capacitor helps deliver peak current when the unit is under full load.

The unit, as built, will run N-gauge, HO-gauge, and O-gauge trains that use 3 amps or less to operate. The two controls operate totally independently, allowing any speed or direction to be selected for each output. If there is a need for greater current and controller power, Q4 and Q6 can be changed to larger units, such as the IRF531ND, which is rated for 14 amps.

Note that R16 must be lowered to allow for greater current limits. To calculate the needed value, use $R16 = V_{be}/I_{out}$; for example, for V_{be} = 0.6 volts and a 10-amp output current, R16 = 0.6/10 = 0.06 ohms. Three 0.18-ohm resistors could be used in parallel to form R16.

The rating of the transformer would, of course, have to be increased for the current required; the bridge rectifier would need to be a 15- or 25-amp, 50-PIV unit; and the forward and reverse switches would need to be upgraded to handle the larger current. The rest of the circuit, however, would stay just as it is.

I hope that the corrections and additional information will make the hook up and assembly go more smoothly. I apologize for any difficulties this may have caused.

Ron Hoffman
Solon, OH

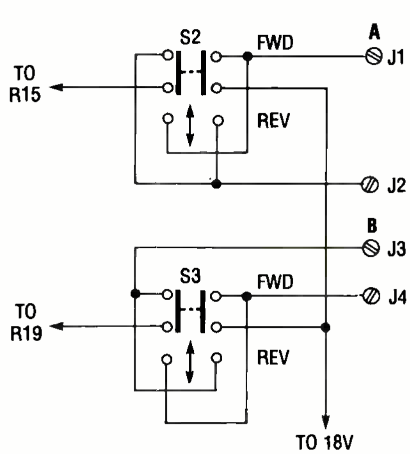


FIG. 1

FRACTURED FACTCARD

In the March 1990 issue of ***Popular Electronics****, the "3A Switching Regulator" circuit in FactCard 134 contains several errors. The PNP transistor, which should have been labeled "Q1, 2N3792," and the output filter capacitor, which should have been labeled "C4, 100-µF, Tantalum unit," were not labeled. L1 should have been labeled 600 µH, instead of 600 M, and V_{out} was incorrectly labeled 18 to 32 volts instead of 1.8 to 32 volts.—Editor.*

APRIL FOOLS TO YOU, TOO!

Your review of the Bozart 911 (**Popular Electronics**, April 1990) prompted me to purchase this highly rated speaker. I wasn't disappointed!

Are we witnessing a slice of tomorrow today? I think so—in fact, I'm willing to predict that Bozart has set a new standard in sound engineering that will force other companies like Phony and Yellpine to follow their move. I was particularly impressed by the new corrugated-cardboard container. Believe me, you can really tell the difference over the old "double-bag" technology.

Congratulations, **Popular Electronics**, for being the first to review this fine product, and for keeping me informed.

S.M.
Calgary, Alberta, Canada

I was glad to see the Cleveland Microwave, model *5199* finger warmer listed in the "New Products" column in the April issue of **Popular Electronics**. I was one of the pre-production testers of the product. I can only predict that it will be warmly received by the public. My family and I speak of it in the most glowing terms.

Development of the product, however, was not without its problems. The early prototype didn't have the "hi-low" power-level control, and kept boiling the liquid-crystal display right out of my wristwatch. Power-line transient filtering had to be improved as voltage spikes would cause sudden bursts of power. Words like "adlkruoe" and "xownqopiruz" would appear randomly on the screen due to the microwave effects on the keyboard circuits.

All in all, I think it's a great product, and I look forward to getting back to my keyboard as soon as the skin grafts on my hands, arms, and face heal.

H. T.
San Diego, CA

HAVES AND NEEDS

I have a Fannon, model *T700* citizens band walkie-talkie for which I need two tuning transformers. The transformers are called coils in the parts lists and have the part number 1003-14. They have one primary winding and one center-tapped secondary, and they are enclosed in a metal can with an adjustable core. The core is accessible from the top of the metal can. Each transformer has five leads brought out to the printed-circuit board and two ground lugs from the metal can.

The unit is covered in SAMS *CB-93*. Do you or any of your readers have that booklet, or know of another source for that type of transformer? I could also use information on the manufacturer, Fannon/Courier Corp.—a current address or phone number, or the name of the firm that might have bought them out, would be appreciated. Thank you.

Terry G. Stewart
Rt. 1, Box 18-E1
Holt, FL 32564

I need a variable capacitor for an old (late 1950's or early 1960's) transistor radio. It is a Sony 6-transistor model *TR-620*. I made the mistake of spraying tuner cleaner into the variable capacitor, which really gummed it up. The radio belonged to my grandfather, and actually played before I "fixed" it. Any help that anyone can give me would be greatly appreciated.

Edward A. Byrnes
412 Taylor Street
Rochester, MI 48063-4327

Help! I need a schematic and/or instruction manual for a Hufco TWS-600 frequency counter. Thanks.

Bill Smith
828 Ayers Road
Wheatland, WY 82201 ■

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VIDEO, STEREO AND OPTOELECTRONICS: 18 Advanced Electronic Projects

by Rudolf F. Graf and William Sheets

With an emphasis on practical projects to enhance the reader's home audio, video, and photographic equipment, this book presents complete instructions for dozens of sophisticated projects (many of which originally appeared in the pages of *Radio-Electronics* magazine). Included are cordless headphones, a video-effects generator, an FM-broadcast receiver, an enlarging light meter, and a universal shortwave converter. Many of the projects are inexpensive to build, especially when compared to the prices of similar commercial units, and others are not available commercially at any price. Some of the other projects presented are an FM-stereo transmitter, receivers for longwave and FM-broadcast bands, a digital photo timer, and SCA and MPX FM receivers.

Besides the actual projects, the book includes a chapter on printed-circuit techniques for the hobbyists, providing descriptions of the materials and processes used in making PC boards. An appendix gives component-identification data, and a source list is included.

Video, Stereo and Optoelectronics: 18 Advanced Electronics Projects is available for $18.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

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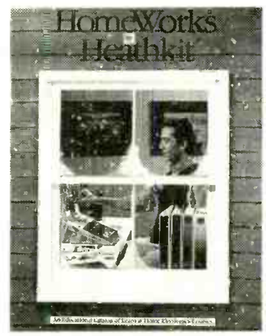
HOMEWORKS BY HEATHKIT

from Heath Company

Heath's learn-at-home electronics courses are developed for consumers and hobbyists who want to stay on top of today's technological advances. Their full line is featured in this 36-page catalog. It includes courses on robotic theory, digital processing, basic and advanced electronics, amateur-radio operation, and more. A variety of Heathkit trainers and trainer accessories that are used in performing the course experiments are also included, offered both pre-assembled and in kit form. Several of the learning programs have optional video or audio tapes that supplement the course workbooks. Continuing Education Units (CEU's), which are recognized as job-related certification by a growing number of



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professional and technical organizations, are earned each time a Heathkit course is taken and the optional final exam is successfully completed.

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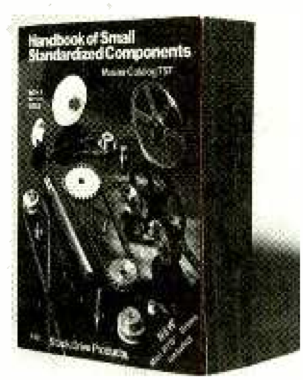
HANDBOOK OF SMALL STANDARDIZED COMPONENTS: Master Catalog 757

from Stock Drive Products

More than 24,000 small, off-the-shelf drive components—in both inch and metric sizes—are featured in this 768-page book. It features 55 pages of new components, primarily mini-HTD timing belts and pulleys that offer curvilinear deep-tooth profiles. The catalog is divided into nine product categories, each with its own photographic and descriptive index. The products include belt and chain drives, gears, speed reducers, motors, couplings, universal joints, flexible shafts, bearings, fasteners, and vibration mounts. Several unique components, such as constant-force springs, splined bushings, and industrial "V" guides are also featured. Every component is identified using an alphanumeric coding system that is explained in the catalog. The book also includes a section that contains useful technical tables.



The Handbook of Small Standardized Components: Master Catalog 757 is available for $5.95 from Stock Drive Products, 2101 Jericho Turnpike, New Hyde Park, NY 11040.

CIRCLE 82 ON FREE INFORMATION CARD

THE ABC'S OF PARADOX

by Charles Siegel

Newcomers to database management—even those who have never before used a computer—will find a hands-on introduction to database management with Paradox 3.0 in this book, which is written especially for business users who want to master the fundamentals in the shortest possible time. The easy-to-follow tutorials will have new users doing useful work almost immediately. It shows them how to start the software and create the first data table, enter and edit information, sort and reorganize the table, create tabular reports, produce mailing labels and other custom printouts, and query the database for selected information. The book also provides an introduction to multitable, relational database management, via a complete sample application that involves multiple related data tables, queries, and reports. Additional topics include using special Paradox tools to simplify day-to-day housekeeping, techniques for ensuring accurate data entry, and using time-saving Scripts to automate routine operations. Throughout the text, practical business examples are used.

The ABC's of Paradox is available for $18.95 from Sybex Inc., 2021 Challenger Drive, Number 100, Alameda, CA 94501.

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USING PFS:FIRST CHOICE RELEASE 3

by Gail Todd

PFS:First Choice is an integrated software program, which means that it has several applications and that those applications all work together. This book covers the program's four major application areas: word processing, spreadsheet, database, and communications. Each application is discussed separately, with practical examples and illustrations, and then readers are shown how to combine the applications and how to use advanced First Choice features such as macros. Experienced users will appreciate the chance to learn how to master the extensive program features and how to integrate First Choice with other software programs, such as WordPerfect, Lotus 1-2-3, Word, and DisplayWrite. Beginners will appreciate the straightforward text, ample illustrations, and practical approach to learning, as well as the opening chapter's instructions on getting the program installed and running.

Using PFS:First Choice Release 3 is available for $22.95 from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Tel. 415-548-2805.

CIRCLE 96 ON FREE INFORMATION CARD

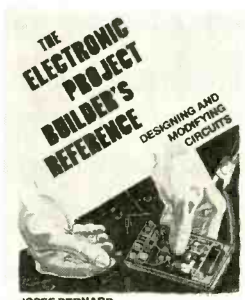
THE ELECTRONIC PROJECT BUILDER'S REFERENCE: Designing and Modifying Circuits

by Josef Bernard

Here's a book that deserves a prominent

spot on any electronic hobbyist's shelf, for a couple of reasons. First, it's filled with information and advice intended to make project building less frustrating and more rewarding. Second, author Joe Bernard's trademark combination of technical expertise, jargon-free writing, and easy-going humor—which should be familiar to all you **GIZMO** readers—makes it a pleasure to read.

Not just a recitation of facts and figures, this book explores the how's and why's behind electronics theory. It explains how all the laws and formulas relate to real-life applications, and answers some nuts-and-bolts questions, such as "Why are there so many different kinds of resistors?" and "How do I choose a current-limiting resistor?" The idea is that by understanding not just what to do, but why to do it, the reader—regardless of his level of experience—will be better prepared to design, build, customize, and troubleshoot his own projects. That philosophy can be applied to constructing the projects presented in the book, to customizing them, or to building the projects found in the pages of **Popular Electronics**.



The Electronic Project Builder's Reference: Designing and Modifying Circuits is available for $14.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

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EXPERIMENTAL ANTENNA TOPICS

by H.C. Wright

Ever since Marconi's first demonstrations of radio communications almost a century ago, researchers have been experimenting with antenna design and performance. This book is designed to help home experimenters to build their own antennas, and perform tests and measurements on those antennas, using inexpensive, easy-to-find materials. To encourage the trial-and-error philosophy that often leads to innovation and discovery, it focuses not on expensive, store-bought antennas and test equipment, but on devices assembled using only simple tools from everyday household items—

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including cardboard, cooking foil, plastic bottles, and tin cans. The antenna projects include the "Abe Lincoln," crossed-field, doubly-fed-coax, frequency-independent, loop-and-frame, and sky-wave antennas. Also presented are tests and measurements for interference, gain, efficiency, matching and balancing, thermal noise, and the skin effect. The text is supported with numerous diagrams and charts.

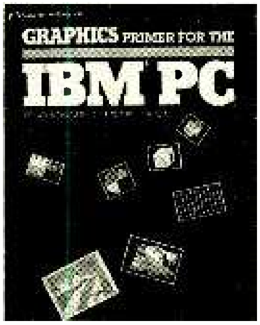
Experimental Antenna Topics (order no. BP278) is available for $7.95 (including shipping and handling) from Electronic Technology Today, Inc., P.O. Box 240, Massapequa Park, NY 11752-0240.

CIRCLE 97 ON FREE INFORMATION CARD

GRAPHICS PRIMER FOR THE IBM PC

by Mitchell Waite and Christopher L. Morgan

This comprehensive, full-color book provides step-by-step instructions for creating dynamic graphics displays on an IBM PC. It is designed to help the reader master his system's graphics commands to produce effective color graphics for business, education, and entertainment applications. In clearly written text the book demonstrates how to design and produce charts, maps, forms, animation sequences, games, and even two- and three-dimensional pictures. The full-color illustrations help the reader



understand how the PC "works" its screen, and demonstrate the color capability of the IBM PC. Every graphics command in IBM PC Advanced BASIC is covered, including the new graphics commands available in BASIC version 2.0. For each command, several illustrations are provided to illustrate the syntax of the command and how it is used. Combinations of several graphics commands, and of graphics and non-graphic commands, are also covered, with suitable examples.

Graphics Primer for the IBM PC is available for $24.95 from Osborne/McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Tel. 415-548-2305. A diskette that contains more than 70 graphics programs presented in the book is available for $29.95 (plus $3.00 shipping and, for California residents, 6.5% sales tax) from Comprehensive Software Support, 2316 Artesia Blvd, Suite B, Redondo Beach, CA 90278; Tel. 213-318-2561.

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DOS, WORDPERFECT & LOTUS Office Companion

by Robert W. Harris

Millions of PC users rely on DOS, WordPerfect, and Lotus 1-2-3 in their work, and this book is a single desk reference for all three of those popular business-software programs. Designed to see users through the problems they face daily, the book provides operating tips, techniques, and strategies for all DOS versions, WordPerfect versions through 5.1, and Lotus 1-2-3 versions through 2.2.

The book is divided into three comprehensive sections with step-by-step tutorials, and tips and shortcuts that are not

found in manufacturer's reference manuals. To avoid intimidating readers, it is written in plain English, with no technical jargon. The author aims to teach readers as much as possible in the shortest time, and offers the practical advice needed to help them take control of the three business-software programs. Beginners will appreciate the friendly, non-technical approach, and more advanced users will enjoy having the basic commands at their fingertips for quick reference.

DOS, WordPerfect & Lotus Office Companion is available for $19.95 from Ventana Press, P.O. Box 2468, Chapel Hill, NC 27514.

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RSGB MICROWAVE HANDBOOK: Volume I

edited by M.W. Dixon, G3PFR

The first of three informative volumes available from The American Radio Relay League (ARRL), this book covers operating techniques, system analysis, propagation, microwave antennas, transmission lines and components, microwave semiconductors, and valves. The presentation of microwave theory and practice is largely non-mathematical. The book also contains a collection of practical designs that evolved from the Radio Society of Great Britain's (RSGB)—the ARRL's British "sister organization"—publications, *Radio Communication* and *Microwave Newsletter.*

RSGB Microwave Handbook: Volume I is available for $35.00 (plus $4.50 shipping and handling) from The American Radio Relay League, 225 Main Street, Newington, CT 06111.

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CMOS/TTL DIGITAL SYSTEMS DESIGN

by James Buchanan

Although today's commercial TTL and CMOS IC's allow design engineers to achieve higher system-operating speed, there's a price to pay for that speed: Logic design cannot be independent of electrical and mechanical design. That means that the electrical interconnection systems must be extremely efficient, and that noise, interconnection impedance, transient current, crosstalk, ground upset, and power loss problems are not only more common, but are also more difficult to solve.

This book is a practical guide to the electrical design of high-speed digital systems. It provides tested shortcuts and techniques, and a variety of solutions to the common problems associated with advanced Schottky and CMOS systems. Based on a course given to Westinghouse digital designers, it presents "real world" design strategies. Every aspect of the design process is covered, from logic families and circuits through specific techniques for noise reduction, clock distribution, and the high-frequency power and signal interconnections required in high-speed digital systems.

CMOS/TTL Digital Systems Design is available in hardcover for $44.95 from McGraw-Hill Publishing Company, 1221 Avenue of the Americas, New York, NY 10020; Tel. 800-2-MCGRAW.

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RS-232 INTERFACE AND MONITORING EQUIPMENT

from B&B Electronics

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(Continued on page 12)

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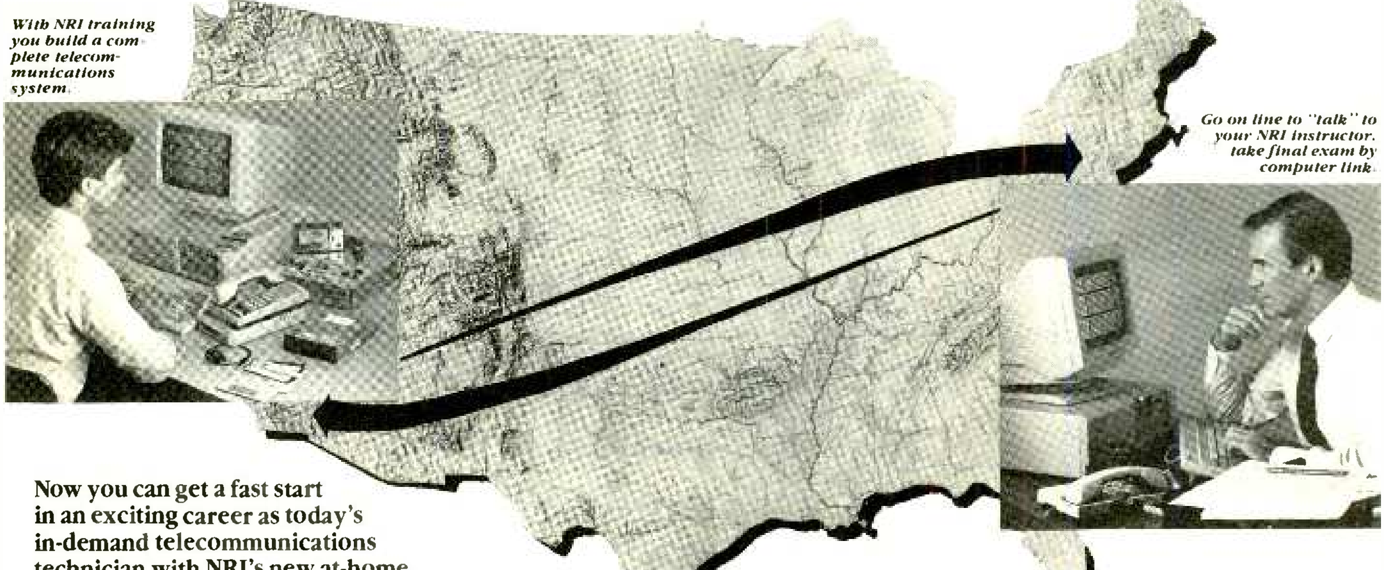

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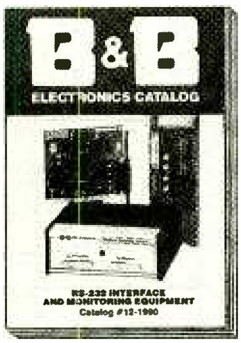
(Continued from page 8)

dustrial-control enclosures, including a four-channel RS-232/RS-232 optical isolator, a four-channel RS-232 to RS-422/485 converter, and an RS-232 to current loop converter, as well as new industrial-converter power supplies. These converters are on printed-circuit boards that fit rigid PVC "Snaptrack" mounting racks, or can be directly panel mounted. Catalog #12-1990



also features B&B's full line of RS-232 converters, switches, jumper boxes, data splitters, adapters, modem-security devices, multiplexers, Breakout II software, cable assemblies, surge protectors, technical publications, and more.

RS-232 Interface and Monitoring Equipment: Catalog #12-1990 is free upon request from B&B Electronics Manufacturing Company, 4000P Baker Road, P.O. Box 1040, Ottawa, IL 61350; Tel 815-434-0846.

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from Seastrom Manufacturing Co., Inc.

In this brochure, more than 130 listings of AN, NAS, M, MS, and USAF Standards are identified for immediate shipment from stock. Most variations and dash numbers are also available for prompt pricing and shipping.

The MIL Standards listing is available at no charge from Seastrom Manufacturing Co., Inc., 701 Sonora Avenue, Glendale, CA 91201-2495.

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MAKE MONEY MOONLIGHTING! The 4 Best Ways to Earn Money With Your Computer and the 4 Traps to Avoid

by John R. Mortz

If you're using your computer only to play games, balance your checkbook, or write an occasional letter, you could be missing out on some money-making opportunities, according to the author of this book. In it, he describes several kinds of businesses that can be run from the home, and how to make those businesses successful by marketing them properly.

The easy-to-read book stresses moonlighting as a low-risk strategy for starting a new business, and presents a no-nonsense, down-to-earth, pragmatic approach to the problems of getting your business running. It describes four ways to earn money faster, and warns of four common pitfalls that can lead to long hours and low earnings. The step-by-step approach shows how to obtain a competitive edge and, perhaps, turn your moonlighting into a lucrative, full-time enterprise.

Make Money Moonlighting! is available for $9.95 (plus $2.50 shipping and handling) from the American Institute of Computer Technology, 30 North Raymond Avenue, Suite 714, Pasadena, CA 91103; Tel. 818-793-8429.

CIRCLE 88 ON FREE INFORMATION CARD

NOW HEAR THIS! Electronic Eavesdropping Equipment Design

by Winston Arrington

Called "intelligence gathering" when it's done by the police, the FBI, or the CIA—but more commonly known as "bugging"—electronic surveillance is becoming increasingly prevalent in our society. It's used by suspicious spouses in the midst of divorces, by businessmen trying to keep ahead of competitors, by private investigators, and by all sorts of government agencies. This book allows electronics hobbyists to get in on it, too.

Reserving moral judgment—but presenting some legal information, including parts of the 1968 "Title 3: Wiretapping and Electronic Surveillance" act—the book provides complete schematics for 58 electronic surveillance devices, of all levels of complexity. Those schematics are accompanied by clearly written instructions, parts lists, and photographs.

The book includes an array of telephone bugs and transmitters, a carrier-current unit, an infrared transmitter, a wireless microphone, and a laser transmitter. Separate chapters are devoted to subcarrier devices and receivers. The book provides the reader with information on converting tape recorders to slow speed and listening through walls—and, not surprisingly, on debugging.

Now Hear This! Electronic Eavesdropping Equipment Design is available for $30.00 (plus $4.00 shipping and handling) from Winston Arrington, 7223 South Stony Island Ave., Chicago, IL 60649.

CIRCLE 89 ON FREE INFORMATION CARD

UPGRADE!

from JDR Microdevices

With PC technology advancing rapidly—and with the price of new equipment keeping pace—owners of older equipment face the dilemma of how to get better performance without replacing their entire systems. This 16-page booklet demonstrates how easy it is to upgrade your old personal computer, and gives step-by-step instructions for how to do so. It is filled with cost-effective alternatives in the form of motherboards, memory upgrades, power supplies, VGA cards, disk drives, and modems. The flyer also includes a series of technical-advice columns written by JDR's chief engineer, Derick Moore. Product descriptions describe the differences in components and capabilities among models in the IBM-compatible line, and the advice columns illuminate the impact of those differences.

The Upgrade! brochure is free upon request from JDR Microdevices, 2233 Branham Lane, San Jose, CA 95124; Tel. 800-538-5003, Ext. 554.

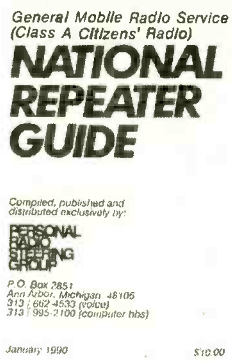
CIRCLE 90 ON FREE INFORMATION CARD

NATIONAL REPEATER GUIDE

from Personal Radio Steering Group

The General Mobile Radio Service (GMRS) is one of the fastest growing private land mobile-radio services, providing valuable information about everything from tourist facilities to motorist aid and emergency services. (For example, travelers in Orlando, Florida have access to detailed information about the repeater operations on many GMRS channels conducted by Walt Disney world.) Many GMRS repeater systems are operated by non-profit community-service radio teams and user cooperatives; others are run by local-government agencies and quasi-governmental services whose assistance might be needed by licensees while passing through the area. New GMRS licenses are available only to private individuals for their personal, family, and business communications.

The *National Repeater Guide* lists more



than 1100 GMRS repeater systems and monitoring watches in all 50 states, the District of Columbia, and Puerto Rico. Many listings include signaling data and station characteristics as well as contact names, addresses, and telephone numbers. The guide also features an extensive introduction to, and tutorial on, GMRS history and capabilities. It is published by the Personal Radio Steering Group, a national service organization for GMRS licensees that also publishes the monthly GMRS users' newsletter, *Personal Radio Exchange*.

National Repeater Guide is available for $10.00 (postage included), or is free with a $30.00 newsletter subscription, from The Personal Radio Steering Group Inc., P.O. Box 2851, Ann Arbor, MI 48106; Tel. 313-MOBILE-3.

CIRCLE 91 ON FREE INFORMATION CARD

CRYSTAL AND CLOCK OSCILLATOR CATALOG

from Pletronics Inc.

Pletronics' broad range of quartz crystals and clock oscillators are featured in their 20-page 1990 catalog. Scores of combinations of packages, frequencies, tolerances, stabilities, operating temperatures, and applications are listed in the fully illustrated brochure. The features, specifications, and dimensions are clearly depicted, along with an extensive list of standard frequencies for each product family. Specification guides for both crystals and oscillators are provided as well.

The 1990 Crystal and Clock Oscillator Catalog is free upon request from Pletronics, Inc., 9026 Roosevelt Way, N.E., Seattle, WA 98115; Tel. 206-523-2350.

CIRCLE 92 ON FREE INFORMATION CARD

ELECTRONIC TEST ACCESSORIES

from ITT Pomona Electronics

Five new product groups—including IC test clips and digital-multimeter test-lead kits—are featured in Pomona's 138-page *1990 Electronic Test Accessories Catalog*. Products in ten major categories are easy to locate via a handy index and selection guides. Also included in the catalog are a selection of cables and jumpers, boxes, plugs and jacks, connectors, adapters, single-point test clips, static-control devices, and much more.

The 1990 Electronic Test Accessories Catalog is free upon request from ITT Pomona Electronics, 1500 East Ninth Street, Pomona, CA 91769; Tel. 714-623-3463. ■

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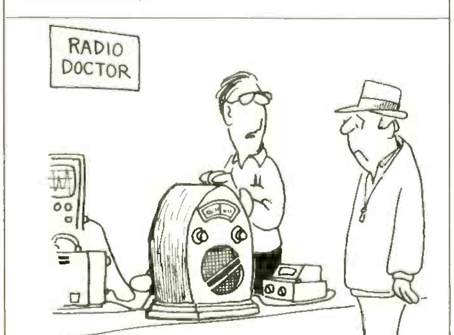
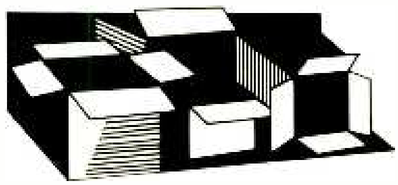


"I've done all that I can do—I think it's time to pull the plug."

CIRCLE 13 ON FREE INFORMATION CARD



New Products

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

CODE SCANNER

If you'd like to read Morse code but don't know the code (or are a bit too rusty to follow high-speed messages), or if you're interested in deciphering radioteletype (RTTY) messages, *Microcraft's Code Scanner* could be just the thing for you. The portable, hand-held unit coverts the "dits" and "dahs" from your communications receiver or telegraph key into alpha-numeric characters displayed on a 32-character, two-line LCD. The Code Scanner lets you listen in on commercial or amateur Morse-code traffic on the airwaves, as well as RTTY news dispatches, weather bulletins, and amateur-radio transmissions. There is a built-in code-practice oscillator; the special practice mode lets you hear and learn the Morse alphabet. Besides Morse and Baudot codes, the unit copies ASCII code from a receiver or computer.

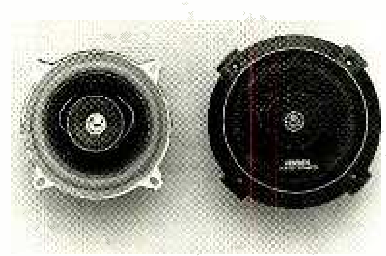
The Code Scanner is easy to hook up using the headphone jack or the external-speaker jack, and easy to operate. The mode is selected by pressing a front-panel push button. When you tune your receiver until a pitch of 800 Hz is obtained, the Code Scanner's front-panel LED tuning indicator will flash in step with the code and the sound from the internal speaker will be at maximum. The decoded messages will appear on the LCD. To practice Morse code, just connect a telegraph key to the input jack and start sending code—it will be decoded and displayed on the LCD. The compact (3½ × 1¼ × 5¾ inches) code reader runs on 12 VDC. A 115-VAC power adapter is included.

The Code Scanner (model *CSCAN*) costs $189.00, plus $5.00 shipping and handling. For further information, call Microcraft Corporation, P.O. Box 513, Thienville, WI 53092; Tel. 414-241-8144.

CIRCLE 101 ON FREE INFORMATION CARD

CAR SPEAKERS

A recent introduction to *International Jensen's* "Classic Blues" line of car speakers is the *JCX225*. This versatile 5¼-inch (130mm) speaker can be installed in domestic or European models; its unique mounting flange increases the number of possible installations. The coaxial speaker has a peak-power handling capacity of 80



watts and continuous power handling of 35 watts. The frequency response is 60 Hz to 20 kHz, and sensitivity is 90 dB (1 watt at 1 meter).

The *JCX225* car speaker has a suggested retail price of $79.95. For further information, contact International Jensen, Inc., 25 Tri-State International Office Center, Suite 400, Lincolnshire, IL 60069; Tel. 800-323-0707.

CIRCLE 102 ON FREE INFORMATION CARD

LOW-PASS FILTER

Promising dramatically improved shortwave reception, *Electron Processing's LPF-1* low-pass filter eliminates interference caused by strong VHF/UHF signals that overload the sensitive amplifiers inside today's wide-coverage, "no tune-up" receivers. It effectively reduces signals for TV, FM, and two-way radio stations from the antenna line of any shortwave receiver.

The LPF-1 connects in the antenna lead between the antenna and the receiver to filter out signals on all frequencies above 50 MHz. Signals in the FM-broadcast band are reduced in strength at least 100 times, yet

signals below 30 MHz are virtually unaffected. The device uses a two-stage low-pass filter network that requires no power. It is housed in a compact 2 × 2 × 1-inch metal enclosure with BNC female connectors provided for easy connection.

The LPF-1 low-pass filter has a suggested retail price of $19.95. For further information, contact Electron Processing, Inc., P.O. Box 68, Cedar, MI 49621; Tel. 616-228-7020.

CIRCLE 103 ON FREE INFORMATION CARD

EQUALIZER/AMPLIFIERS

Jensen has introduced two models to its line of equalizer/amplifiers. The compact model EQA-110 is a 10-band graphic equalizer with an 80-watt maximum-total-power amplifier and 16 watts-per-channel RMS into 4 ohms. Its signal-to-noise ratio is 80 dB (A-weighted) and input sensitivity is rated at 1 volt into 47 ohms and 100-mV into 10 Kohms. The EQA-110 provides ±12-dB

boost or cut at 3, 60, 20, 250, 450, and 700 Hz, and at 1.3, 3, 6, and 12 kHz.

The *EQA-77* (pictured) is a 7-band graphic equalizer with a 60-watt maximum-total-power amplifier and 15 watts-per-channel RMS into 4 ohms. It has an 80-dB (A-weighted) signal-to-noise ratio, and its input sensitivity is rated at 1 volt into 47 ohms and 100 mV into 10 Kohms. Its seven equalizer controls provide ±12-dB boost or cut at 50, 125, 250, and 500 Hz, and also at 1.2, 3.5, and 8 kHz.

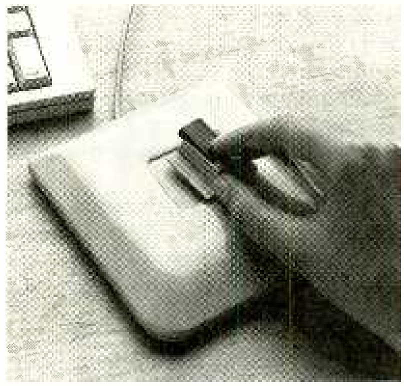
The models EQA-110 and EQA-77 equalizer/amplifiers have suggested retail prices of $137.95 and $109.05, respectively. For more information, contact International Jensen, Inc., 25 Tri-State International Office Center, Suite 400, Lincolnshire, IL 60069; Tel. 800-323-0707.

CIRCLE 104 ON FREE INFORMATION CARD

PC POINTING DEVICE

A compact alternative to the common computer mouse, *Altra's FELIX* pointing device provides full-screen, precision cursor control via a movable button that floats on a one-square-inch control surface. The control surface sits atop a one-inch-high pedestal that measures only 5¼ × 5¼ inches and can be placed to either the right or left of the keyboard. An on-board microprocessor translates movements of the floating button directly into screen coordinates. The device comes with control software that provides high-resolution performance of up to 4000 dots per inch, along with time-saving window-management and control features. FELIX frees up desk space while giving users immediate fingertip response that increases throughput and reduces fatigue.

FELIX, which is currently available for the Macintosh SE and II lines of personal computers and is under development for IBM PC's, offers a greater degree of accuracy and speed than either mice or trackballs. The on-board microprocessor interprets the speed and direction of the floating button, automatically adjusting the precision to take into consideration the type of cursor movement—broad-stroke or fine-precision—that is being used.

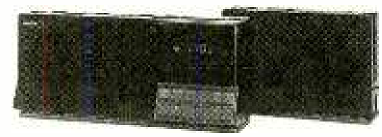


The FELIX pointing device has a suggested list price of $169.00. For additional information, contact Altra, 1200 Skyline Drive, Laramie, WY 82070; Tel. 307-745-7538.

CIRCLE 105 ON FREE INFORMATION CARD

STEREO CLOCK RADIO

The sleek model *RS-420* stereo clock radio from *Proton* has an optional extension speaker that adds full stereo sound. The AM/FM clock radio provides two separate alarm systems that can be programmed for different wake-up times, and for low, medium, loud, or gradually increasing volume. A snooze function grants seven minutes of extra sleep. The unit's digital display has



both an automatic light-sensor control and a manual dimmer to ensure legible readings in different ambient lighting.

The digitally tuned AM/FM radio, which has 12 station presets, has a 3-watt amplifier and a 5-inch speaker for rich sound at any listening level. There is a stereo headphone output for private listening, an auxiliary input for a tape deck or CD player, an FM-antenna terminal for an external antenna, and a built-in battery system.

CIRCLE 18 ON FREE INFORMATION CARD

The optional extension speaker (model *RS-421*) has an internal 3-watt amplifier and a 5-inch full-range speaker. To accommodate households that run on diverse schedules, the extension speaker has an independent alarm with volume, snooze, and sleep controls, as well as preset-search function.

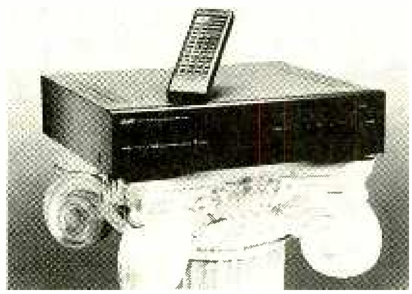
The RS-420 stereo AM/FM clock radio has a suggested retail price of $160.00; with the RS-241 extension speaker, the suggested retail price is $250.00. For further information, contact Proton Corporation, 5630 Cerritos Avenue, Cypress, CA 90630.

CIRCLE 106 ON FREE INFORMATION CARD

SATELLITE RECEIVER

The top of *R. L. Drake's* "Series II Plus" line of deluxe integrated receiver decoders (IRD's) is the model *ESR1424*, which includes the state-of-the-art VideoCipher II Plus descrambler. For trouble-free programming, the unit features a full-function UHF remote control and on-screen programming with color graphics. The remote control also provides access to the "parental lock-out" feature, up to 100 audio and 100 video presets, program-name memory, and a display feature. Programs can even be selected by entertainment category. Depending on the programming source, viewers can enjoy discrete, matrix, or digital stereo sound.

The ESR1424 has a built-in actuator-control system with pulse interface, allowing the user to precisely move the antenna to any of 50 satellite positions with the push of



a button. Operation on either C- or Ku-band is automatic. The remote control provides direct satellite access, and satellite positions are stored in a convenient, non-volatile memory system. The IRD has a built-in VCR timer that is programmable for as many as eight events, selectable audio-bandwidth filters, and a terrestrial-interference filter.

The ESR1424 infrared receiver descrambler has a suggested list price of $1689.00. For more information, contact R.L. Drake Company, P.O. Box 112, Miamisburg, OH 45342; Tel. 513-866-2421.

CIRCLE 107 ON FREE INFORMATION CARD

ALL-IN-ONE SOUND SYSTEM

For those who are intimidated by the cost and complexity of assembling a home-audio system from components, *Casio* has introduced the *MS-450* desk-top audio system. The system includes a compact-disc player, a dual-cassette deck, a semi-automatic belt-driven turntable, an AM/FM stereo synthesized tuner, a full-function wireless remote control, and two-way speaker system. The compact, streamlined unit won't take up too much space in a wall unit or book case.

The system combines state-of-the-art analog and digital audio technology. Its CD player features horizontal slide-load operation, three-beam laser pickup, analog and digital filters, and 2× oversampling. Its functions include 16-track programmability, skip/search in both forward and reverse, repeat of one song or the entire disc, and pause control. The cassette deck allows the user to record from CD, the radio, or another tape. It offers high-speed dubbing, continuous play, and auto-stop in the play-

back and record modes. The tuner has 18 station presets, up/down scan tuning, auto/manual tuning, and a built-in five-band graphic equalizer. The wireless remote controls power, volume, mute, tuner scan, and CD functions.

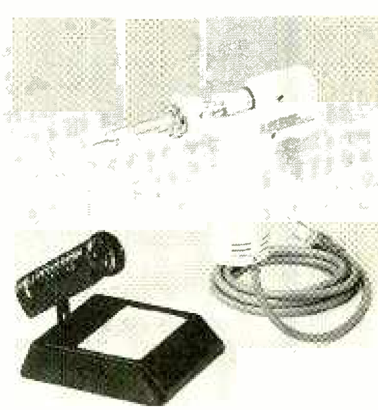
The *MS-450* desk-top audio system has a suggested retail price of $489.95. For additional information, contact Casio, Inc., 570 Mt. Pleasant Avenue, P.O. Box 7000, Dover, NJ 07801; Tel. 201-361-5400.

CIRCLE 108 ON FREE INFORMATION CARD

PORTABLE DESOLDERING GUN

The UL-approved *Soder-Wick SC-5000* from *Solder Removal Company* is a completely self-contained hand-held desoldering gun that conforms with Department of Defense Specification DOD-STD-2000-1B. The portable desoldering gun contains a motorized diaphragm pump that is activated by trigger touch and that has a 15-liter-per-minute capacity. That vacuum-pump design, combined with the device's suction nozzle, produces a 0.1–0.2-second arrival time, with peak vacuum of 600mm Hg. The gun operates from any 120-volt outlet, and no factory air hookup is required. The unit also contains a ceramic heater with built-in thermal sensor that allows it to be used as a hot-air blow gun for shrink tubing and heat checking.

The SC-5000 portable desoldering gun, with medium tip and standard work-station



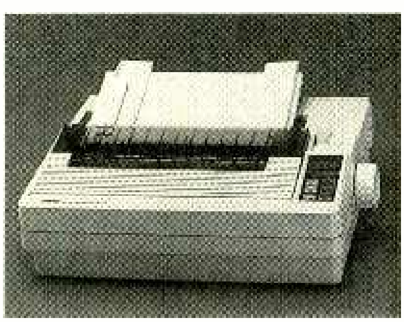
stand, costs $422.50. It is also available with a work station that features an automatic on/off switch for $467.89. The automatic-on/off work station stand can also be purchased separately for $67.89. For further information, contact Solder Removal Company, 1077 East Edna Place, Covina, CA 91722; Tel. 800-767-9425.

CIRCLE 109 ON FREE INFORMATION CARD

COLOR DOT-MATRIX PRINTER

A narrow-carriage, 24-wire printer from *Tandy*, their model *DMP 240*, features color-printing capabilities and print speeds up to 192 characters per second. With built-in IBM Proprinter X24 and Epson LQ printer emulations, the DMP 240 offers high-quality word-processing and data-processing modes. In addition, it provides 24-wire graphics capability at a resolution of 360 dots per inch. The included color motor kit allows the user to add color text or graphics simply by installing the optional four-color fabric ribbon. Using the Epson LQ emulation mode, many widely available software packages that support printing of up to eight solid colors can be used.

The built-in, reversible push/pull tractor feed, which features automatic paper advance for tear off, handles paper and forms with equal ease. Fanfold paper and forms



are not wasted, as paper is advanced to the tear-off position at the end of printing and automatically returns to the print position when printing resumes. A "paper-park" function allows fanfold paper or forms to remain in the printer while single-sheet paper or envelopes are printed.

The printer provides four letter-quality fonts—Roman, Sans Serif, Courier, and Prestige—all in 10, 12, and 17.1 characters per inch. Font and menu selection, and other printer features, are controlled via a front-panel, push-button LCD. In addition, macro facilities allow the user to store four different printer configurations in memory. To allow the continued use of the computer during printing, The DMP 240 stores up to 8,000 characters in its built-in memory; an optional 32-kilobyte memory upgrade is available as well. The printer can be connected to any PC-compatible computer using the standard IBM parallel-printer port.

The DMP 240 color dot-matrix printer (catalog no. *26-2839*) and optional four-color ribbon (catalog no. *26-2826*), are available at suggested retail prices of $549.95 and $29.95, respectively, at Radio Shack Computer Centers and participating Radio Shack stores nationwide. For additional information, contact Radio Shack, A Division of Tandy Corporation, 700 One Tandy Center, Fort Worth, TX 76102.

CIRCLE 110 ON FREE INFORMATION CARD

MARINE EMERGENCY RADIO

A handheld VHF marine emergency radio from *Midland*, the "Ready Rescue" model *78-300*, is designed for use on any boat, whether or not that boat is equipped with a conventional VHF radio. The radio has a snap-on battery-pack that allows distress calls to be placed should the boat's battery fail. Operators have all 55 U.S. channels available, or the unit can be converted to cover all 55 international channels or all

Canadian channels. Ten marine-weather channels provide 24-hour weather reports. The Ready Rescue's advanced features include ETR frequency control for precise channel selection, fully variable squelch, a four-stage electronic meter to measure incoming signal strength and output power, instant access to Channel 16, and a noise filter that reduces or eliminates noise pulses from boat motors. When operating in-harbor, the 78-300 can be switched to low power to conserve battery strength. It also features dual-speed up/down channel selection, digital channel readout, and a double-layered heat sink for long life.

The model 78-300 Ready Rescue marine VHF radio has a suggested list price of

New Products

$269.95. For further information, contact Midland International, Consumer Communications Division, 1690 North Topping, Kansas City, MO 64120; Tel. 816-241-8500.

CIRCLE 111 ON FREE INFORMATION CARD

IN-VEHICLE CELLULAR ANTENNA

Designed to be mounted on a window *inside* a vehicle, *ORA Electronics' CMX760* is a full-featured 3-dB cellular antenna that requires no outside parts. The "Full Spectrum Thru Glass" antenna features unique ground plane radials that resemble wings, and has a low SWR and wide bandwidth. Inside installation reduces the possibility of theft or vandalism, and protects the antenna from being damaged in harsh weather or in automatic car washes.

The CMX760 in-vehicle cellular antenna, including 12 feet of cable, two TNC connectors, and a limited lifetime warranty, has a suggested retail price of $99.00. For more information, contact ORA Electronics, 9410 Owensmouth Avenue, Chatsworth, CA 91311; Tel. 818-772-2700.

CIRCLE 112 ON FREE INFORMATION CARD

INTERFACE CONVERTER

Telebyte's model *63-2* RS-232-to-RS-422 interface converter supports full-duplex transmission from an RS-232 port while providing the necessary conversion circuitry to accommodate the differential input and output required by RS-422. RS-422, which was designed to overcome the speed and distance constraints of RS-232, uses differential-signaling techniques to provide the capability of driving a twisted-pair transmission line 4000 feet at 38,400 bits per second. The model 63-2 can support data rates

as high as 38,400 BPS, and can support Pin 2, TD (transmit data) and Pin 3, RD (receive data) RS-232 interface signals. Those signal can be interchanged using the unit's DTE-DCE selector switch to allow interfacing to CRT terminals, modems, or computers. "TD" and "RD" LED's indicate the unit's operating status. Power is supplied by a wall-mounted transformer.

The transmission cable used to connect the RS-422 ports together can exhibit different impedances depending on the type used. The model 63-2 features a two-position dip switch used to program termination to match the cable impedance, which reduces reflections and ringing. The impedance can be set to 200, 120, or 75 ohms, or left as an open circuit.

The model 63-2 interface converter costs $110.00. For more information, contact Telebyte Technology Inc., 270 Pulaski Road, Greenlawn, NY 11740; Tel. 800-835-3298 (in NY, 516-423-3232).

CIRCLE 113 ON FREE INFORMATION CARD

HAND-HELD CELLULAR PHONE

With all the cellular electronics and the transceiver built into its trimmed-down handset, *Audiovox's CTX-4500* 0.6-watt hand-held phone is totally portable. It is small and light enough to be carried in a briefcase or pocketbook, and can be used in practically any location. The phone's built-in battery system provides eight hours of standby and one hour of talk time. The phone comes with a spare battery, and small, rechargeable, plug-in battery cartridges are available optionally. Another option is a 3-watt base cradle that allows the phone to be used in a boat, car, or RV. The CTX-4500 also features 16-digit repertory memory, end-to-end signaling, last-number redial, on-air call timers to keep track of accumulated time and number of calls, and multi-city registration.

The CTX-4500 hand-held cellular telephone has a suggested retail price of $1,295.00. For additional information, con-

(Continued on page 20)

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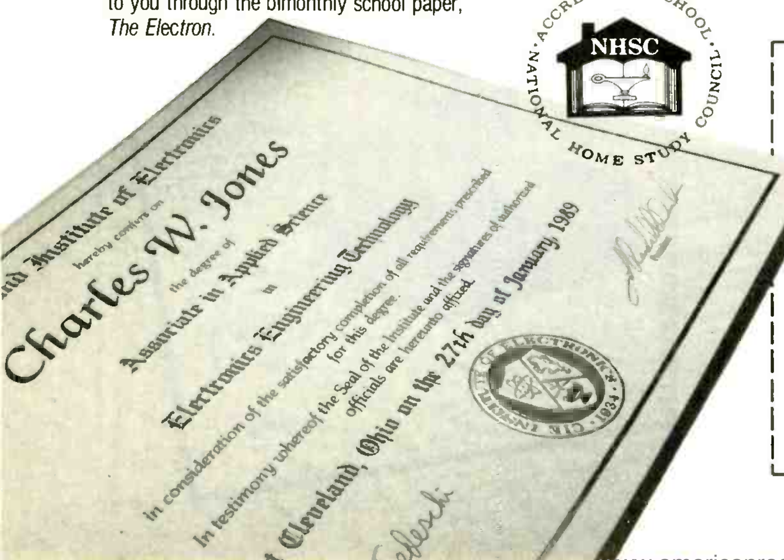

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MULTI-FUNCTION WIRE ANALYZER

A single tester that performs several valuable circuit checks—*Polytronics' SureTest Pro* wire analyzer—quickly, easily, and accurately pinpoints problems common to electrical circuits, and even pinpoints which conductor has the problem. The fully portable, hand- held instrument tests for current-carrying capacity with a built-in 15-ampere load. SureTest applies the load and determines if the voltage drop is less than 5%, as recommended by the National Electrical Code. The unit also checks circuits for voltage level, ground resistance, neutral-ground leakage, false grounds, wiring connections, and operation of ground-fault circuit interrupter. Intended for use by electricians, electronic equipment installers, and anyone who requires reliable information on electrical circuits, the SureTest Pro does the work of several individual testers. It features an easy to interpret go/no-go format, automatic test sequencing, microchip solid-state circuitry, and a retractable ground pin. Its proprietary circuitry avoids fuse of defect overheating during testing. An accessory kit is available optionally.

The SureTest Pro multi-function wire analyzer has a retail price of $179.95. For more information, contact Polytronics, 273 Vulcan Street, Buffalo, NY 14207; Tel. 800-442-3462.

CIRCLE 115 ON FREE INFORMATION CARD

PORTABLE ALARM

Featuring a built-in flashlight for safety and convenience, *Arkon Resources' Arkor Portaguard II Personal 4-in-1 Guard* motion detector and alarm is intended for use at home, in hotel rooms, at the office, or any place where an alarm is needed.

The battery-operated, portable security device employs a passive infrared sensor that has a detection distance of up to ten feet. When the sensor is activated, the Portaguard II will automatically sound a loud buzzer alarm or illuminate the area with light, depending on the switch setting. The device can also be used as an emergency hand-held flashlight or as an automatic night light that provides instant illumination when motion is sensed—for example, when the user gets out of bed at night.

The streamlined Portaguard II measures 7 × 2¾ × 1½ inches and weighs less than a pound with three "C" batteries installed. Those batteries provide approximately six

months of power under normal use. The device comes with a wall-mount holder and a spare bulb for the flashlight.

The Arkor Portaguard II (model *PP-300*) has a suggested retail price of $49.95. For additional information, contact Arkon Resources, Inc., 11627 Clark Street, Suite 101, Arcadia, CA 91006; Tel. 818-358-1133. ■

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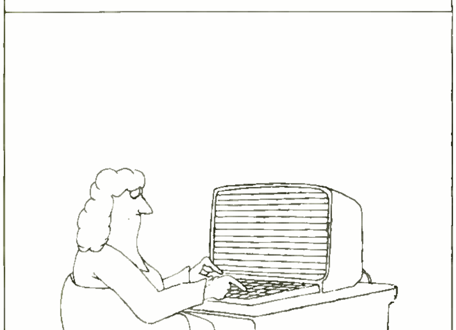

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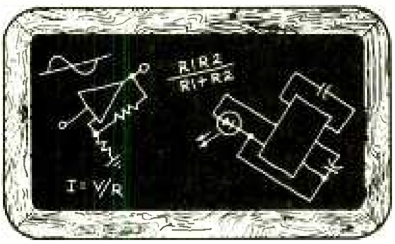


Think Tank

By Byron G. Wels, K2AVB

TWO FOR ONE!

I was right. A lot of you missed that puzzle last month, so here's the answer: He simply asked, "Which is the way to *your* village?" If he was talking to one of the nice chips, he'd get a truthful answer and would be safe. If it was a bad chip, the chip would have to lie, thereby directing him to the safe village. See? You have to apply the powers of deductive reasoning!

And just to keep the old ball rolling, we have an offering from Dwight Eggleston, a retired electrical worker from Hendersonville, NC. Dwight tells about the time the foreman explained that they had to wire a circular night club, and had ten lighting fixtures that had to go on the ceiling. The boss explained that he wanted a symmetrical pattern, consisting of five rows of lights, with four fixtures in each row. "But boss," explained Dwight, "four times five is twenty, and you only gave me ten fixtures."

"Dwight," the boss replied, "You can do it!"

Dwight dood it. Can you? If you can, send me your layout. I'll show you how in the next issue.

We're still looking for good schematics, so if you've got a pet circuit, please send it in. We'll reward you with a copy of our Think Tank Book. Make sure that you draw the schematics clearly and *please* indicate all component values (1 μF, 10k, 10 μH, etc.) and part numbers (1N914, 2N3904, MC1458, etc.) directly on the diagram. In addition, it would also be helpful if you would indicate junctions (connecting points) with a dot at each point. Omissions of that nature will disqualify your efforts.

Some Great News! I just came from a meeting with our Publisher, Larry Steckler. From here on, we're going to be publishing not only the best circuits our readers can come up with, but to make life a little easier all around, we're now going to be accepting "Helps & Hints" as well! We'll publish them and reward the submissions with copies of the Think Tank book. Now what constitutes a Help or Hint? Any idea that you've used to make your work in our hobby easier. Here's an example: Slip a small rubber grommet over one handle of your long-nose pliers, slide it all the way up, and the pliers will automatically open. The grommet is sufficiently flexible that you can still apply pressure to the handles to make the jaws close.

Now if you've been holding off because you can't come up with a circuit that you think is worthy, you've just lost your last excuse!

On the down side, I've gotten word that some of our readers have been copying circuits from books or other magazines and submitting them to us as original. This is called *plagiarism* and it's illegal. If the original developer of that circuit sees it in print here, you can be sued to a fare-thee-well! Believe me, it isn't worth going through for a free book.

I also wanted to remind you once more about our Think Tank books. Think Tank II is now available, and you can buy it for $3.00. Ask for #169A. And Think Tank I (#169) is still available at $3.50. If you order both at the same time, you'll save fifty cents. The price for both is $6.00. Please include $2.00 for postage and handling and New York residents add applicable sales tax. You can order from **Popular Electronics**, Reprint Book Store, 500-B Bi-County Blvd., Farmingdale, NY 11735.

Now let's see what's been keeping you people busy all month!

Theft Preventer. "I just blinked my eye for a second!" According to police, that's what most people say when reporting the theft of a car stereo. Chances are that you're insured and will recover the cost of the unit, but the inconvenience of driving around in silence while you wait for all the paperwork to be processed is one heck of an inconvenience.

Most modern units are designed to pull-out so you can easily remove the stereo and lock it in your car's trunk when you're away from the car. That word "inconvenience" shows up again. It's a lot easier to leave the stereo there and keep your fingers crossed. My circuit (see Fig. 1) will sound the car's horn continuously if anybody removes the stereo. Once triggered, it can be turned off *only* by opening S1, which is concealed under the dash. The SCR can be any type rated for 25 PIV (Peak Inverse Voltage) at 15 amps or better.

How does it work? Positive voltage appears across the horn button when that switch is open. This will be applied to the SCR's anode when S1 is closed. But without the positive triggering voltage at the SCR's gate, the SCR will not switch on. Since the gate pin is grounded to the car's chassis, it will stay in the off condition. This grounding takes place through the stereo unit, so when the stereo is removed, the gate pin becomes ungrounded. Resistor R1 supplies a positive triggering voltage to the gate, activating the SCR. Immediately, the horn sounds and continues to do so until switch S1 is opened. The TEST BUTTON, switch S2, is an option. If you want to, include it as a test for the SCR. So what do you think By? Have I got a book coming?

—*Arnel S. Traje, Aboard the USS Alamo*

On the way, Arnel! I just don't know what you're doing with a car on board a ship. Of course, thinking readers will realize that this system can easily be expanded to protect other valuables in a car as well.

Versatile Charger. By, I always look for the circuits you offer and usually find them useful and all of them interesting. Although the simple circuit shown in Fig. 2 has proven useful in several of my projects, it was originally used as a constant-current source for rapidly charging NiCd batteries. As a matter of fact, R1 and R3 aren't really needed. Resistor R1 can be chosen to meet your current needs by dividing 0.6 volt by the current in amperes. For example, if you wanted a 20-mA current limit, you would divide 0.6 volt by .02 ampere, which works out to 30 ohms.

Resistor R2 can have any value from 15K to 100K. Resistor R4 can have a value ranging between 4.7K to 47K. As the value of R4 is reduced, current increases and could be used as a fine adjustment to get just the right amount of current. A 2N3906 general-purpose

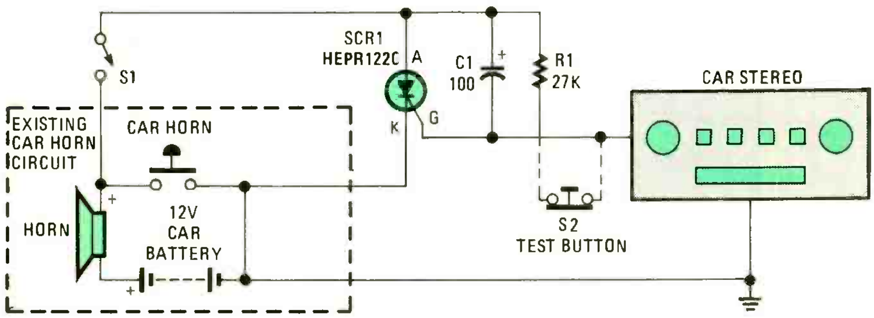


Fig. 1. This theft-deterrent circuit—actually little more than an SCR—is designed to use the existing horn circuit in your car to scare-off would-be burglars.

PNP transistor should be used for Q1; Q2 should be chosen to handle the desired current and should have a good gain. For currents up to 100 mA, a pair of 2N3906 units configured as a Darlington should do nicely, and for currents up to a couple of amps, try a TIP125 with an adequate heat sink.

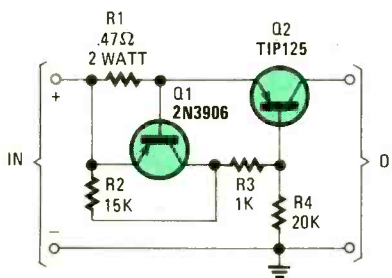


Fig. 2. This NiCd-battery charging circuit, consisting of two transistors and four resistors, can be modified to shut down automatically when the battery is fully charged.

The unit can be made to shut down by adding a transistorized or mechanical switch in series with R4 and ground. If that addition is made, resistor R2 provides current to the base of Q2 to ensure shutdown and should be included.

By the way, if you're drawing over 300 mA, take the current in amps, multiply it by 1.5 and choose the next-higher wattage for resistor R1.

Hope you can chop this to fit, as I'd like to find out what's in the Fips book!

—*Marc Young, Phoenix, AZ*

Sorry Marc! We're all out of Fips books. I'm sending you a Think Tank book instead. Hope that you like it.

Auto-Cad-Zapper. After leaving a NiCd battery uncharged for over a year, I figured it was time to recharge it. I hooked it up, but the cell wouldn't charge. I remembered a circuit that would remove internal shorts, and looked it up. The circuit consisted of a large-value capacitor, which was charged from a DC source, and a pushbutton switch that when pressed, would dump the capacitor's charge across the NiCd cell.

I built the circuit, connected the NiCd battery and began pressing the switch at consistent intervals. After a few minutes of push-push-push-push, I decided to automate my circuit. I used an astable pulse generator. You can see my circuit in Fig. 3.

Without going into all of the details about the 555 timer, the components and configuration provides negative

THINK TANK

pulses of about 0.1 second in duration with a repetition rate of about one per second (1 Hz). While the timer output is high, the PNP transistor and the SPDT relay are off and the capacitor charges through the resistor and the normally-closed relay contacts. When the timer output goes low, Q1 turns on, energizing the relay. With the relay energized, the wiper (center contact) of K1 is pulled to its lower, stationary contact, dumping the capacitor's charge across the NiCd cell. From there, the process repeats.

I built the circuit, connected the NiCd cell, turned it on, and let it go. Soon the battery was charged and has worked well ever since. I'm not lazy. I just have better things to do with my time (such as reading Think Tank) than sitting around pushing buttons.

—Dwayne Jones, Roanoke, AL

Dwayne, you got me to thinking about how many other applications might there be where a switch has to be constantly operated. What a unique application this is.

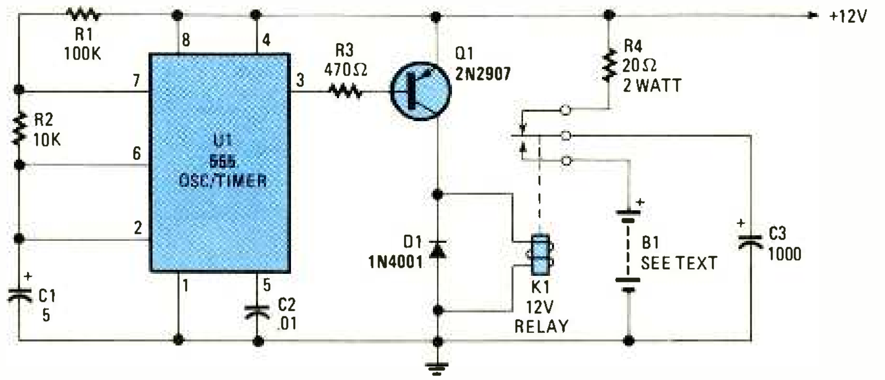


Fig. 3. The Auto-Cad Zapper—a likely companion to the NiCd charge circuit—is designed to restore NiCd cells to their original charge capacity.

Block Signalling System. I came up with a nifty idea for my model railroad. I wanted to put in a working block-signalling system for that authentic look. I applied a bit of relay logic and what evolved was a circuit that is easy to build and works very well.

A schematic diagram of the circuit is shown in Fig. 4. Each block signal has red, yellow, and green lamps to indicate track conditions. A minimum of three signals are used in a closed-loop configuration. Any number of additional signals can be put in place by simply adding relays. Switches S1, S2, and S3 can be any sort of train-detection switches (reed, micro, etc.) mounted beneath the track and adjacent to the signal light.

When S1 is made, relay K1 (a DPDT unit) energizes via the normally-closed contacts of K2 and is held in that position through one set of its own contacts. Relay K1's normally-open contacts will close, applying power to the red lamp of SIGNAL 1, the green lamp of SIGNAL 2 and the yellow lamp of the preceding sig-

CORRESPONDENT CLASSICS

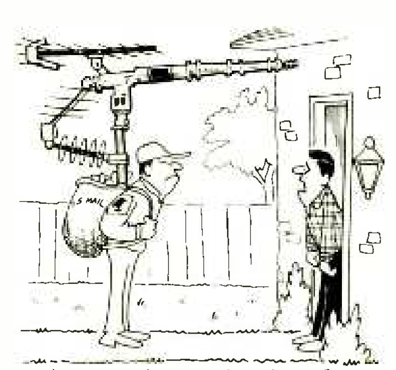
by JACK SCHMIDT

"That plain brown wrapper better be your electronics correspondence course!"

"It's my TV course from 'All-America School.' The parts are Korean; the computer, Japanese; and the manual, French."

"It's not a pizza—one of our trucks backed over your TV-repair lesson."

"What do you think, Marvin, does that void the warranty?"



"When the company said they'd mail it, I thought it would be in a box!"

nal (in this case, SIGNAL 3). When the next switch (S2) is closed, K2 energizes and holds similarly, dropping power to K1's coil, causing SIGNAL 1 to change from red to yellow; SIGNAL 2 now turns red and SIGNAL 3 turns green.

The entire sequence changes in the same manner from signal to signal, as each switch is made by a passing train. Switch S4 is a normally-closed pushbutton switch used to reset the whole system by momentarily interrupting the supply voltage. In my case, I used 6 volts to power the system, but any DC voltage can be used provided that the lamps and relays are of the same voltage rating. Simple as it is, it works just like the real ones, and I hope it rates a Fips book!

—*Marc Barbani, Granada Hills, CA*

Marc, we used to say that if you scratch an electronics nut, you'll find a photographer. The way the mail has been indicating however, it seems that scratching an electronics nut these days, reveals a model-train aficionado! And sorry Marc, we're out of Fips books. I sent you a Think Tank book.

Keypad Sequential Switch. I use this circuit (see Fig. 5) to arm the security system in my home. It's a sequential-type switch that must be sequenced in the proper order. What's more, it must be sequenced in the time frame provided by the RC time constant on transistors Q1–Q3. That is to say, when S1 is closed, C1 begins to charge via the +5-volt supply bus. When S1 is released, the charge on C1 is bled off through R1, causing Q1 to conduct.

The length of time during which Q1 conducts is determined by the RC time constant in that portion of the circuit; for example, with the values shown for R1 and C1, the time constant on Q1 would be: $10K \times 33\ \mu F = .33$ second. The same holds true for the two other transistor circuits (Q2 and Q3). And because the emitter-to-collector circuits of those three transistors are connected in series, the entire unlock sequence must be keyed in before the first RC circuit has timed out.

If the proper sequence is keyed in within the set interval, power is supplied to the bounce-free switch (Q4 and its support components) so that when S4 is pressed, the JK flip-flop toggles, activating Q5, which in turn energizes the relay.

Although the circuit was originally designed as an external keypad, it can also be used in any of a hundred applications where a time-dependant electronic combination lock/switch is needed. All transistors are general-purpose 2N2222 units. I hope this qualifies for a copy of the Fips book!

—*Marshall A. Tappe, Shreveport, LA*

Sorry about that Marshall! You're just a bit late. However, I am sending you a copy of our Think Tank book.

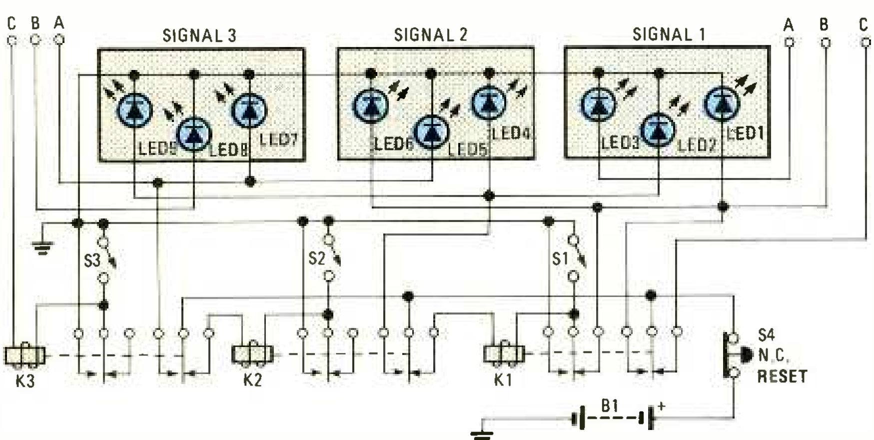


Fig. 4. This model-train Block-Signalling System will give your model railroad operations a more realistic look.

Sound Effects. It almost happened by accident, but we connected a pair of 555's (see Fig. 7) and came up with a stable full of sound effects, including bird chirps, Star Wars, and ambulances! What we really have here is a dual astable circuit; one running at 1 Hz and the other at about 100 Hz. Integrated circuit U1 is powered by a 4.75-volt source and U2 is powered from an 8-volt source. The entire circuit consumes about 50 mA, and if you use single 9-volt battery

(Continued on page 27)

"Where can I turn for help?"

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(Continued from page 25)

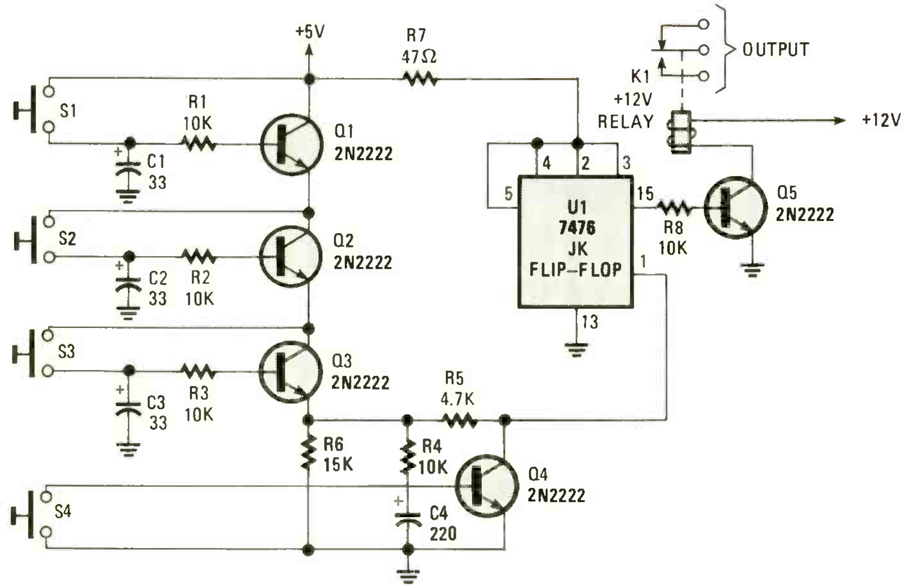


Fig. 5. This Keypad Sequential Switch is a simple and inexpensive way to add an electronic combination lock to your security system.

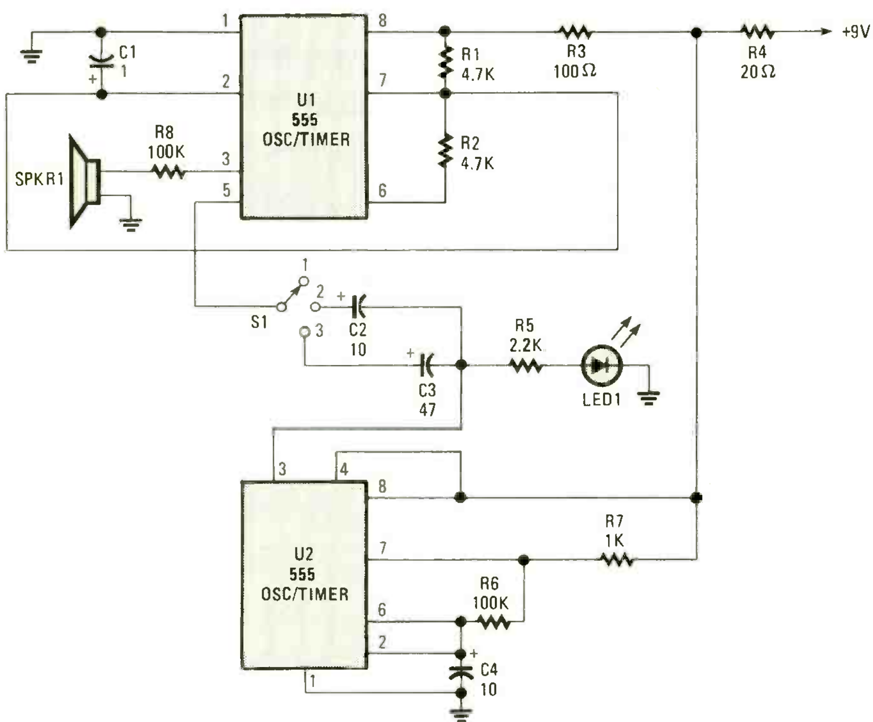


Fig. 6. Built around a pair of 555 oscillator/timers, this Sound-Effects generator can produce bird chirps, Star Wars, and ambulance sound effects!

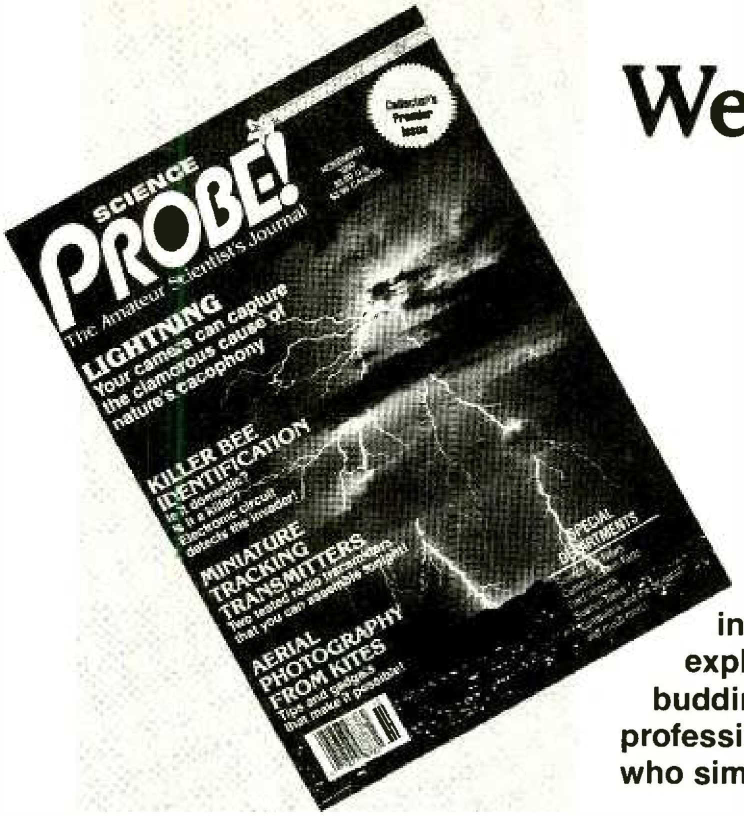
as the power supply, you can use a 20-ohm resistor for the required voltage drop.

With S1 in POSITION 1, the 1-Hz oscillator distorts the supply voltage, thus creating the ambulance sound. When S1 is set to POSITION 2, a bird-chirp sound is produced, and in POSITION 3, the VCO is held on for a longer time, causing an overlapping frequency and sweep, which creates a Star-Wars type sound effect.

—Fernando Afable, Vancouver, B.C., Canada

Nice job, Fernando!

Remember to send your ideas, schematics, and Helps & Hints to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■



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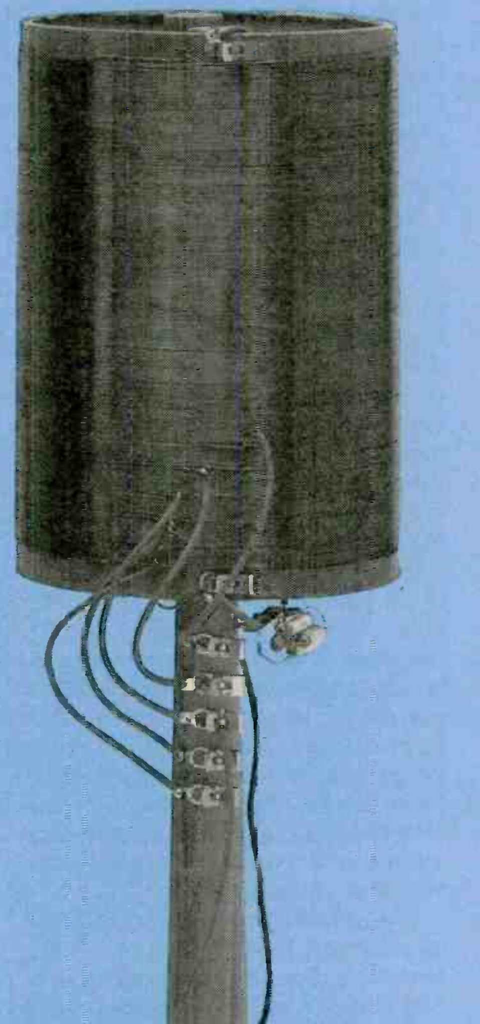
Popular Electronics®
JULY 1990

BUILD A VLF TRANSMITTER AND RECEIVER

Explore the world below 10 kHz with this experimental VLF receiver/transmitter pair

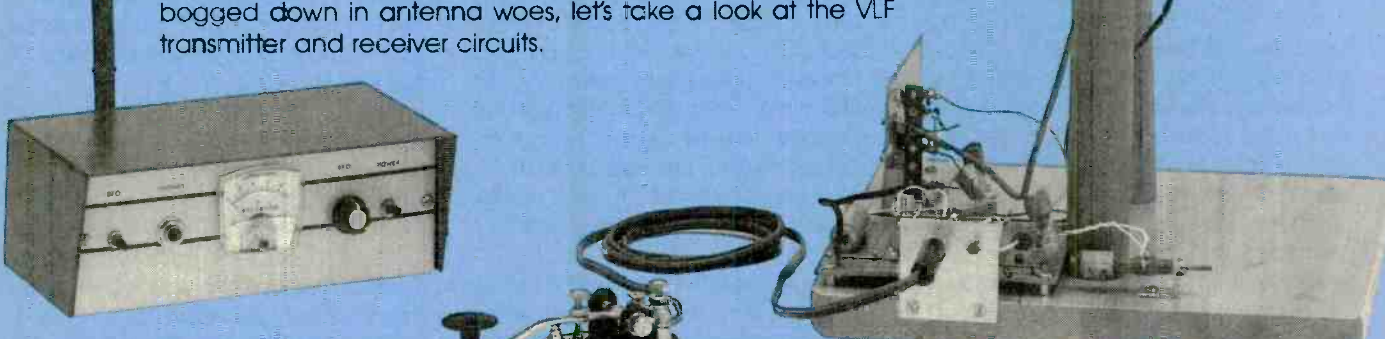
BY CHARLES D. RAKES



The increasing demand for additional communication frequencies has pushed the usable RF spectrum so far into the gigahertz range that it is approaching the infrared region. However, left behind is a narrow but fascinating piece of the RF turf at the very bottom of the RF spectrum that's wide open to pioneering electronic experimenters.

All frequencies below 10 kHz are considered audio and are not thought to be a useful medium for wireless communications—but, don't You believe it! By duplicating the *VLF Transmitter And Receiver* described in this article, you'll be able to send and receive Morse code and remote-control commands over a distance of a quarter mile or more.

One of the more difficult problems facing the VLF experimenter lies in building a suitable antenna system. For instance, a simple ¼-wavelength vertical antenna for 10 meters is small enough to be mounted to the bumper of the tiniest sport car, but a ¼-wavelength antenna for 10 kHz would reach about 1 mile high. Of course, there are a number of electronics tricks we can play to get us around that limitation. But before we get bogged down in antenna woes, let's take a look at the VLF transmitter and receiver circuits.



WARNING!! The publisher makes no representations as to the legality of constructing and/or using the transmitter referred to in this article. The construction and/or use of the transmitter described in this article may violate federal and/or state law. Readers are advised to obtain independent advice as to the propriety of its construction and the use thereof based upon their individual circumstance and jurisdiction.

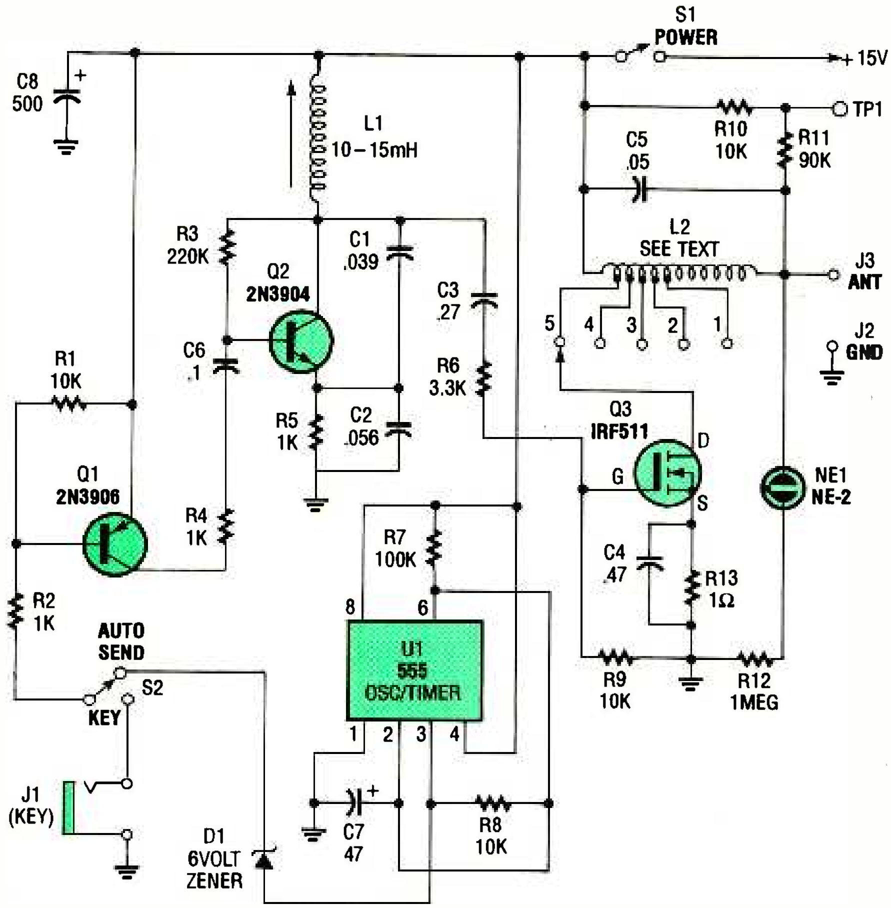


Fig. 1. The VLF Transmitter circuit is built around three transistors and a single 555 oscillator/timer, and requires an external 15-volt, 1-amp power supply. Transistor Q1 functions as a keying device, Q2 is configured as an inductor-tuned Colpitts oscillator, while Q3 is essentially an electronic switch.

VLF Transmitter. A schematic diagram of the VLF transmitter is shown in Fig. 1. The circuit, centered around three transistors and a single 555 oscillator/timer, can produce 5 to 10 watts of output power at a frequency of 8 to 10 kHz. The circuit requires an external 15-volt, 1-amp power supply.

Transistor Q2 (a 2N3904 general-purpose NPN unit) is connected in an inductor-tuned Colpitts oscillator. Components C1, C2, and L1 determine the operating frequency of the oscillator. Transistor Q1 functions as the keying device to turn the oscillator on and off. When the base of Q1 is tied to ground through either the key or the auto-send circuit (more on that later), its collector pulls the base of Q2 to ground, causing the circuit to oscillate.

The oscillator output at the collector of Q2 supplies the drive signal for the gate of Q3 (an IRF511 power hexFET). The drain of Q3 is connected to a tap on L2 (the transmitter's tank coil) to complete the current path to the positive supply. Inductor L2 allows for better matching when tuning the transmitter and/or experimenting with different antenna systems. Capacitor C5 is used to tune the tank circuit to the frequency of the oscillator.

Integrated circuit U1 (the 555 oscillator/timer) is configured as a low-frequency oscillator, which produces a 1-second on/1-second off output at pin 3 to key on the oscillator through Q1 for the auto-send beacon signal. The auto-send beacon signal is much easier to locate and identify in a noisy RF environment than a continuous carrier signal. The beacon signal also helps when testing the VLF system for its maximum operating range.

An oscilloscope or AC voltmeter can be connected to the circuit at test point TP1 to monitor the transmitter's output level during tune up and checking antenna loading.

The VLF Receiver. Figure 2 is a schematic diagram of the VLF receiver circuit. That circuit—built around a quad op-amp IC and two transistors, which work together to select, amplify, and detect the VLF transmitter's signal—is slightly more involved than the transmitter circuit.

The RF signals picked up by the antenna are sent to the tuned input circuit (consisting of L1 and C4) through either C1 or C2. The tuned RF signal is then fed through C3 to the input of a high-impedance isolation amplifier (U1-a), which provides a voltage gain of 1. The output of U1-a is then fed to U1-b at pin 6, where it is amplified, producing an output that's up to 50 times the input, depending on the setting of the RF-gain control, R15. The output of U1-b is fed to U1-d, the last RF-gain stage, which amplifies the signal by a factor of 10.

The output of U1-d at pin 14 is fed to the input of a simple transistor detector circuit (centered around Q1). The detector circuit supplies sufficient audio-output power to drive a pair of headphones through J1. That signal voltage is also converted to DC by a voltage-doubler circuit made up of C8, C9, D1, and D2. The resulting DC voltage is used to drive a signal-strength meter (M1) through transistor Q2 (which is configured as an emitter-follower amplifier).

Because the VLF transmitter sends out CW signals only, the receiver requires a BFO (Beat-Frequency Oscillator). The output of the BFO is mixed with the incoming signal so that the detector circuit (Q1) can supply an audio tone to the headphones. Op-amp U1-c and its associated components make up a tunable oscillator that serves as the circuit's BFO.

Building the VLF Transmitter. Since the circuit isn't complicated and the layout requirements are non-critical, you can use just about any construction method desired. The author's prototype of the transmitter was assembled breadboard style on an 11- × 11- × 1-inch wood base. Transistors Q1 and Q2, as well as the 555 oscillator/time and their associated components, are mounted on a section of perfboard measuring 4 × 5 inches.

A heat sink made from a piece of 1⁄16-

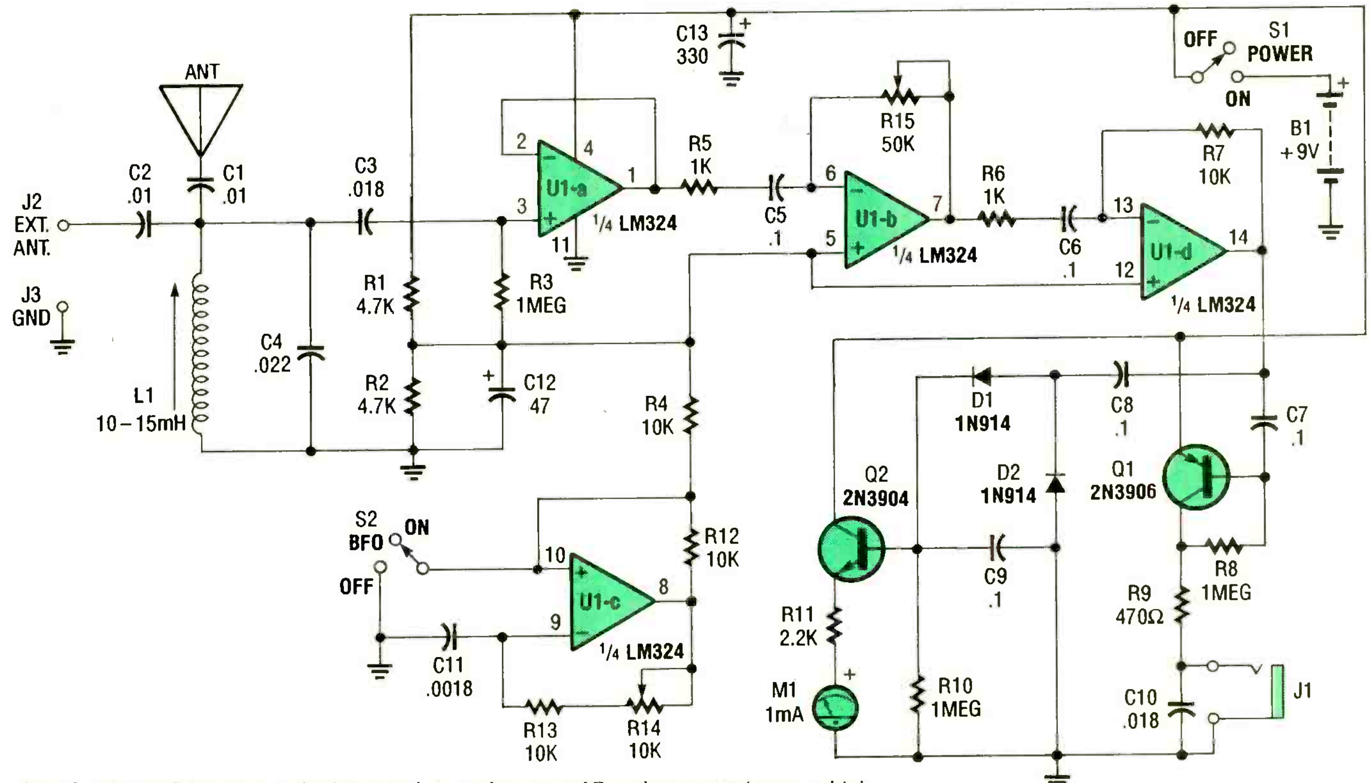
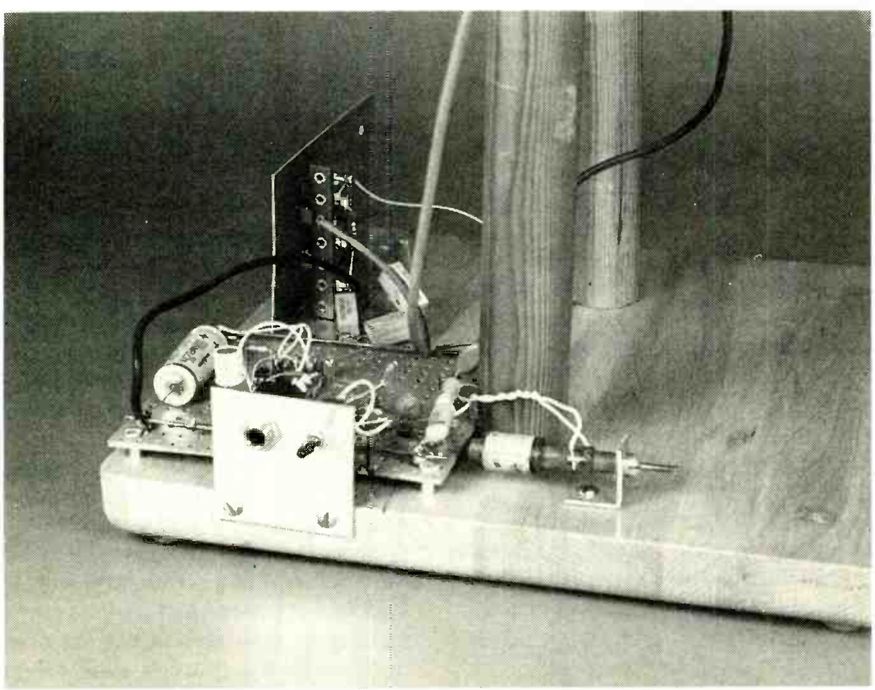


Fig. 2. The VLF Receiver is built around a quad op-amp IC and two transistors, which work together to select, amplify, and detect the VLF transmitter's signal.



A major portion of the VLF transmitter circuit was assembled on a section of perfboard measuring 4¼ × 4¾ inches. The remaining circuit components—switches, coils, Q3 (the IRF511 hexFET)—were mounted on the wooden baseboard, and wired to the perfboard-mounted components.

inch aluminum (measuring 4 × 5 inches) keeps the hexFET cool. A 1-inch, 90-degree bend at one edge of the heat sink makes mounting it to the breadboard a breeze. A 5-lug solder-terminal strip was mounted to the heat sink to support R9, R13, C4, and the jumper wire from the drain of Q3 to the tapped coil.

Inductor L1 was mounted to the base with a small aluminum "L" bracket, and J1 and S2 share another similar bracket. Switch S1 was omitted in the prototype. Rubber feet are mounted on the underside of the breadboard.

Inductor L2 was wound on a 7¾-inch diameter by 11¼-inch long cardboard tube that was removed from a large wire spool, but any similar size non-conductive form will do. The exact coil-form size or the number of turns used won't make too much difference as the coil will be tuned to the desired frequency by selecting the value of C5.

In any case, though, it's a good idea to stay as close to the suggested dimensions and wire size as possible. Make a light mark on the coil form at the locations indicated in Fig. 3, starting ¾ inch from the form's bottom edge, and every ½ inch until 5 marks are made. Also make a mark ½ inch down from the top of the form. At the bottom mark, drill two holes within ¼ inch of each other. Do the same thing at the top of the form. Make sure that the holes are just large enough for the wire to pass through. Those four holes are used to keep the coil winding in place.

Using 18-gauge enamel-coated copper wire, thread one end of the copper wire through the two start holes at the bottom of the form (see Fig. 3) and start winding the coil. At the first ½-inch mark, make a ½-inch twisted loop in the wire for the first tap. Repeat that procedure at the next four ½-inch marks to complete the five coil taps,

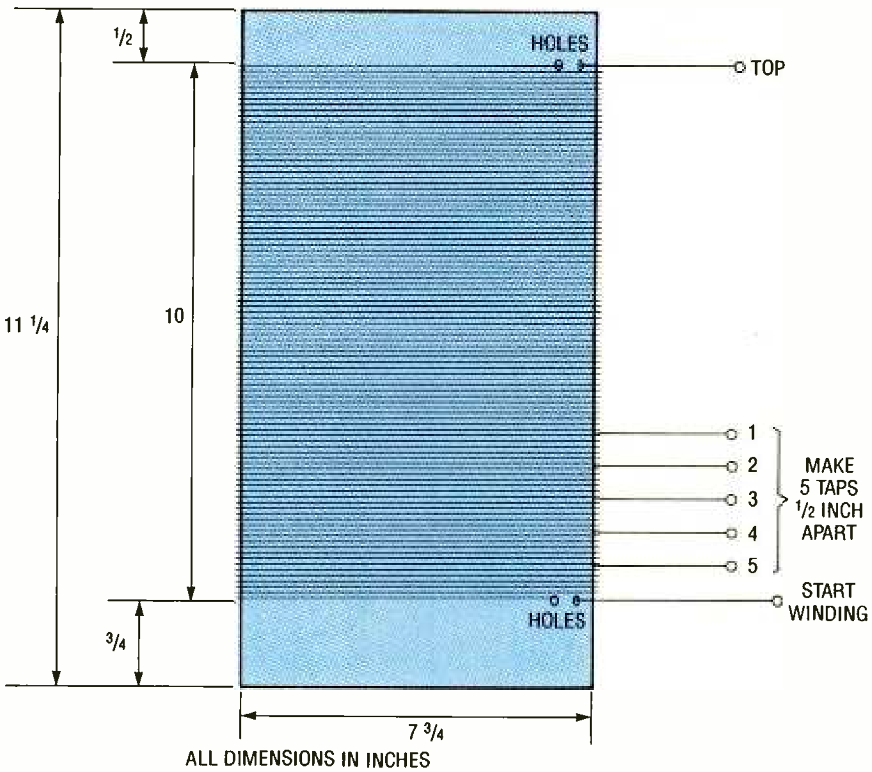


Fig. 3. Winding the large transmitter coil (L2 in Fig. 1) isn't too difficult. Simply mark the coil form as shown here, drill holes at the appropriate points on the form, and wind it, making five taps in the coil at the points indicated.

then finish winding the coil. The finished coil should have about 236 turns.

The coil is then mounted to two 25-inch lengths of 1¼-inch wood-dowel rods. The coil/dowel assembly is then mounted to the baseboard. After mounting the coil/dowel assembly, seven large Fahnestock clips (or other spring-tension terminals) are then mounted to one of the dowel rods. The Fahnestock clips are used as termination points for the two coil ends and the tap connections.

Firing Up the Transmitter. Temporarily connect Q3's drain to the middle tap of L2 through a 100-ohm, ½-watt resistor, and connect C5 across L2. The 100-ohm resistor helps to keep Q3's drain current low during the initial tune up. Capacitor C5 may consist of a number of high-voltage capacitors (with a rating of 800 to 1000 WVDC) wired in parallel to provide an equivalent capacitor value of about .05 µF. The actual operating frequency of the circuit isn't too important, as long as it falls somewhere between 8 and 10 kHz.

Use an oscilloscope (or AC voltmeter) to monitor the transmitter's output at TP1. If a frequency counter is handy, connect it to the emitter of Q2 to keep track of the oscillator's actual operating frequency during tune up.

Temporarily connect a jumper across J1, place S2 in the KEY position, and apply power to the circuit; the oscilloscope should indicate an output of 1-volt peak-to-peak or more. Adjust L1's tuning slug for the maximum output, which should be over 8-volts peak-to-peak. Remove the 100-ohm resistor from the drain lead of Q3, connect Q3's drain lead directly to the coil's tap, and fine tune L1 for the maximum output; you should get a reading of more than 30 volts peak-to-peak.

Next, remove the jumper from J1, flip S2 to the AUTO-SEND position, and the scope should show the beacon's interrupted output signal. The final transmitter-output adjustment must be made using the receiver as a field-strength measuring instrument, so it will be necessary to lay the transmitter to one side for now and move on to the receiver.

Building the VLF Receiver. The majority of the receiver's active components are mounted on a 3½- by 4½-inch piece of perfboard, and is housed in an 8- × 4- × 3-inch metal cabinet to reduce AC hum and low-frequency RF-noise pick up. The potentiometers, switches, meter, jack, and the remaining parts are mounted to the front and back panels of the cabinet. If you go the perfboard-construction route, be sure to use a socket for the IC, and keep all interconnecting wires short and neat. Even at such low frequencies, a poor wiring job can adversely affect the operation of the circuit.

To tune the receiver, set R15 to its mid point, plug in a pair of headphones, and turn on the power. If everything is functioning properly, you'll hear a low-level frying sound. Move the antenna toward a fluorescent light fixture that's operating and the noise level should increase considerably.

Now power up the transmitter with S2 in the manual KEY position and key on. Move the receiver toward the transmitter; when M1 indicates a reading of about ¼ to ½ of the meter's full scale deflection, adjust L1's slug for a max-

PARTS LIST FOR THE VLF TRANSMITTER

SEMICONDUCTORS
U1—555 oscillator/timer, integrated circuit
Q1—2N2906 general-purpose PNP silicon transistor
Q2—2N2904 general-purpose NPN silicon transistor
Q3—IRF511 power hexFET
D1—6-volt Zener diode

RESISTORS
(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R8–R10—10,000-ohm
R2, R4, R5—1000-ohm
R3—220,000-ohm
R6—3300-ohm
R7—100,000-ohm
R11—90,000-ohm
R12—1-megohm
R13—1-ohm, 1-watt

CAPACITORS
C1—0.039-µF, 100-WVDC, Mylar
C2—0.056-µF, 100-WVDC, Mylar
C3—0.27-µF, 100-WVDC, Mylar
C4—0.47-µF, 100-WVDC, Mylar
C5—0.05-µF, 1000-WVDC, see text
C6—0.1-µF, 100-WVDC, ceramic-disc
C7—47-µF, 25-WVDC, electrolytic
C8—500-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
L1—10-to-15-mH variable inductor
L2—236-turns of 18-gauge wire on 7¾-inch form (see text)
NE1—NE-2 (or similar) neon lamp
J1—Phone jack
S1—SPST toggle switch
S2—SPDT toggle switch
Perfboard materials, wood base, heat sink, 15-volt power source, Fahnestock clips, heavy-gauge hook-up wire, solder, hardware, etc.

imum meter reading. You will probably need to keep reducing the gain as you tune to keep the reading below the full-scale mark. If the coil's ferrite slug is all the way in and the meter reading is still climbing, add a small capacitor in parallel with C4. But, if the meter is still increasing with the slug almost out of the coil, remove C4 and replace it with a smaller value capacitor.

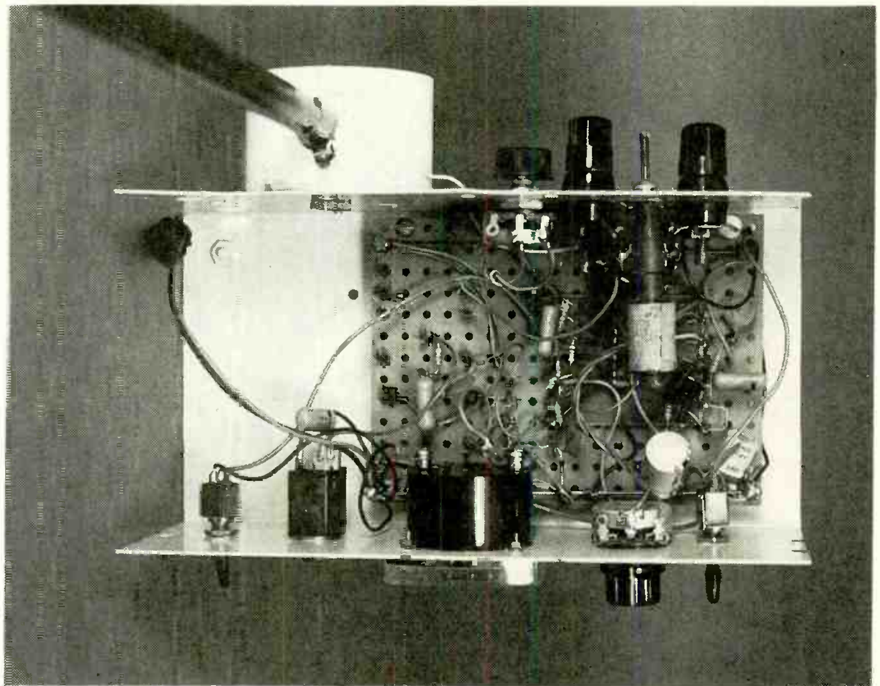
Move the receiver several feet away and turn on the BFO using S2. Adjust R14 for a pleasant 500- to 1000-Hz tone. Place S2 in the AUTO-SEND position and you should hear the interrupted tone loud and clear.

Experimenting with the VLF System. The real challenge in VLF'ing is to find new ways to stretch the usable operating range between the transmitter and receiver. Ask any amateur-radio operator what is the single most important item in their communication system and the majority will tell you that it's the antenna system, without a doubt.

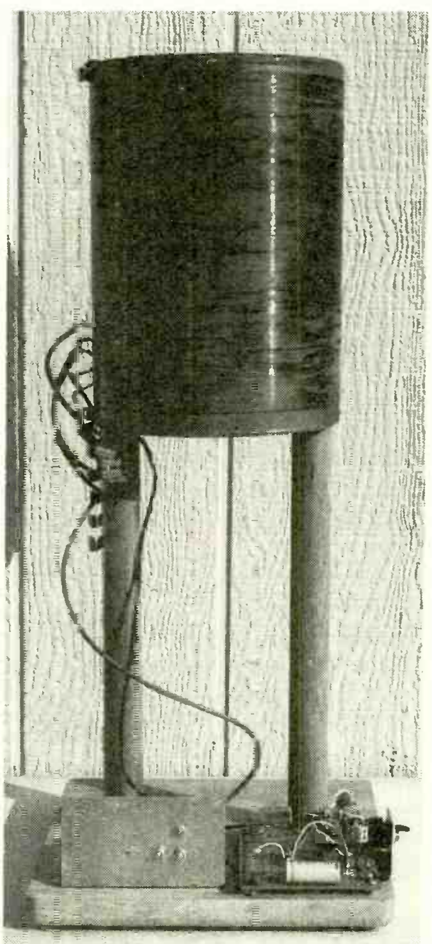
With the transmitter connected to a 120-foot long-wire antenna (that's only about 10 to 15 feet above ground), our portable receiver picked up the beacon signal from a distance of over a quarter mile. That's not too bad when you consider that the receiving antenna is only an eight-foot vertical. (I wonder what the range would be if a long-wire antenna was used instead?)

To select the best tap on L2 for getting the most RF into the antenna system, first connect an antenna and ground to the transmitter, and key for a continuous output. Locate the receiver at a position where R15 can be adjusted so that the meter reading is about ⅓ to ½ of the meter's full scale. Starting with the transmitter operating on tap 1 of L2, fine tune L1 for the maximum reading on M1. Repeat the procedure with each tap until the maximum RF output is obtained. Always turn the transmitter's power off when changing taps, and don't touch the antenna terminal because there can be over 500 volts of RF at the top of L2.

Good luck on VLF'ing. If you do meet the challenge of working VLF DX, please write and let us know. ■



The VLF receiver, like its mate (the transmitter), was assembled on a section of perfboard, but was housed in a metal cabinet. On the front panel of the enclosure, the author mounted S2 (the BFO select switch), J1 (the phone jack), meter M1, R14 (the BFO adjust), and the power switch. Mounted on the rear panel are R15 (the gain control), J1 (the antenna jack), L1 (the tuning inductor), and the antenna.



Once L2 is completed, it is mounted on wooden dowels and the assembly is mounted to the baseboard.

PARTS LIST FOR THE VLF RECEIVER

SEMICONDUCTORS

U1—LM324 quad op-amp. integrated circuit
Q1—2N3906 general-purpose PNP silicon transistor
Q2—2N3904 general-purpose NPN silicon transistor
D1, D2—1N914 general-purpose small-signal silicon diode

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R2—4700-ohm
R3, R8, R10—1-megohm
R4, R7, R12, R13—10,000-ohm
R5, R6—1000-ohm
R9—470-ohm
R11—2200-ohm
R14—10,000-ohm, potentiometer
R15—50,000-ohm, potentiometer

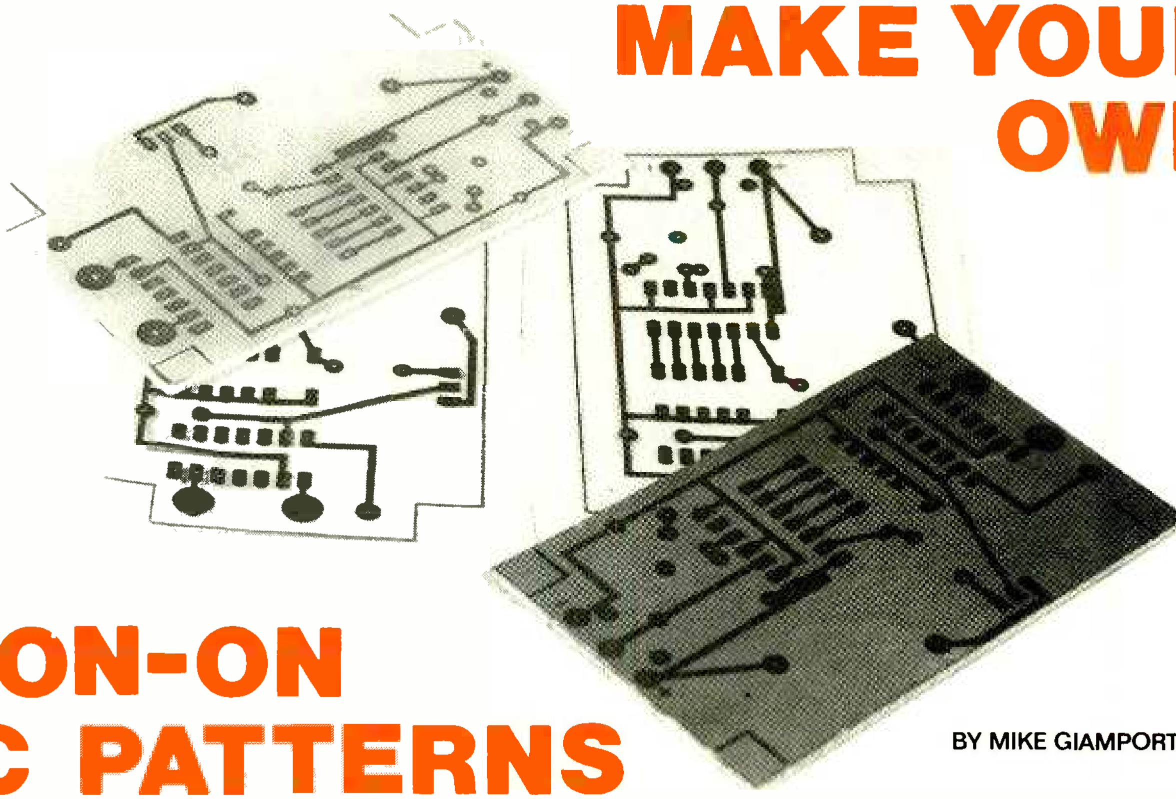
CAPACITORS

C1, C2—0.01-µF, 100-WVDC, Mylar
C3, C10—0.018-µF, 100-WVDC, Mylar
C4—0.022-µF, 100-WVDC, Mylar
C5–C9—0.1-µF, ceramic-disc
C11—0.0018-µF, 100-WVDC, Mylar
C12—47-µF, 25-WVDC, electrolytic
C13—330-µF, 25-WVDC, Mylar

ADDITIONAL PARTS AND MATERIALS

B1—9-volt transistor-radio battery
L1—10-to-15-mH variable coil (see text)
M1—0-1-mA meter
J1—Monophonic phone jack
S1, S2—SPDT toggle switch
Perfboard materials, 8 × 4 × 3 metal cabinet, 96-inch telescoping antenna, knobs, battery holder and connector, binding post, wire, solder, hardware, etc.

MAKE YOUR OWN



IRON-ON PC PATTERNS

BY MIKE GIAMPORTONE

Make your own printed-circuit patterns and turn out professional-looking printed-circuit boards in a fraction of the time!

Do you find making your own printed-circuit boards tedious, expensive, and time consuming? Have you ever left out a trace when making your own board and then spent a considerable amount of time troubleshooting your mistake? Doesn't it bother you that up to that point, without the wire you added to replace the missing trace, your project looked good enough for the cover of **Popular Electronics**?

With wire-wrapping, do you find it difficult to build multiple-IC circuits? Are you just plain tired of waiting for the arrival of circuit boards that you decided to order because of the complexity of the pattern? Wouldn't it be nice to make several patterns at one time and be able to pull out a ready-made pattern whenever the need arises? Well, now you can by following the simple set of step-by-step instructions discussed in this article!

With a special sheet of plastic film—TEC-200—a plain paper copier, and an iron, you can produce a professional looking printed-circuit board using what is probably the easiest and cheapest method of producing single or multiple printed-circuit boards.

Rolling Your Own. Making printed-circuit boards using TEC-200 plastic film can be broken down into three easy steps:

- Photocopy the printed-circuit pattern onto the plastic film.
- Transfer the copied pattern onto the copper-clad blank (unetched printed-circuit material) by ironing.
- Let the board cool and then peel off the plastic film.

The toner from the copy machine fuses to the blank, leaving a very tough etch-resist pattern that is also very precise!

There you have it—a quick and inexpensive way to make printed-circuit boards. But rather than expound the virtues of the process, lets get into the nuts and bolts of making iron-on printed-circuit board patterns.

If you are going to copy a full-size pattern from an electronics book or magazine, copy it onto paper to test the quality of the machine and the clarity of the pattern it can produce. It is important that the copy machine be a "plain paper" type that uses dry toner. Lower-cost machines are often incapable of recognizing the film sheets (transparent medium) as paper, and as such will not copy to them. Don't worry though, there are plenty of copy machines that accept transparencies.

Before handling the film sheets, make sure that your hands are thoroughly clean, and then handle the sheets *only* by the edges. Body oils deposited on the plastic film will interfere with the toner resist just as it does with other resists. To copy a pattern onto the film, place a sheet of TEC-200 in the copier's single-sheet feeder (which is normally used to copy onto the back side of a copied page), or if the machine doesn't have a single-sheet feeder, place the TEC-200 film on top of the paper stack in the feed tray and then copy the pattern onto the transparent plastic film.

If you are copying the pattern from a printed page (magazine article, electronics-hobbyist construction book, etc.), the pattern shown is most-likely of the copper side of the board, therefore the image must be reversed. To reverse the pattern, simply copy the pattern to a sheet of TEC-200, then copy the image from the first film sheet onto a second sheet of TEC-200. The first sheet of film must be placed in the scanner upside down (*i.e.*, pattern side up), and covered with a clean sheet of paper to prevent a dirty machine-lid background from adding to your pattern.

The image produced on the second sheet of film is then placed toner-side down on a copper-clad blank and backed-up by a sheet of plain paper. A hot iron is then used to transfer the toner-resist pattern onto the copper-clad blank.

The film sheet you used to get a mirror image may now be cleaned and reused, using nail polish remover, acetone, paint thinners, or other solvents that you may already have around your home. Sometimes the cleaned sheets look a little bit cloudy, but that doesn't seem to affect how well they work.

When using organic or flammable solvents, don't forget to keep them or their fumes away from open flames or sources of heat, including lit cigarettes. Be sure to wear protective gloves and eye protection, and use solvents only in an area with good ventilation.

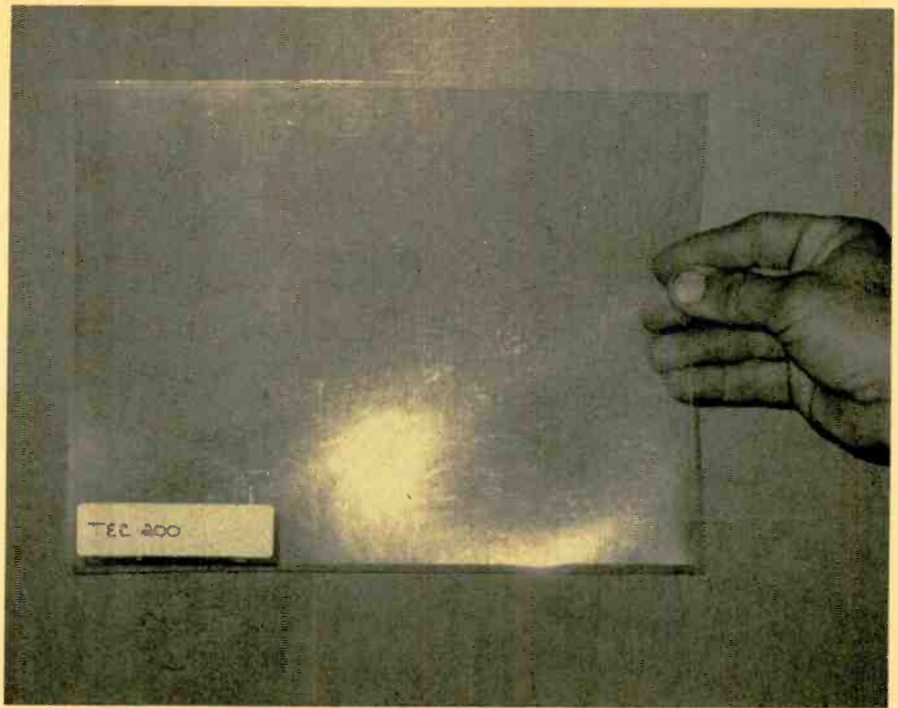
If you are one of the industrious-few who are into designing their own printed-circuit layouts, TEC-200 transparencies can be used here as well. You can simply develop the pattern on a sheet of white paper using dry-transfer patterns (inserting component labels as you progress). Then when the layout pattern is complete, it can be transferred to TEC-200 film. The pattern is then ready to be transferred to the printed-circuit blank, and your original layout (the one on paper) can be used as a parts-placement guide.

Making the PC Board. Cut your copper-clad blank to size if you have not done so already. Before attempting to transfer the pattern to the blank, it must be cleaned. Clean the blank with warm water, a little bit of scouring powder, and a scouring pad—preferably a plastic one. Dry the blank with a clean paper towel and handle it only by the edges. Cut the desired printed-circuit pattern from the TEC-200 sheet to the same size as the blank.

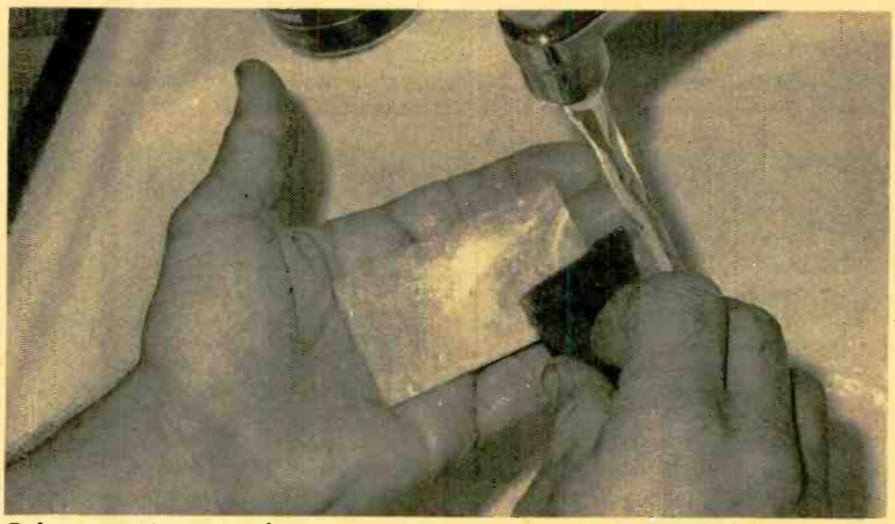
Tape the pattern to the blank toner-side down using lengths of cellophane tape to make sure that the film will not shift out of position during the transfer process (ironing). The toner side is the side of the film where the copied pattern (black toner ink) has no glare when held up to or viewed under normal room light.

Place the blank, film-side up, on an old magazine or small stack of newspapers and cover with a sheet of paper, paper towel, or thin cotton cloth. Preheat a clothes iron to about 290°F (cotton/linens setting) for several minutes. Place the iron directly on top of the covered blank and let it sit for ten seconds. Do not leave the iron unattended. Then move the iron around the blank for twenty seconds, using medium pressure.

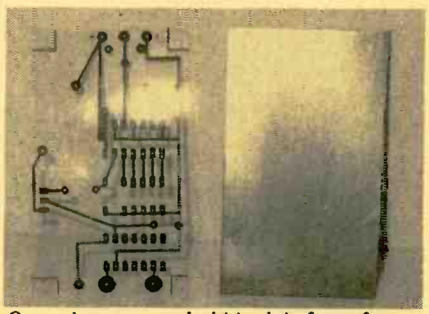
At the end of that time, use the tip of the iron to go over the entire pattern. If the transferred pattern doesn't appear solid black, or if transfer isn't complete, you may wish to increase your ironing



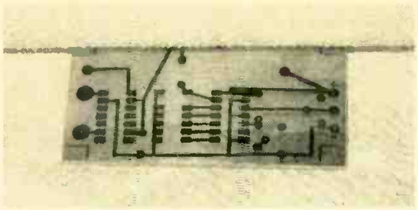
With a sheet of TEC-200 plastic film, a plain paper copier, and an iron, you can produce a professional looking printed-circuit board.



Before attempting to transfer the printed-circuit pattern from the TEC-200 transparency, make certain that the copper-clad blank is thoroughly clean—free of oxidation, body oils, and anything else that might interfere with the consistency of the pattern being transferred.



Once the copper-clad blank is free of contaminants, place the TEC-200 film on the blank toner-side down and tape the film to the blank to ensure that the film does not shift during the transfer process.



Place the blank film-side up on a flat surface, and cover with a sheet of paper, paper towel, etc.

time. If circuit lines appear broadened, or very close traces are touching, you likely were using too much pressure.

An alternate way of transferring the toner from the film to the copper blank is to first place the bare blank on a heating surface (such as the iron or an electric hot plate) long enough to heat the copper to 270–290°F. Remove the blank from the heat source, immediately place the film on the hot blank, and transfer the pattern by rolling the film against the blank with a small rubber roller. Such rollers are available from art-supply houses or photography shops.

Regardles of the transfer method that you use, once the blank has completely cooled, cut the edges of the tape, and remove the film, slowly peeling it from one side. If you find minor deficiencies in the transferred pattern, touch them up with a fine-point permanent-ink marking pen—Sanford brand, Sharpie fine, or extra fine point, etc. The blank is now ready for etching.

The etching solution will not undercut the pattern unless the etching rate is excessively slow, a condition usually caused by weak or cool solution, and/or the lack of agitation. Weak (overly used) solutions should be discarded. The temperature of the etching solution can be raised by subjecting it to a blast of hot air from a hair dryer or similar hot-air blower. Agitating the solution can be handled in several ways—by hand agitation (shaking the etching tank), or by using an aquarium air pump.

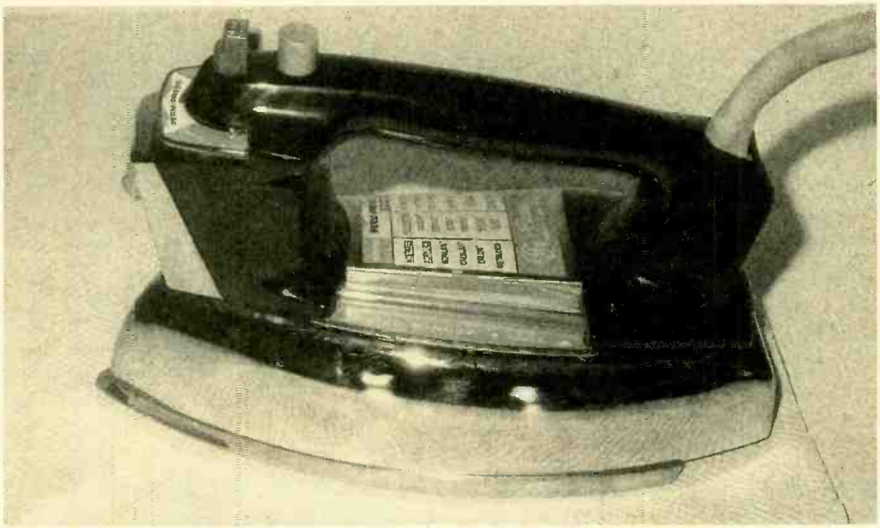
Once the entire blank is etched, treat it as you would any other board. Clean the resist off with scouring powder, warm water (the warmer the better), and a plastic scouring pad. You can also use solvents to remove resist from the board.

Your printed-circuit board is now ready for drilling. A word of caution here. New evidence shows that very small particles of fiberglass have been shown to cause cancer, so do your cutting and drilling outside or in front of a vacuum hose when possible, since much of the available circuit-board material is fiberglass based. We want to keep our hobby safe and fun.

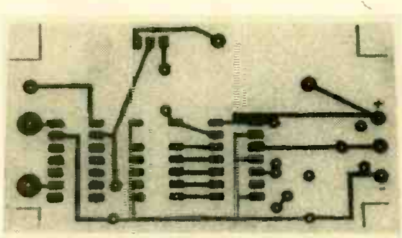
Getting the Film. By now you are probably wondering where do you get TEC-200 film? You have several choices. You can order TEC-200 film directly from Meadowlake Corp., PO Box 497, Northport, NY 11768: five sheets sell for $3.95 plus $1.25 postage; 10 sheets for $5.95 plus $1.25 postage. Another source for TEC-200 is DC Electronics (PO Box 3203, Scottsdale, AZ, 85271-3203, call 1-800-423-0700). DC Electronics sells the film by the sheet ($1.00), or in 5- and 10-sheet packages (which sell for 3.95 and 5.95, respectively). TEC-200 film is fully guaranteed.

Laminating film—which is available

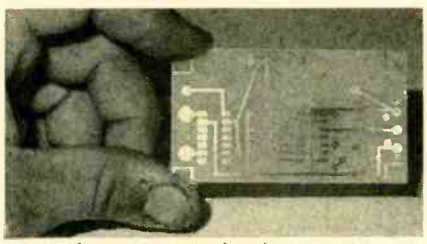
(Continued on page 90)



Preheat a clothes iron to about 270 to 290°F, and place on the blank for about 10 seconds. Then run the iron over the blank exerting medium pressure.



After peeling off the film, the printed-circuit pattern remains on the blank. The blank is then immersed in etching solution. Here what your post-etching blank should look like.



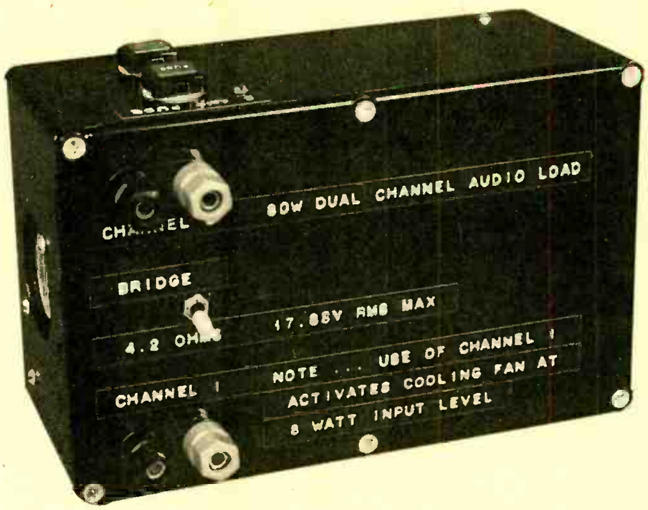
Once the toner-resist has been remove from the blank, all that left to do is to drill holes of appropriate size in the pads to accommodate the components leads and wire connections.

After checking to see that all excess copper has been completely removed from the blank, remove the toner resist from the copper traces using a plastic scouring pad and household cleanser. If you don't mind the added expense, there are solvents that can be used for that purpose.

TWO-CHANNEL AUDIO LOAD BANK

BY MARK A. VAUGHT

You know how useful an audio dummy load can be. Here's a homebrew dummy load bank that you can build yourself in a single evening.



I recently started servicing commercial P.A. amplifiers. One of my first customers asked me to check an amplifier that would cut out after it had operated for some length of time. There was no question that some component was overheating, causing the circuit to shut down. In order to check the amplifier's operation, I needed a load bank of sufficient capacity to cause the circuit to get hot.

Armed with some power resistors that I had laying around, the *Dual Channel Audio Load Bank*—a two-channel 80-watt load bank—was born. The circuit consists of 16 2-ohm, 10-watt power resistors connected in parallel/series combinations to form two 4-ohm load banks.

Most modern P.A. amplifiers produce outputs of 100 watts or more. Such amplifiers are, for the most part, inefficient so it is usually not necessary to load them to full capacity in order for them to get hot. It was obvious, however, that if the load bank was to be operated at full power even for a short time, some way of keeping the resistors cool would be needed. So a small 12-volt DC micro-fan was included in the circuit to help vent the heat produced by the resistors when the circuit is in operation.

There were several power-supply options for the fan; a bench power supply was the most obvious. But I kept thinking about the inconvenience of hooking up my bench supply to operate the fan each time it was necessary to use the load bank. Then it came to me: Why not use some of the enormous output audio power to operate the fan? Since the micro-fan selected for this application requires only 150 mA for it to operate at peak efficiency, the fan would not greatly affect (cause undue strain on) the amplifier output. And if there was insufficient power from the amplifier to drive the fan, it probably would not be needed anyway. If only one channel was needed, CHANNEL 1 would be selected, in order to activate the micro-fan to keep the load bank cool.

Circuit Description. Figure 1 is a schematic diagram of the Dual Channel Audio Load Bank. Each bank is made up of four-pairs of 2-ohm, 10-watt paralleled power resistors connected in series with each other. The parallel/series power resistor combination gives each resistor bank an equivalent resistance of about 4 ohms. A bridge rectifier (BR1) is connected across the CHANNEL 1 load bank. When the load bank is connect across an audio source, the audio is rectified by BR1, filtered by C1, regulated by U1, and then used to power the fan (assuming that the audio amp is producing sufficient power).

It is standard to feed a 1-kHz sine wave to the input of an amplifier for testing; the bridge rectifier/capacitor combination works even better at 1 kHz than it does at 60 Hz. Inductor L1—which has a very small DC resistance—is inserted in the circuit to filter out any fan-generated noise that might be reflected back into the audio.

When the load bank is operated at full capacity, the maximum voltage at the input terminals is 17.88 volts. That was calculated by first solving for current using $I = \sqrt{P/R}$, where P is the maximum power rating for the load bank (80 watts) and R is the total resistance of the load bank (4 ohms). Once the value of I was calculated (which works out to 4.47 amps), it was used to solve for voltage using $E = IR$. Calculating the maximum current in the circuit also indicates what size fuse is required—5 amps.

Then using RMS/.707, I figured the peak rectified voltage and subtracted 1.4 volts for the rectifier voltage drop, which works out to 23.88 volts. Thus, it was safe to use a three-terminal voltage regulator to supply the fan voltage. The input/output voltage differential of three-terminal regulators is typically 30–40 volts, so with a 12-volt output, the regulator can withstand a 42–52 volt input.

The voltage regulator/fan combination was operated using a bench supply to determine what voltage and current was necessary to activate the fan. The fan began to operate at about 5 volts, or 6.5 volts if the regulator was in series with it, and draws about 35 mA. Using that information, and working backwards through the above calculations, the fan turns on when the audio power is about 8.1 watts, and will run at full speed (12 volts at 150 mA) when the audio power is about 32 watts.

If the 2 sections are connected in parallel (by closing S1) the power ratings for fan operation in all cases will simply be doubled. However, the power is now dropped across twice as many resistors and the fan is still in full operation before the half-power rating is reached. If the two sections are connected in series (using an external jumper at the circuit's banana-jack inputs), the resistance of the load bank and thus the amount of power required to operate the fan will be doubled.

Construction. Assembling the Dual Channel Audio Load Bank is not at all difficult. In fact, the author's prototype circuit was assembled on two sections of perfboard, measuring about 4.5 × 2.5 inches and interconnections between components was accomplished using point-to-point wiring. The circuit was then housed in a metal enclosure measuring 7⅜ × 4¾ × 3¼ inches.

The 16 resistors are held suspended between the two perfboard sections. Then their leads are paired off and connected in parallel, and the four pairs of resistors are then connected in series. Wire both load banks in the same manner. Solder lengths of hook-up wire to the end leads of the load banks.

The AC terminals of a bridge rectifier are then connected to the CHANNEL 1 load bank, along with the rest of the components. The bridge rectifier along with L1, C1, U1, and the micro fan are mounted to the side-wall of the circuit's metallic enclosure. A hole was made in one of the end-walls of the enclosure for the fan. The micro fan requires a 1.5-inch mounting hole. The easy way to make the fan hole is to punch it out with a Greenlee-type chassis punch.

PARTS LIST FOR THE DUAL CHANNEL AUDIO LOAD BANK

U1—7812 12-volt, 1-amp, voltage regulator, integrated circuit
BR1—8-amp, 100-PIV, full-wave bridge rectifier (ECG5312 or similar)
R1–R7—2-ohm, 10-watt wire-wound ceramic power resistor
C1—1000-µF, 35-WVDC, electrolytic capacitor
L1—2.5-mH, 160-mA, coil (J.W. Miller M6302)
J1–J4—Dual banana jack
S1—DPDT miniature toggle switch
F1, F2—5-amp 3AGC fuse
Perfboard materials, enclosure, micro fan (RS 273-244 or equivalent), panel-mount fuse holders, spacers, wire, solder, hardware, etc.

Note: A kit of parts for the Dual Channel Audio Load Bank (minus hook-up wire) is available for $69.95, plus $3.50 shipping and handling form Applitron Services, 2721 Crestwell Rd., Bel Air, MD 21014. Maryland residents, please add appropriate sales tax.

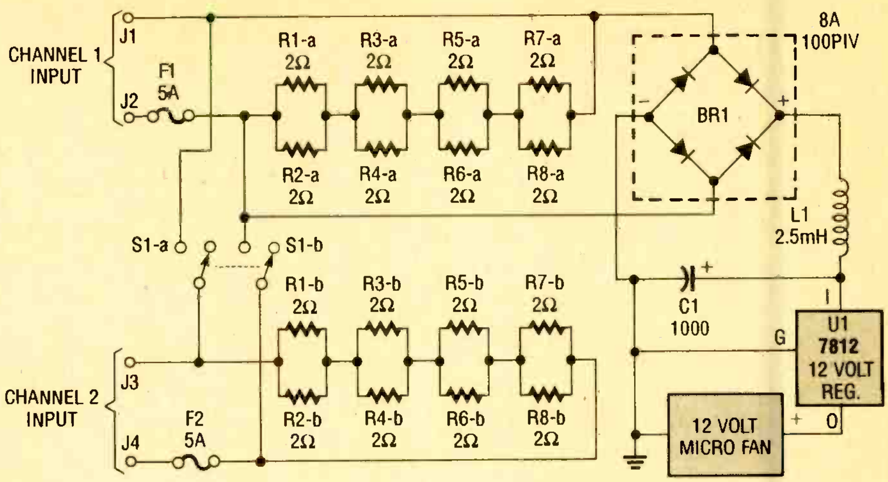


Fig. 1. Each channel of the Dual Channel Audio Load Bank is made up of 4-pairs of 2-ohm, 10-watt paralleled power resistors connected in series with each other. The parallel/series power-resistor combination gives each resistor bank an equivalent resistance of about 4-ohms.

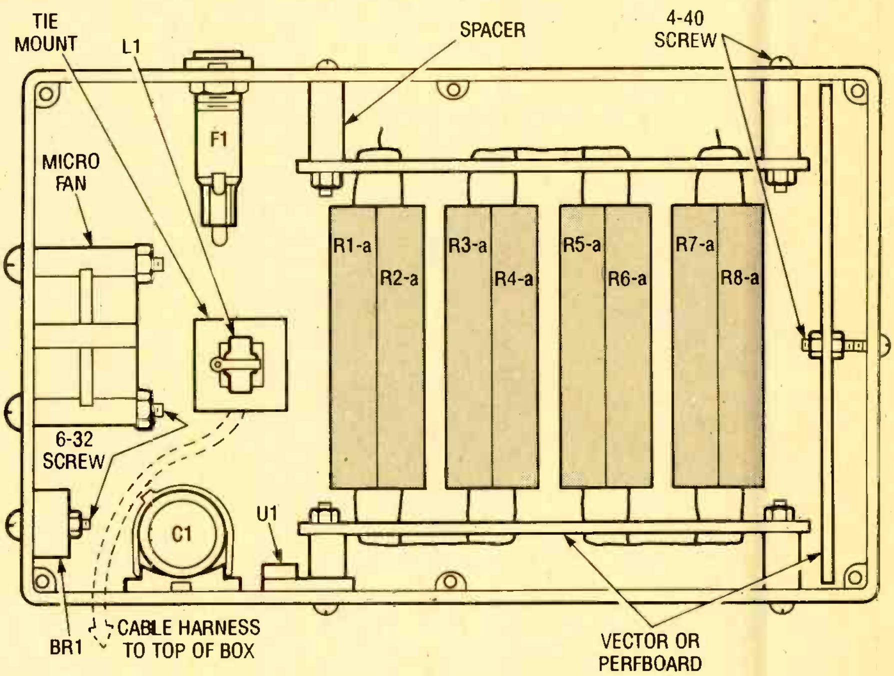


Fig. 2. The power resistors that make up the two load banks of the circuit are suspended between two pieces of perfboard. The remaining components are mounted to the walls and lid of the enclosure.

If you don't happen to have a 1.5-inch punch, simply mark the location of the fan on the end-wall of the enclosure with a compass or small container lid. Drill the largest holes you can using a power drill and a large-bore bit inside the fan circle. The final shaping of the hole can be accomplished using a Dremel (or similar) tool fitted with a small rotary rasp.

Next, you'll have to make several holes in the opposite end of the enclosure to serve as an air intake. The author used a ¾-inch chassis punch to make four equally spaced holes in the enclosure. (Several smaller holes would have worked just as well.) After that's done, drill mounting holes for the enclosure-mounted components (fuse holders for F1 and F2, BR1, U1, etc.), and in the lid of the enclosure for the banana jacks and the switch. Mount the parts and you are done.

Now all that is left to do is to test the circuit. That can be easily done by feeding an audio source to the CHANNEL 1 input. At around 8.1 watts of audio input signal, the fan should begin to operate. If all is okay, your Dual Channel Audio Load Bank is ready for use. ■

Keeping PACE with PACEMAKERS

Would you believe that the first pacemaker was designed by a TV repairman?! Learn about that and more as we explore a device that's close to the heart.

BY JULIAN S. MARTIN

What do the lovable actor/comedian Jonathan Winters and Hall of Famer Joe DiMaggio have in common? The answer is that both famous personalities have pacemakers. In the autumn years of their lives, both men rely on medical-cardiac technology to permit them to continue useful and enjoyable lives that may have otherwise been snuffed out years before their time.

The ubiquitous pacemaker is an electronic device that is implanted in the chest of a person to artificially stimulate the heart to beat regularly in cases where the heartbeat's regularity has been disturbed by cardiac illness. Using electrical pulses from man-made devices to assist heart rhythm began in the 1930's, but the bulky devices had to remain outside the body. By 1958, with the development of semiconductor products and miniature batteries, complete implantation was made possible.

How The Heart Works. Few people realize that the heart is only a little larger than the fist and weighs less than a pound. It is a powerful, hardworking organ that pumps blood throughout your body every minute of your life.

The human heart is a hollow, four-chamber organ (see Fig. 1). Its strong and muscular wall (*myocardium*) is coated on the inside by a thin membrane (*endocardium*) and encased in a strong, fiber-like bag (*pericardium*). The heart is divided down the middle into a *right heart* and a *left heart* by a wall (*septum*). In turn, each half of the heart is divided into an upper chamber (*atrium*) and a lower chamber (*ventricle*). Valves, functioning very much like diodes, direct the flow of blood through the heart as it expands and contracts the chambers.

The heart pumps blood to the lungs and then the body. The right heart pumps bluish-red, carbon-dioxide-rich blood from the body to the lungs. (Carbon dioxide is a waste product of the body's cells.) In the lungs, the blood gets rid of the carbon dioxide and acquires a fresh supply of oxygen, which turns the blood bright red again. The left heart receives the oxygenated blood from the lungs and pumps it via the arteries to the body.

Before the heart will contract, it must receive an electrical signal. Normally, that signal comes from the *sinus node*, a natural pacemaker located in the muscle of the upper-right atrium chamber. Those signals are sent at a regular pace, causing the heart to supply the blood at the required rate to the body. Work or exercise demands that additional blood be supplied to the body, thus the pace will accelerate and the heart will pump more blood. Rest and sleep will cause the pace to slow down, decreasing the blood supply to the body.

Under normal conditions the pace of the heart is sufficiently regulated to supply oxygen and nutrients to the body at the rate required. Should the regulating mechanism fail to work satisfactorily, artificial pace-setting becomes a mandatory requirement.

In the Beginning! During Emperor Nero's time, 47 A.D., a man accidentally administered only when the ventricles came to a halt. Shortly thereafter the patients heart failed and the device was switched on for 52 consecutive hours. Then the heart began to beat normally, the machine was shut off and two days later the electrodes were removed. Eventually the patient recovered enough to leave the hospital. Thus was the beginning of the science of controlling the cardiac rhythm with an external pacemaker. For this and other pioneer work Dr. Zoll was dubbed the "father of the pacemaker."

The most dynamic and unusual step in the development of the pacemaker came in Minneapolis when Dr. C. Walton Lillehei and TV repairman Earl Bakken teamed up to develop prototype pacemakers. Bakken was frequently called to repair defective and broken electronic operating-room equipment. Bakken designed and assembled the first pacemaker to Dr. Lillehei's specifications in just a month's time. The unit worked fine. All that was needed was to make it smaller, wrap it in plastic, and implant it in a patient. In 1957, Earl Bakken incorporated a company to make the first commercial pacemakers. That little company he named Medtronics and the company has continued to be a pioneer and major supplier of pacemakers to the world.

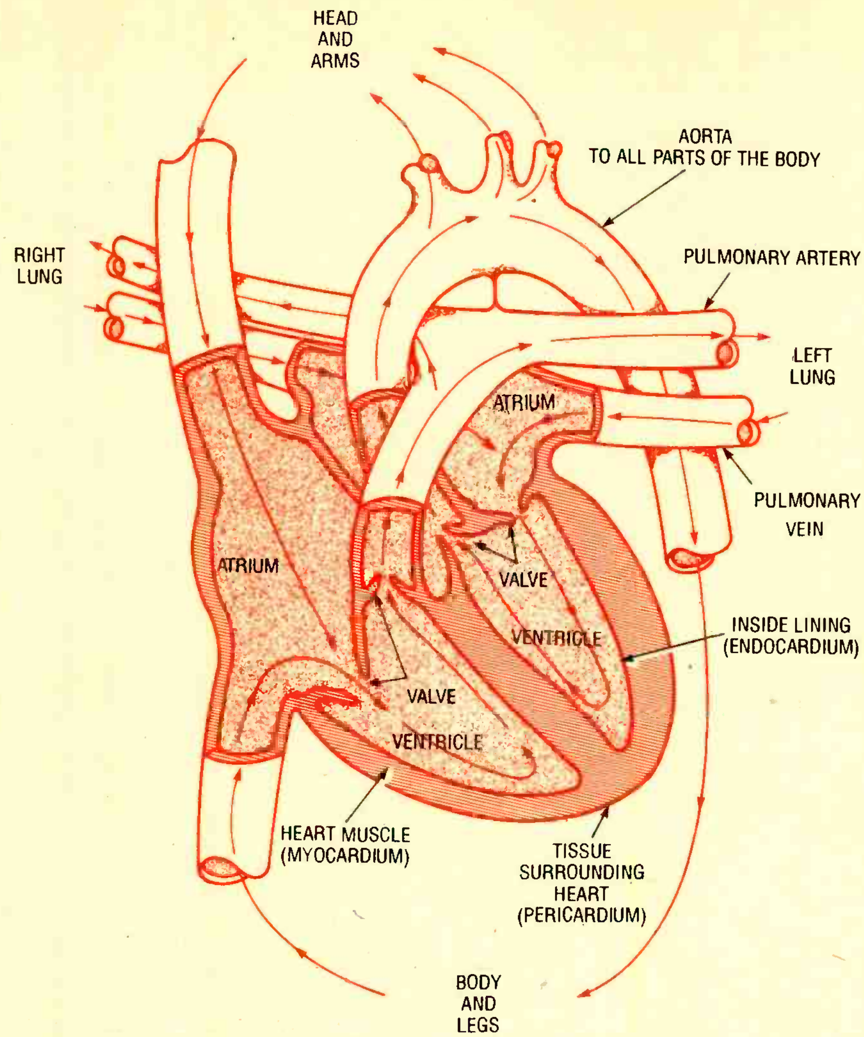


Fig. 1. The human heart is a four-chamber organ. Before it will contract it must receive an electrical signal from the sinus node. When the sinus node fails to work properly it can be augmented with a pacemaker.

came in contact with a live "torpedo" fish or electric ray. It was recorded that it cured the man's pain from gout. Later, the physician Discordes used the same fish to cure headaches. Through the centuries the mystique of electroshock inspired "cures" for many diseases. In the eighteenth century, the Reverend John Wesley, founding father of the Protestant Methodist Church, recorded a treatment for a man suffering from a heart attack: "I advised him to take no more medicine but to be electrified through the breast. This was done and the violent symptoms immediately ceased and he fell into a sweet sleep."

In the nineteenth century, ventricular fibrillation (irregularity in the hearts timing causing its parts to function in an uncoordinated fashion) was understood and thoracic thumping (banging on a victim's chest) was an accepted treatment. However, a little-used electrified, portable, resuscitation chair was invented for heart patients. It's consoling to know that the first practical electrified chair was designed to save life, not take it!

In the 1930's, Dr. Albert Hyman experimented with a crude but effective pacemaker, however he used it not for pacemaking, but to electro-resuscitate patients with fibrillating hearts. He was so close!

In 1952, Dr. Paul Zoll invented an external shock-maker that attached under the skin at the apex of the heart and at the skin surface at the fourth rib interspace. A certain patient with congestive heart failure from heart block was helped with drugs for six days. The heart's main pumping chambers were beating at only half the normal rate and often the patient's heart would stop beating for up to a minute. Zoll's shock-maker was attached and electrical shocks lasting 2/1000 of a second, fifty to a hundred times a minute were

Crude, but Life Saving. The first life-saving pacemakers were crude devices by today's standards. In 1957 Medtronic's first wearable external pacemaker appeared like an experimenter's project. The device was housed in a relatively flat plastic box with two radio-type knobs to control pulse rate and signal amplitude, and an on/off slide switch. External connections were made to push-to-release connectors commonly found on speaker cabinets. Crude, yes; but, nevertheless, those units extended lives.

Today, the Legend Pacemaker is Medtronic's thinnest, smallest, and lightest rate-responsive pulse generator. The Legend system is comprised of the pulse generator, lead, and desktop programmer.

The Legend Pacemaker serves patients whose conditions or lifestyles indicate a need for pacing of the atrium (upper chamber) or ventricle (lower chamber) of the heart to correct a heartbeat that is too slow or erratic to meet the circulatory requirements of their bodies. The Legend is particularly useful to the patient whose "natural pacemaker" (the sinus node) is not originating electrical impulses consistent with the needs of the heart and circulatory system during physical activity (walking, housework, gardening, etc.) Most pacemaker patients fit in that category.

Pacemaker size is important to patients cosmetically; the smaller and thinner it is, the less distinguishable after implant. Size is also related to ease of implant and patient comfort after implant.

The pulse generator within the Legend Pacemaker is externally programmed with telemetry signals to deliver precisely controlled electrical impulses to the cardiac myocardium, causing the depolarization of electrical cells that trigger muscle contraction (the pumping motion) of the heart.

The lead from the Legend Pacemaker is an insulated wire with a specialized electrode on the end. Connected to the pulse generator, the lead carries the electrical impulse to the inner wall of the upper or lower chamber of the heart. The newer electrodes on the lead emit a steroid that facilitates optimum receptivity of the pacing impulse by the heart muscle. Increasing conductivity thus extends the overall life of the pacemaker's battery, because then lower pulse magnitudes can be used.

Pacemaker Facts

- Heart disease is the number-one killer of Americans.
- More than 100,000 people receive pacemakers in the United States each year; an additional 30,000 people are potential recipients.
- The external battery-operated pacemaker was developed in 1957 by Earl Bakken, Medtronic founder.
- By mid-1958, 18 patients were implanted with pacemakers.
- On April 4, 1959, the Hunter-Roth bipolar electrode, connected to an external pacemaker, was implanted in a 72-year old man, who then lived another nine useful years with the aid of the device.
- First U.S. internal implant with a self-contained power supply took place on June 6, 1960. The unit measured 6 cm (2.4 inches) in diameter and 1.5 cm (0.6 inches) in thickness.
- In 1963, there were slightly fewer than 1,000 pacemaker implants in the U.S.
- Nearly 110,000 pacemaker units were implanted in 1988 in the U.S.; about two million pacemakers had been implanted worldwide.
- 75% of pacemaker wearers are between the ages of 50 and 79, 3% are under 30, and 32% are over 79.
- Approximately 60% of pacemaker implants are done in the U.S., 40% in the rest of the world.
- The modern pacemaker, averaging 70 impulses per minute, generates about 36 million impulses a year.
- Rate-responsive pacing based on patient activity was developed in 1980. Clinical implants of the rate-responsive pacemakers began in 1983. ■

Power Source The Legend is powered by a lithium iodine cell with an estimated average life of about five years at nominal settings. Battery life will vary according to use. For example, if more or stronger impulses are needed, battery life decreases accordingly.

Legend is programmed with a standard, portable programming device. Using that desktop instrument, the physician sends messages to the pulse generator in the Legend Pacemaker. On command, the Legend pulse generator also sends information to the programmer. That information is used by the physician in "fine-tuning" the system to provide the best pacing for the individual patient.

The Legend and its external programmer provide new flexibility in pacing therapy. Lower pulse rates are selectable from 40 to 90 *bpm* (beats-per-minute) in rate-responsive mode. The upper rate is selectable from 100 to 170 *bpm* in 10 *bpm* steps.

In the normal activities of a day, the Legend's linear rate-response curves and programmable rates of acceleration and deceleration allow smoother rate transitions and more control of the pulse generator's response to changes in user activity level. To appreciate that, monitor your pulse and note how quickly it increases as you go from a sitting-rest situation to a brisk walk for one minute and back to a sitting rest situation. For a healthy person the pulse rate may quickly increase from 70 *bpm* to 90 *bpm* in a fraction of a minute, then begins to decline as the rest period begins again, returning to 70 *bpm* in about two minutes.

The attending physician has the option to program other programmable parameters such as pacing mode, activity threshold, pulse width, pulse amplitude, sensitivity, polarity, and a few others.

Histograms and Trend Analysis. As a key demonstration of technological accomplishment, histogram and trend analysis features are designed to add precision to the programming of the pulse generator within the Legend. Counters separately count the pacing pulses delivered and the number of natural heart beats sensed. Those events are then sorted by the circuitry into "bins" according to the equivalent heart rate.

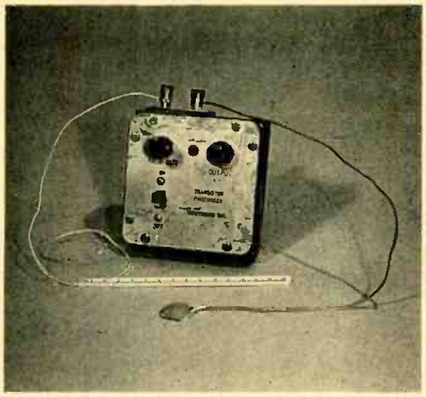
The trend-analysis capability is new and exclusive in the Legend. The circuitry is designed to detect the relationship between natural and stimulated heart action and send that information to a properly interfaced graphical printer. A physician can then review the information, analyze paced and sensed events at various points on the curve generated, and tailor program the unit's desired performance for the patient.

This is a small, light, implantable pacemaker designed to adapt its rate of impulses to the needs of the wearer. It can record information about the heart and "talk" to a physician about it when requested. The physician can then fine-tune the pacemaker for the user.

By interpreting the information received from the Legend, the physician can answer such questions as:

- Has the pacing rate been within the desired range?
- Does the pacing rate correlate well with the patient's range of activity?
- Does the programmed lower rate-limit allow the patient's own rate to prevail during sleep and at rest?
- Can the patient's heart increase its own rate during increases in activity?
- Does the programmed rate-response curve, together with the upper rate limit, allow the patient to achieve the desired maximum heart rate?
- What is the maximum heart rate actually achieved?

Knowing the recent profile of heart rates actually achieved by a patient



The first wearable external pacemaker designed and assembled by Earl Bakken in 1957. The two knobs control pulse rate and the pulse's output amplitude. The quality of the construction appears very much like a hobbyist's project.

over the range of activities normal for his or her lifestyle, the physician can more objectively decide what values to program for the future.

Rate Response. The Medtronic group introduced rate-responsive pacing to the European market in 1985 and the U.S. market in 1986. That technology, also incorporated in the Legend Pacemaker, uses a ceramic piezo-electric-crystal bonded to the inside of the pacemaker container. When the sensitive crystal is flexed or stressed only a few millionths of an inch by pressure waves from body activity, it produces a tiny electrical voltage that signals the pacemaker to adjust the heart rate as appropriate to pump more blood to the body.

Sitting quietly, the wearer of a Legend Pacemaker may have a heartbeat of about 40 to 90 pulses per minute. As he or she rises to change the TV channel or answer the phone, the crystal sensor "feels" the motion and signals the circuitry to increase pacing. Similarly, in doing housework or playing tennis or when sleeping, the patient's pacemaker responds and adjusts the heart rate.

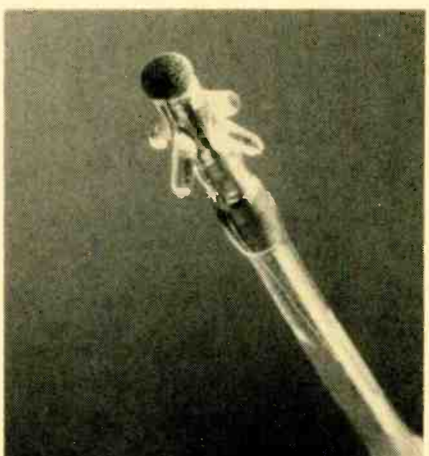
Patients often are able to return to activities that they were forced to give up in the pre-pacemaker days when their hearts beat inadequately or when they wore a pacemaker that paced at a fixed rate. Rate-responsive pacing brought flexibility to their lifestyles.

Latest Development. The latest pacemakers use a special activity sensor to help synchronize the heart rate in both the upper and lower chambers of the heart to provide optimum pumping action and maintain proper blood circulation. The new therapy is especially useful for patients experiencing problems with cardiac-rate control and conduction of electrical signals within the heart muscle. Such problems may prevent efficient, synchronized pumping of blood.

Dual-chamber pacemaker systems deliver impulses through two leads, one in an upper chamber (atrium) of the heart and one in a lower chamber (ventricle). Conventional dual-chamber pacemaker systems adapt and synchronize their pacing rates by sensing the heart's natural "pacemaker," the sinus node, located in the right atrium, and sending impulses around a defective conduction system to the right ventricle.

However, if damage or disease impairs the sinus node, the conventional pacemaker reverts to constant-rate pacing (usually 70 to 80 beats per minute), which may be too fast to allow comfortable sleep, but too slow for some everyday activities.

The new pacemakers, like the Synergyst II by Medtronics, keep watch over the sinus node and conduction systems, allowing them to do their natural jobs when they can. When they don't, Synergyst II offers automatic rate-variable therapy. The addition of sensor-based, rate-responsive, technology to dual-chamber pacing adds a high degree of therapeutic flexibility. That is desirable because of the difficulty in predicting what patients will encounter future sinus-node or conduction problems and, in some patients, the intermittent nature of such problems.



To reduce the battery drain in implantable pacemakers, a new steroid-eluting lead reduces pacing thresholds by reducing myocardial inflammation.

Pacemaker Fact vs. Fiction. Signs in too many hospitals read, "Pacemaker wearers, beware! Microwave oven used here!" That sign came about because of the mistaken belief that if the wearer of a pacemaker were near a microwave oven, the pacemaker would miss-function and the wearer would suffer severe consequences. Nothing could be further from the truth. Microwaves do not affect the operation of today's implanted pacemakers, nor is there evidence that the older implanted units would ever have been affected. The radiated microwave field outside a microwave oven under normal circumstances will not affect a pacemaker.

Many pacemaker wearers travel by air. Consider the radar waves that impinge on a person travelling to the airport, walking about the airport, and on a plane. The magnitude of microwave intensity is several thousand times higher than that of a person next to a microwave oven waiting for a meal to be cooked. In spite of the extensive exposure to airport-radar microwaves, there are no warning signs because no pacemaker wearer ever had an incident due to powerful radar radiation.

While we are discussing airports, consider the effect of metal detectors used at security checkpoints. Many believe that those devices will damage or interrupt the action of a pacemaker. That's another myth! The metal detector may indicate presence of the pacemaker, but the unit and the wearer won't be harmed.

It is mistakenly believed that the electrical activity of industrial arc welders and large electrical motors can confuse the electronic circuitry in a pacemaker. Though pacemakers can be affected by electrosurgery and magnetic-resonance imaging, they are used in controlled medical procedures done by skilled health-care professionals, which minimizes any risk.

To the Future! More demanding goals for pacemakers will keep scientists, doctors and engineers striving for the perfect pacemaker. It will be wafer thin causing no bulge or discomfort to the patient. Self-programmable, the pacemaker will learn from the body's activity and the heart's reaction what the optimum pulse rate should be without outside programming. The unit's power supply will depend on the body's heat and chemicals to power the pacemaker for the life of the patient. ■

JULY 1990

GIZMO®

VOLUME 3, NUMBER 7

A CHRONICLE OF CONSUMER ELECTRONICS

Good Things ... Small Package

SONY CCD-TR5 HANDYCAM 8mm CAMCORDER. Manufactured by: Sony Corporation, One Sony Drive, Park Ridge, NJ 07656. Price: $1500.

When the *Sony* people asked whether we'd like to try out the "world's smallest camcorder," their 8mm *CCD-TR5 Handycam,* we immediately took them up on their offer. It's fun to see how much performance can be stuffed into a small package. And, boy, has Sony stuffed a lot of performance into this one!

The camcorder *is* small; it measures approximately 4¼ × 4¼ × 7 inches, and can be gripped comfortably in one hand. (For steady images, however, we suggest you use both hands, or a tripod. There's a tripod socket built into the bottom of the case.) When we threw the camcorder over our shoulder (using its carrying strap, of course) we were surprised at its lightness. It seemed less of a burden to carry about than even our 35mm still camera. Checking, we discovered that, battery pack and cassette included, the camcorder weighs only about two pounds—more or less the same as the 35mm camera. That's pretty good, and you should have little difficulty in taking the unit with you wherever you want to go, for as long as you want to carry it.

Power is provided by a six-volt rechargeable nickel-cadmium battery pack that offers a record time of about an hour. Another pack, with a two-hour working life, is available as an option. The battery pack must be removed from the camcorder for recharging and slipped into a separate recharger, which also doubles as an AC adapter for the camcorder. Unfortunately, because of the—undoubtedly intentional—layout of the recharger you cannot charge a battery pack and power the camcorder at the same time, and to run the camcorder from AC you must remove the battery pack from it. (The power accessories are the same as those used by Sony's Video Watchman, that small portable LCD-TV/8mm-VCR combination.)

The TR5 Handycam is a bit of an optical curiosity, but don't get us wrong—it's not a *bad* curiosity. The unit is equipped with an *f/2* lens with a 6:1 zoom ratio. That just tells you that, at its maximum telephoto position, the lens' focal length is six times its focal length at its wide-angle extreme. What you really need to know are the lens' minimum and maximum focal lengths, which are 11mm and 66mm, respectively. That still doesn't tell you much, because, not knowing the size of the image it focuses on the camcorder's CCD pickup, you have no basis of comparison with any other camcorder. Aha! There's a paragraph down at the bottom of page 70 of the manual that states that in 35mm-camera terms ("35mm" refers to the width of the film used in the camera and has nothing to do with the focal length of the lens) that equates to a range of 58.5 to 351 millimeters. Now we're getting somewhere but ... wait a minute ... can that be right? The "normal" lens used with 35mm cameras has a focal length between 50mm and 55mm. Does that mean that the maximum "wide-angle" position that the Handycam lens can zoom back to is still "more telephoto" than that of a plain-vanilla 35mm-camera lens?

Yes, it does. We checked with Sony, not believing what we had read, and independently compared the TR5 Handycam lens' field of coverage with that of the 50mm lens on our 35mm SLR camera. Sure enough, the manual is correct, and the "wide-angle" focal length of the lens is such only in comparison to its rather substantial 66mm (351mm in 35mm-camera terms) telephoto one.

When you take time to think about it, the philosophy Sony has applied here makes a lot of sense, especially in a camcorder intended for casual videomakers. For one thing, you can do something with a camcorder that you can't do with a still camera—you can pan. If there's too much scenery to fit into the viewfinder at once, start at one end of the vista and swing around slowly until you get to the other. If you do need a true wide-angle shot, you can purchase a supplementary lens to mount in front of the camcorder's built-in one. Sony supplies a screw-in adapter for that purpose.

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This month in GIZMO®

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CIRCLE 51 ON FREE INFORMATION CARD

Taping it on the Road

SANYO MGR95R FM STEREO/AM RADIO PORTABLE CASSETTE RECORDER. Manufactured by: Sanyo, 21350 Lassen Street, Chatsworth, CA 91311. Price: $89.99.

Have you ever been out listening to a personal stereo, or to the radio portion of a portable cassette player, when something came on that you knew would be gone forever if you couldn't put it on tape? And you couldn't, so it was? Well, among the others to whom that must have happened were the engineers at *Sanyo*. They responded with the little *MGR95R* that we recently tried.

This small portable cassette player is also a recorder, and contains an AM/FM radio section to boot. It is not expensive—with a list price under $90—but it performs quite nicely in general. We found the little (4½ × 3¼ × 1½-inch) black-plastic-cased unit quite convenient to carry about with us; it weighs only a hair under 10½ ounces, with two "AA" cells and a cassette included. Power can come from the two "AA" cells just mentioned, from a rechargeable nickel-cadmium battery pack available from Sanyo (the pack fits in the recorder in place of the throw-away dry cells), or from an optional AC adapter that also recharges the NiCd's. Sanyo has thoughtfully designed the recorder so the cells can be recharged simply by plugging in the AC adapter; you don't have to keep taking the NiCd's out and putting them back in.

As a player, the MGR95R is good, although nothing out of the ordinary. It does its job well, but without much in the way of bells or whistles. Tapes can be listened to in either single-play fashion, where the player automatically reverses at the end of the first side to play the second and then stops when it has completed one play cycle, or in a "continuous" auto-reverse mode that switches from one side to the other and back again until you become tired of hearing the same stuff over and over again. You can also change the direction of tape travel manually at any time.

There is no noise-reduction circuitry, but there is something called "EBSS" (Extended Bass Sound System) that can be switched in to add a noticeable low-frequency "kick." There's also a normal/metal switch for playback that introduces a high-frequency cut to compensate for the edge that CrO_2 and metal-formulation tapes have at that end of the spectrum. That switch might also prove useful in reducing the shrillness of tapes that have been recorded on other equipment using noise-reduction techniques when you play them back on the MGR95R.

Sanyo thoughtfully provides a belt clip for the unit that attaches with a big easy-to-turn screw so you can take it off or put it on with little difficulty (we left ours on all the time), so—naturally—we attached the player to our belt and went out for a brisk walk. We found the speed stability of the little unit to be pretty good. As is the case with others of its ilk, stability was worst when we wore the player at our side. When we moved it around to the small of our back, perpendicular to our direction of travel, the irregularities introduced by our movements died down considerably.

The phones that come with the MGR95R are of the ear-bud type, but come—in "audiophile" fashion—without the foam earpads that supposedly swallow up the high frequencies. The "buds" can be attached to a supporting headband if you like, and are color-coded (red is "right" and blue is "left") for convenience. The phones' connecting cable also doubles as an antenna for the FM tuner.

The AM- and FM-tuner sections of the MGR95R worked pretty well, although we found the FM section to be a bit lacking in selectivity. (Most people probably won't even notice, though.) The tuning mechanism is mechanical and located in the recorder's flip-up cover, connected to the unit's electronics by a flat printed-circuit-type cable running into the case. The radio section is activated by sliding the tape/radio switch—also located on the cover—to the radio position and the AM/FM/FM-stereo switch to whatever mode you desire. A tiny LED illuminates to indicate FM-stereo reception.

Recording from the radio is simple. With a blank tape in place, you simply push the play and record buttons, located next to one another, and whatever it is you're listening to will wind up on tape. Level control is automatic, and, although we found our unit to be a bit on the sensitive side, the recordings we made from the radio section played back fairly well, even on our big sound system. It's not a good idea to move around while you're recording since any change in signal quality, be it strength or interference, introduced by your movements (remember, the headphone cable doubles as an FM antenna) will be reflected on the tape. For AM, there's a ferrite-core loop antenna built into the unit and as you take the receiver/recorder around corners, signal strength will vary tremendously. Best to record sitting down or, better still, while you're not even wearing the unit.

There's also a tiny stereo microphone (again color-coded, with red and blue dots) included with the MGR95R that plugs into a red-ringed (to avoid confusion with the headphone output) jack. With the tape/radio switch in the tape position, pressing the play and record buttons together puts you into the "record-from-microphone" mode. As in recording from the radio, the record level is set automatically. The mike that came with our unit was extremely sensitive (we're beginning to wonder whether there's an internal record-level adjustment that was turned up too high in our recorder) and we had to be careful not to overload it to distortion by speaking too close to it. Keeping our distance, though, the results we got were quite good and, again, reproduced well even on our big system. We would have liked some sort of record-level indicator however, even if was only something as simple as a peak LED.

There's a small clip on the mike that you can use to attach it to an article of clothing—not something we'd recommend in view of the sensitivity problems we had—and also included with the recorder is a separate small metal clamp-like object that's not mentioned in the manual and whose use we were at first unable to decipher. (Maybe it was a clip to hold the pages of the manual in place while reading it in a stiff breeze?) It turns out that this artifact is—we think—a mike stand. You clip the mike to the metal "clamp," which you don't really clamp to anything but rather sit on a flat surface with the mike facing the sound source. Well, that's the way we used it, at least.

Sanyo's MGR95R, in sum, is a competent little machine. It is far from being of professional caliber, but it doesn't carry a professional price tag, either. It plays tapes well, provides you with off-the-air music and news, and can record both off-the-air and live material. It can keep you entertained going to and from work and will even find use while you're there ... or anywhere else for that matter. ■

Sound and Safe

SAFE & SOUND STEREO ACTIVEWEAR. Manufactured by: Sport Electronics, Inc., P.O. Box 1412, Northbrook, IL 60062. Price: $34.

CIRCLE 52 ON FREE INFORMATION CARD

A few years ago we were much taken with a device called a Bone Fone. The Bone Fone is like a headphone ... only different. You don't wear it on your ears; you wear it around your neck. And no, it's not just a couple of speakers that you hang over your collarbone. The transducers are speakerlike, but they do more than just project sound into the air. Since they rest against your collarbone, when the transducers vibrate, your collarbone vibrates. And because, as someone with a medical bent once put it, "we're all connected inside," the vibrations are carried up to your head where you hear them from the *inside*. It's sort of like thumping your head with a pencil, only a lot more entertaining.

One of the problems with the Bone Fone was that, while it was great for sitting and listening, whenever you got up and started dancing (or whatever) you lost a lot of the effect. And if you really got moving, you lost the Bone Fone, too. Perhaps as a remedy to that, the creator of the Bone Fone, *Sport Electronics*, is now marketing a device that works on the same principle but that you can wear a lot more comfortably. Indeed, you really do wear the *Safe & Sound* personal listening device—it comes as part of a jacket or sweatshirt!

Whatever the piece of apparel (our Safe & Sound unit was part of a lightweight athletic jacket), the transducer part is zipped into a compartment that, when you don the jacket or shirt, fits around your neck. One transducer is on the left, and the other on the right (the two are in a single fabric package, separated by a length of material that acts as a separator—or maybe it's a connector). You can remove the transducer unit when it's time to clean the garment, and Safe & Sound even suggests taking it out and wrapping it in a towel to lie on or to sling around your neck in warmer weather. A cable with a miniature stereo plug at the end snakes down inside the jacket to a pocket that's large enough to hold a personal stereo or portable CD player. Safe & Sound supplies a bit of Velcro material should you want to keep your music machine from slipping around in there.

The sound from the Safe & Sound unit is a mixed quantity. It is far from high-fidelity; indeed, our unit sounded a little to us like a radio or TV simulation of an AM radio broadcast, heavily filtered to restrict its frequency response. That's a shame, because our recollections of the original Bone Fone include a very rich texture, due in part to the bone-conduction phenomenon. It may be that because of the physical restrictions involved in fitting the Safe & Sound transducers into a garment—they are contained in the collar of the jacket—contact with your body is minimal. (The effect was probably not helped by the fact that the weather was rather cold when we used the unit and that we usually had on a sweatshirt or sweater beneath the jacket, which is really more of a windbreaker. Perhaps the sweatshirt model is better in that regard.) Indeed, we discovered—by using the tried-and-true scientific method of sticking our fingers in our ears—that very little sound was being transmitted internally; most of it was reaching us through the air. That could account for the fidelity problem.

However, even with minimal bone-conduction, the effect from the Safe & Sound unit was quite something. Because some of the sound is diffused by your body, it takes on a directionality and spatial quality of a sort that's different from what you would obtain from either speakers or ordinary headphones. You discover you are hearing with more than just your ears, and while you can easily locate sound sources, the soundstage becomes broad and deep. At the same time, as you turn your head, you are turning it within the soundfield and not, as would be the case with ordinary headphones, turning the source of the sound as well. The overall effect is quite pleasant.

The sound is not loud—indeed, while it is adequate, you may find that you need more than just a little one-"AA"-cell radio to drive the transducers properly—but there is enough of it. On the other hand, this listening device is not going to destroy your eardrums.

When we used the Safe & Sound unit with a radio that normally depended on the earphone cable to act as an antenna, we ran into some slight difficulties. The cable that connects the Safe & Sound unit to the radio's headphone jack is shorter than the usual headphone cables, and in marginal-signal areas may not provide enough pick-up to eliminate noise altogether. Still, most of the time it worked pretty well.

There are a couple of reasons for the "safe" in "Safe & Sound." First is the fact that there's no external headphone cable to snag on anything, or for you to watch out for as you pump your arms vigorously during your exertions. We didn't realize how conscious we had been of that cable until we no longer had to concern ourselves with it. Indeed, although it's not a big deal, we took some pleasure in not having to unknot the headphone cable, or having to make sure the phones were oriented correctly and on snugly, before setting out on our walks. All we had to do was throw on the jacket, turn on the radio, and there was the music.

A much greater safety factor derives from the fact that the Safe & Sound reproduction system does not cover your ears. And the facts that your ears are uncovered and that the music the Safe & Sound system reproduces is not blasting directly into your ears mean that you are much more receptive to sounds emanating from around you. Those include sounds that may carry warning information—sounds such as barking dogs, automobile horns, police sirens, and so forth. You can even "tune in" to the leaves rustling on the trees, or the birds singing.

There is no decision in yet on whether devices such as the Safe & Sound system are legal for use where headphones are not—driving an automobile, for example—but there are still plenty of places where the unit can be used and enjoyed without even having to consider that problem. We liked the convenience of being able to just put on the jacket and get the music right away. The question now is, what are we going to do when the weather warms up? Maybe they could make one built into a swimsuit...? ■

SONY HANDYCAM

(Continued from page 1)

Another reason for starting with such a "long" focal length may arise from the fact that most people—whether because of shyness or because they want to "get it all in"—don't get close enough to their subjects. When you shoot Uncle Mel and Aunt Lucille you want to see *them*, not them and the house across the street, and the cars parked down the block, and the sunset .... Getting the amateur videotaper closer to his subject than he thinks he is may be Sony's contribution to better composition in home videos.

There's a lesson to be learned from that. The zoom ratio that's always boasted about in camcorder ads really tells you very little about the lens. You have to know at least one of the endpoint focal lengths—and the size of the image area—to make a judgment about the lens' wide-angle-to-telephoto performance.

Leaving the subject of optics to return to the camcorder itself, there are a surprising number of useful features built into the little TR5 that you might expect to find only on larger units. A number of those consist of manual overrides that the advanced videotaper can employ when he feels his judgment is better than that of the camera's automatic systems, or just when he needs to do something out of the ordinary.

For instance, the camcorder allows you to adjust both focus and white balance manually. The former permits you to get sharp pictures of scenes that the camcorder may have difficulty bringing into focus—images in mirrors, or shots through windows where strong reflections are involved. You can use the manual-focus mode for macro (extreme closeup) shots, too.

The white-balance control makes it possible for you to get more accurate color rendition under difficult lighting conditions than the camera can provide by itself. In addition to selecting automatic color balancing, you can choose among an outdoor (sunlight) position, an indoor (incandescent light) position, or one marked "hold," in which you point the camcorder at a white object and let it adjust its internal filtration so it sees the white as *white*, rather than trying to average into white all the colors in the scene it is trying to capture. Those colors might not always average out to white—in a brilliant sunset, for example—and setting the white balance using a white card (which you *know* is white!) can yield superior results. There is an interesting section on illumination and color balance at the back of the manual.

And, speaking of sunsets, a backlight button allows you to add extra exposure when you're shooting into the light. That keeps you from winding up with the subject in the foreground (which is what you were hoping to capture) in deep shadow while the sky in the background is perfectly exposed. With the backlight control, the foreground is more-or-less properly exposed against a slightly overexposed background. The function locks until it is released by pushing the backlight button again or until the camera is turned off. That lock frees your left hand for such things as pushing the fade button.

Ah yes, the fade button. On most camcorders we've used, you push the button (and hold it depressed until you're done) when you want to fade into or out of a scene. On the TR5, after the button's been pushed you can let go. The camcorder will automatically fade you in and out when you start and stop recording. In the interests of better video, the manual cautions you against overusing that automatic fea-

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L*D*C*S*

SANSUI CD-X311 LDCS CD PLAYER. Manufactured by: Sansui Electronics Corporation, P.O. Box 625, 1250 Valley Brook Avenue, Lyndhurst, NJ 07071. Price: $445.

CIRCLE 53 ON FREE INFORMATION CARD

What sets the *CD-X311* compact-disc player from *Sansui* apart from most of the others on the market today is not its front-panel features—of which there are plenty, by the way—but what goes on inside it. Rather than using the conventional time-tested digital-to-analog conversion techniques, this player is one of the first commercially available models to use the new "MASH" (which, somehow, is supposed to stand for "multi-stage noise shaping") system originally developed in Japan by the Nippon Telephone and Telegram Company to improve transmissions of digital signals over its lines. Since we are going to see a lot of that system in the future, and since this is the first CD player using MASH-based technology that we've reported on, we'll spend most of our time on what goes on inside, rather than outside, the CD-X311.

First for the outside, though. The player comes with all the usual amenities: 20-track programmability, a random-play function, remote control, and so on. A feature perhaps not also found on a number of other CD players, though, is called "Compu Edit." When you're going to transfer a CD to tape, you tell the player the length of the tape per side (it knows a few standard lengths and you can enter others in one-minute increments) and it selects the number of tracks that will fit on that side. That is not a random function; the player starts at track one and continues through in order until it finds the track that will put it over the limit. It does not select that one, but records all those before it. In other words, it is not a process that optimizes tape usage by picking and choosing selections of varying lengths to make up a target total, but simply one that ensures you will not cut off a selection in the middle as you run out of tape. When one side of the tape is complete, the selections for the other side of the cassette pick up with the next unplayed CD track and continue until the maximum tape time again is approached. The player's blue-green vacuum-fluorescent display shows you the total playing time of the selections that have been programmed.

Another useful feature of the CD-X311 is the ability to adjust the output level from the remote control (incidentally, not all the player's front-panel functions are available from the remote; much of the programming must be done at the unit). That control adjusts the level of both the headphone jack and the line-level outputs that go to your amplifier. It's a nice convenience if your amp doesn't have its own remote.

In conventional digital-to-analog converters all the bits in a single word are treated as a single entity. As the bits representing each sound sample come off the disk in serial form, one at a time, they are collected and lined up until the word is complete. That word is then processed in parallel as a whole. Most of the processing takes place in the digital filter, where oversampling and noise shaping are performed. The digital word that ultimately results is supplied all at once to the player's D-to-A converter, which turns it from digital to analog form.

In most current CD players, D-to-A conversion is performed by switching current through a series of resistors. Each resistor, or set of resistors, represents one bit. The network is weighted so the most significant bit switches the greatest voltage. The output of the D-to-A converter is a voltage proportional to the sum of the values of bits making up a digital word, and this voltage defines a single point on the reconstituted audio signal.

There are a few problems with that type of D-to-A conversion. The first is that, if accuracy is to be maintained, the resistors must be very precisely matched—which is very expensive to do. And, no matter how carefully matching is done, there is still room for error, which eventually shows up as discrepancies between the waveform that was recorded and the one that's reproduced. The switching process that turns current to the resistors in the network on and off can also generate transients that introduce spurious information.

The MASH process—Sansui's version, incidentally, is called "LDCS," for "Linear and Direct A/D Conversion System"—relies on pulse-width modulation to reconstitute the audio waveform. Each pulse is of the same amplitude, but the number and relative values of the bits that create the pulses determine those pulses' duration and density. By electronically plotting pulse width against time, a sine wave representing the analog audio waveform is generated. There are no fancy resistors involved in the process, and only one or two capacitors. Since there is no switching, just a few components, and only a single voltage involved in the process, several sources of nonlinearity in the reproduced waveform are eliminated, with the result of greater fidelity to the original. Incidentally, the lessened requirement for a lot of high-precision components is said also to reduce the cost of manufacture of a MASH-type player to less than that of a "comparable" conventional-design one.

The MASH process is a fast one—it operates at 256 times the CD sampling frequency of 44.1 kHz, or 11.2896 MHz! That's the equivalent of sixteen-times oversampling in a conventional player. And, as the oversampling rate increases, extraneous information such as quantization noise—glitching that is a natural, but unfortunate, result of the digitizing process—decreases in intensity. Additionally, harmonics that may be generated by the digital signal's square-wave nature are, shifted *w-a-a-a-y* up in frequency, where their intensity is less and where they can very easily be filtered out. The end result of that noise-shaping process is a quieter and cleaner analog signal.

Finally, the high oversampling rate reconstructs a large number of intermediate samples from the information supplied by the CD. That, taken together with the lack of quantization noise, makes for accurate reproduction at low signal levels, where original information is scarce.

That, in short, is what happens inside the CD-X311. The result is not bad. We have a few CD's with extremely quiet passages and, playing them, did seem to be able to discern something of a difference there between what we heard from the Sansui player and our own old-style one. We also noticed much more high-end information, not all of which we could attribute to the response curve of the player's analog-output section. Perhaps we were hearing a cleaner and more accurate reproduction of what was on the CD. It's been said that the digital recordings for many early CD's were made using miking techniques more appropriate to black-vinyl reproduction, where the highs needed a boost to overcome attenuation that occurred later in the manufacturing process. On some CD's that showed up as an overly bright, sometimes strident quality, and that is what we may have heard for the first time from some of our discs. That, we suppose, is the price of progress. ■

The Walrus and the Carpenter's Tool

SEIKO HC-1000 HOME CONTRACTOR CONVERSION COMPUTER. Manufactured by: Seiko Instruments Inc., 2990 West Lomita Blvd., Torrance, CA 90505. Price: $89.99.

At first you think it's maybe a new type of handheld subspace communicator, or possibly the handle from a *Star Wars* light saber. But it's not. Despite its futuristic appearance, *Seiko Instruments'* new *Home Contractor* is nothing quite that advanced. What it is, is a measurement and conversion computer for handymen—an electronic replacement for tape measures and conversion tables. If you're a high-tech do-it-yourself member of the *This Old House* crowd, or even if you're into construction or renovation for the money, this could be quite a handy device for you to have.

About as big as a medium-size flashlight, the Home Contractor's primary function is to measure distances between interior surfaces. Doing away with tape measures and rulers, it determines distances electronically. The Home Contractor works on the same principle as sonar; it emits pulses of ultrasonic sound and then listens as their echoes are returned from reflecting surfaces. (It doesn't "*ping*" like the *Red October*, or squeak like a bat; it makes small snapping sounds, like those created by a spark jumping a gap. Since the transducer is described in the specifications as being "electrostatic," perhaps that is not surprising.) By measuring the time interval that elapses between the origination of the sound pulse and its return, and relating that to the speed of sound (approximately 1080 feet per second at sea level), the unit can calculate the distance between it and the surface at which it is aimed.

Using the Home Contractor for calculating distances is simple. You aim it at the far surface (say, the opposite wall of a room) and squeeze one or both of the two levers recessed conveniently in its sides. The device emits four bursts of ultrasonic sound (which you hear as those snapping sounds) and, when it has made a distance determination, it beeps rapidly four times. You can then read off the distance—in feet-and-inches, in decimal parts of a foot, or in meters—from a large six-digit LCD. It appears that the device takes four readings (hence the four snaps) and either averages them or perhaps makes its calculations based on "the-best-three-of-four" principle. You can see each distance flash briefly on the LCD as it's calculated, and not all of the four are the same.

Distances are calculated from the butt of the unit (which you normally place against one of the surfaces defining the distance you are measuring). The effective range of the Home Contractor is about 33 feet, but that can be more or less doubled if you stand between the two surfaces and take a reading first in one direction and then in the other. A sum button lets you add the two. Just remember to pivot the device around its back end, which is the point from which distances are measured.

However, determining how far it is from one side of a room to the other, or from its floor to the ceiling, is just the beginning of the Home Contractor's capabilities. By measuring the length and width of a room (and pressing the large "L" and "W" buttons to store each measurement in the unit's memory) and then pressing the area button, you can calculate the room's area in square feet or meters, and if you measure the floor-to-ceiling distance as well, its volume in cubic units. You can calculate wall areas by measuring the height and width of the surface, entering them as length and width, and then pressing the area button. The system assumes, of course, that areas it calculates, and the volumes they determine, are those of simple rectangles. If you're dealing with irregular shapes, you'll have to break them up into smaller rectangular areas with which the device can deal. If you're into remodeling grain silos or wells, or any other spaces with circular cross-sections, you'll have to do the required calculations yourself.

Measuring and calculating linear distances, areas, and volumes, is still not all the Home Contractor can do. Turn it over and there's another, more complex array of buttons and another LCD, that one with eight digits. Some of the buttons (which, by the way, are much tinier, and which we found harder to work with, than the large ones on the "measurement-computer" side) bear the familiar calculator-type markings; you can use this side of the Home Contractor as an ordinary calculator when you need one. Other buttons bear labels the likes of "heat," "4 × 8," and "paint."

This is where the device turns from being a "simple" carpenter's tool to a *contractor's* tool. By entering, say, an area calculated on the "measurement computer" side into the calculator on the "conversion computer" side—alas, you can't just push a button and have a value passed from one side to the other—and then pushing the one marked 4 × 8, the calculator will determine for you how many four-by-

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Slimming Down

BONDWELL B310 SUPERSLIM 80286 LAPTOP COMPUTER. Manufactured by: Bondwell Industrial Company, Inc., 47485 Seabridge Drive, Fremont, CA 94538. Price: $3695.

It was just about ten years ago that the first portable computer saw the light of day. It was the Osborne 1, a system about the size of a salesman's sample case and weighing ... well, the saying was that if you could carry the computer *and* something else, it was portable; otherwise it was "transportable." The Osborne 1, with its 5¼-inch disk drives and five-inch CRT, was definitely a transportable. Since MS-DOS had not yet been invented, it used an operating system called CP/M. And, at least in the first models, you had to plug the computer into the wall to power it. Despite its primitiveness by today's standards, the Osborne computer was quite popular in its day and gave rise to a number of imitators.

Today, of course, our laptops—they're no longer "transportables," or even "portables"—have rechargeable batteries built in, use little 3½-inch plastic-shell floppies with capacities as great as 1.44 megabytes, have thin, flat LCD screens, and come off-the-shelf with about a million bytes of RAM (the Osborne 1 had 64K).

Adam Osborne demonstrated that there is a big market for portability, however you may define it, and even if you have to sacrifice some convenience (the Osborne 1's screen couldn't display 80 characters at a time—you had to scroll it sideways to read long lines of text.) Even today, with the latest in consumer-electronics technology, we must often "give with one hand so we can pick up and carry with the other."

That is the case with the *B310 Superslim* laptop system from *Bondwell*. The computer has a lot going for it and, if you weigh its capabilities against your needs, it may prove to be exactly what will do the job for you. However, in achieving its design goals, Bondwell also had to leave out some things you may consider essential to your purposes.

The B310 is billed as "the world's smallest and lightest laptop," and it may very well be that. The case measures just 13 × 12.2 × 2.2 inches, and the system's weight, including its 1.8-ampere 7.2-volt battery pack (to which we'll return), is a mere 8½ pounds. That really *is* light, and it is a pleasant surprise to grasp the built-in handle (which folds into a recess in the bottom of the case when not in use) and pick up the computer so effortlessly. The unit's center of gravity is such that it can be put down and rested on its rear end with the handle sticking up as you shuffle forward in the car-rental line at the airport (although, to be honest, we'd feel more comfortable if the center of gravity were still lower than it is). And, as long as nothing is plugged into the printer connectors or external power/recharger jack at the rear, you can do the same at home when you lift the unit off your lap (that's why it's called a "laptop," right?) to get up out of your easy chair. If the power jack had been located at the side of the case, you could have left the computer plugged in when you set it down.

The B310 comes with what Bondwell feels is necessary to your on-the-road or off-the-desk computing—a fast (25 ms.) 40-megabyte hard-disk drive, a 1.44-megabyte 3½-inch floppy-disk drive, and a megabyte of RAM divided into a lower 640K and an upper 384K of extended memory. You can add another megabyte of RAM if you need it. The CPU is a CMOS 80286 running at 12 MHz. The display, to which we'll also return shortly, uses a supertwist LCD and is housed in a hinged panel that folds down to lock and cover the keyboard when you're not using the computer. The cover has two "sight glasses" that let you see the Power and Ext. Power/Charge indicators even when it's closed, a convenient feature. The keyboard is, thankfully, full-sized; its right-hand side also doubles as the numeric keypad when a key marked "Fn" is pressed. You should also note that the keyboard has no Pause/Break key. If you're into BASIC programming and don't know how to use Control-C, that could present a problem. (But, of course, you do.) There are indicator LED's to show when the Caps Lock and Fn keys are down and locked. The layout of the cursor-movement keys is a bit unorthodox—as seems to be the case with every laptop we've used—but that should not take much getting used to. Ten function keys are arrayed, in the new style, across the top of the keyboard. There are no F11 and F12 keys.

At the rear of the computer are a pair of 9-pin D connectors for two serial ports, and one 25-pin one for the parallel port. There's also a 9-pin RGB Out connector for an external color monitor (CGA-type).

The B310 comes with MS-DOS 3.3 and GWBASIC, and uses a BIOS from the reputable Award Software; there should be no software-compatibility problems. We did encounter a conflict, though, between Microsoft Word and a built-in utility that, among other things, is supposed to tell you the amount of charge left in the battery pack. When we tried to invoke that utility from within Word, the system locked up and we could only get started again by rebooting. We suspect that the conflict arose from the fact that Word does not rely on the system's character generator but prefers to define for itself everything it shows on screen, while the rest of the system uses the Extended ASCII characters built into its ROM. Use caution, therefore, when using programs like Word, and maybe graphics programs as well. (We thought of installing Windows to further verify that, but there's no place on the computer to connect a mouse.)

And that parenthetical remark brings us to one of the sacrifices that had to be made

CIRCLE 55 ON FREE INFORMATION CARD

to get the B310 into such a small, slim package: With the exception of the second megabyte of RAM mentioned earlier, there's no way to expand the computer internally. Not even a second floppy-disk drive or internal modem can be added. (You could, we suppose, add one of those miniature external modems from Touch-Base!) Not that there's anything really essential left out of the system, but if you feel you're going to need something more, forget it. There's no place for you to install or connect it.

And, while we're on the subject of essentials, we may as well mention the LCD. It's not backlighted. Using the computer the first time at night in a not-too-well-lit room we thought the display was defective, or that the battery was low, or maybe just that our eyes were tired. It appeared fuzzy and was hard to read. The problem wasn't anything like what we had supposed, just that we had expected the (relative, for an LCD) clarity of a backlit screen, and it wasn't. That is another one of those size-and-weight tradeoffs you'll have to take into account when deciding whether this system is for you.

The B310's power pack, probably again to keep weight and size down, is not especially hefty. A capacity of 1.8 amps might sound like a lot, but it isn't when you're calling on the batteries not only to do your computations, but also to drive the LCD and hard- and floppy-disk drives as well. That is probably one of the reasons there's no backlighting; to conserve power. Another power-conservation measure consists of a configurable timer in software that shuts off the hard-disk drive motor and the LCD after a specific interval of inactivity (of the drive or keyboard). Start-up again is automatic when you need it. You can disable that feature if you like, but our advice is to use it. With moderate hard-disk accesses, our fully-charged battery pack started flashing its "Low Batt" warning after roughly 1¾ hours. Recharging takes about eight hours (an outboard charger is supplied) and, although it will slow down charging considerably, the computer can be used at the same time the battery is being topped off.

A power-saving measure you might want to try is setting up a RAMdisk; our system came from Bondwell already configured to establish a 384K RAMdisk in its extended memory when it was booted. If you can move your disk-intensive program(s) up there, you'll pick up a lot of operating time.

Despite those criticisms, we found the Bondwell B310 laptop computer to be a pretty good performer for a "lightweight" (in more than one sense of the word) computer. Once we sat down with it and came to grips with the engineering sacrifices that had to be made to achieve its admirable compactness and portability, we got along with it quite well. ■

HOME CONTRACTOR

(Continued from page 6)

eight-foot wall panels are required to cover that surface. Similarly, the heat button will tell you how many BTU's are involved in heating a given volume of space. In all, the conversions the Home Contractor can perform based on calculations of area or volume are: "Air" (air conditioning BTU's); "Heat" (heating BTU's); "Tile-C" (2 × 4-foot ceiling tiles): "Tile-F" (10 × 10-inch floor tiles): "Paint" (gallons or liters of paint); "Rug" (square yards); "4 × 8" (wall panels): "Roll" (rolls of wallpaper to cover a surface).

As with the measurement computer, figures can be entered and calculated in Imperial (English), U.S., or metric form. For linear and area measurements, the difference between the Imperial and U.S. systems is simply the difference between presenting the numbers in decimal- or in feet-and-inches form. Be aware, though, that in working with volume an Imperial gallon is nearly twenty-percent greater than a U.S. gallon; make sure you're in the correct mode when determining how much paint you'll need. The Home Contractor manual—which, incidentally, is conveniently sized to fit in the pocket of a pair of overalls—erroneously states that Imperial and U.S. gallons are equal in volume. Don't you believe it! The Home Contractor's "rolls of wallpaper" conversion function is also error-prone.

There's one more thing that the Home Contractor does. Professional contractors, when they charge you for materials, mark up the price. That is, they add a certain percentage to what they paid for an item to cover their time, expenses, and so forth. The calculator side of the unit includes a button marked "mu," for figuring markup (it took us a while to figure out what the label meant; we thought that since that key was located along with the other memory buttons, maybe the label stood for "memory undo" or something like that). By entering the original material cost, and then pressing mu and entering the percent of markup, you are supposed to be presented with the price you should charge your client. Unfortunately, there seems to be a bug in the Home Contractor's ROM, and the percentage it adds is more than what you instruct it to (we've known real contractors like that, too.) You're better off using the calculator's % key, which can do the same thing.

That aside, Seiko's Home Contractor seems to be a very useful tool. It's certainly more accurate than a sagging tape measure (and can easily be used by a person working alone), and being able to do on-the-spot materials calculations electronically can be a great time saver. If you push the right buttons it may even be more accurate than pencil-and-paper and save you time, money, and materials. ■

SONY HANDYCAM

(Continued from page 4)

ture. By the way, the TR5 fades to and from white, not black.

We've saved the best feature—for our money, at least—for last. The TR5 Handycam has a titling facility. No, not a character generator, but simply a quantity of RAM that's used to store single frames of video that can then be superimposed over the "live" video. The idea is that you neatly letter your title on a white card and, pointing the camcorder at it, store it using the memory button. You can then use the title either as shot, in reverse video (white-on-black), or in any of six or seven other colors (depending on whether you count white and black as colors). You can even make titles scroll into a scene from the bottom of the frame, and scroll out the top. If you don't want to superimpose the title over other distracting video, just record it against a neutral background.

We cheated and created a number of titles on our computer, using a desktop publishing program to get a selection of type sizes and styles, and shooting right from the screen. Freezing the titles in memory did away with any flicker problems that might have arisen from differing scan rates, and the results were quite impressive.

If you haven't guessed by now, we were quite taken with the TR5 Handycam. While we could have wished for just a *few* more special features to meet our particular requirements, this camcorder does an incredible job, especially for its size. The novice videomaker will appreciate the TR5 Handycam for its small size and weight and ease of use. The more serious user will value even more the array of features that permit him a degree of control and creativity not usually found in such a small package. ■

Coming Next Month in GIZMO®

- Northgate Slimline 320 80386 Computer System
- Toshiba Model 3200 Facsimile Machine
- Recoton Power Wave TV600 Indoor Amplified Antenna
- 3-D TV Model 2001 Home Stereo Theater
- And much more

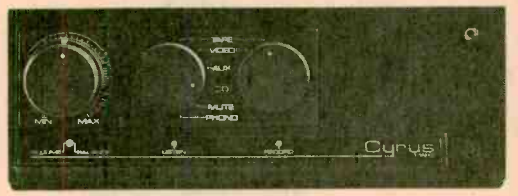
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

High-Current Integrated Amplifier

The impedance of a loudspeaker system varies considerably over the audio frequency spectrum. And as a speaker's impedance changes so does the amount of current it requires from the amplifier driving it. Many amplifiers find themselves taxed to (or beyond) the limit when demand for current exceeds what they can supply. Not so with the *Cyrus Two* integrated amplifier. According to its manufacturer, *Mission Electronics USA Inc.* (18303 8th Avenue, Seattle, WA 98148), this amplifier is rated at 50-watts-per-channel into eight ohms, and is designed to deliver as much as 50 amperes without straining. (An additional DC-power supply, the *Cyrus PSX*, can be added to increase output to 70 watts with a 50-ampere continuous-current capability.) To maintain low distortion in the signal path, the Cyrus Two employs military-grade components and uses straight-line signal paths that contain as few connections as possible. Signal inputs go directly to the volume control, pass to the power amplifier, and are delivered to the outputs. Distortion is further reduced through the use of an electrically transparent chassis and cover, which ensure that any electromagnetic fields radiating from the unit will not be reflected back inside. Price: $799.

CIRCLE 56 ON FREE INFORMATION CARD



Mission Amplifier

Trundling Down the Bunny Trail

Why should you have all the fun? Kids three and older will get a kick out of *Remo Rabbit*, an eight-inch-tall plastic rodent trained by *Bondwell* (47485 Seabridge Drive, Fremont, CA 94538) to follow a plastic carrot. The carrot contains an infrared LED, and a sensor in Remo's nose keeps him going after it, wherever it may be carried. Remo can "smell" the carrot from as much as 20 feet away. He can also tell when he's run into an obstacle, and upon encountering something in his way he spins around and tries moving in another direction. Intended for indoor use, the toy operates on all kinds of surfaces, including carpeted terrain. Price: $24.99.

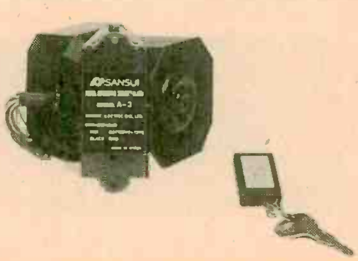
CIRCLE 57 ON FREE INFORMATION CARD


Bondwell Rabbit

Car Security System

Although *Sansui's* (1250 Valley Brook Avenue, Lyndhurst, NJ 07071) *A-3* car security system can be hard-wired to a vehicle's doors, trunk, and hood if desired, all that's necessary at the bare minimum is a single-wire connection to the positive battery terminal (the return is through the chassis, to which the siren/alarm module is mechanically attached). The A-3 system incorporates two sensors. If there is a forced entry, or if an attempt is made to move the car, a shock sensor triggers the siren, which outputs a 128-dB scream. If for some reason the shock sensor is bypassed, a voltage-drop detector senses the change arising from a light going on or the ignition system being turned on, and also sounds the siren. The sensitivity of the unit is adjustable from a handheld remote control that communicates with the user through a series of chirps. The remote is also used to arm and disarm the system. The A-3 meets all legal requirements in that the alarm sequence lasts 40 seconds, and repeats every four minutes until disarmed. Price: $139.95.

CIRCLE 58 ON FREE INFORMATION CARD



Sansui Auto Alarm

Active Speakers

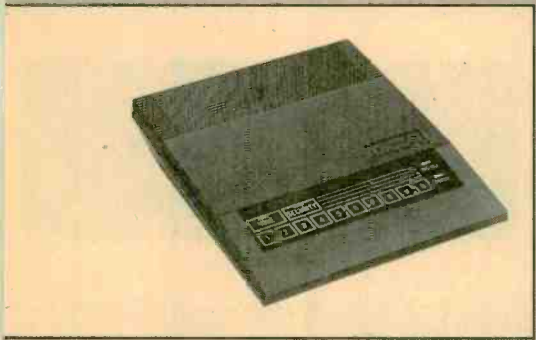
If you need a pair of little speakers to take with you when you travel, take a listen to *Sony's* (One Sony Drive, Park Ridge, NJ 07656) *SRS-37*. The amplifiers in the 5¼-ounce powered speakers are rated at 1.2 watts each, plenty of power to fill a motel room or even larger space. The 3⅛- × 6- × 3⅛-inch units, which contain two-inch drivers, include bass-reflex ports for improved low-frequency response, and have volume controls as well as direct-input switches to bypass the built-in amplifier should that be desired. For convenience in packing and transporting them, the speakers employ an interlocking joint system. Price: $79.95/pair.

CIRCLE 59 ON FREE INFORMATION CARD

Sony Active Speaker

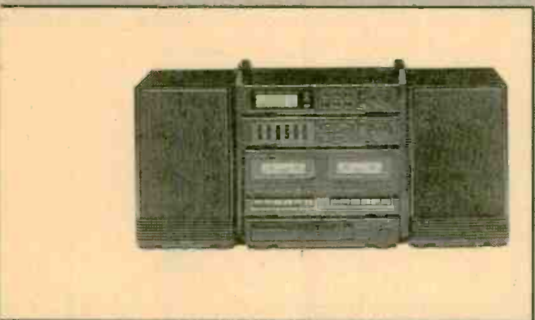
ELECTRONICS WISH LIST

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



Dicon Wireless Burglar Alarm

AKG Headphones



Lloyd's Music System

Tandy Computer

Wireless Burglar Alarm

Dicon's (631 Executive Dr., Willowbrook, IL 60521) new *Dicon 3000* wireless home burglar alarm offers a built-in telephone dialer and emergency-message system, and features a computerized central console that talks to you. In addition, the system—which consists of the central console, a siren, a passive infrared motion detector, and accessories—monitors itself for proper operation and vocally reports its status to its owner. The central console can guide a user vocally through a brief setup procedure, and provides prompts and messages during regular use. Should a break-in occur, the console automatically places calls to up to four numbers (specified during the initial setup procedure) and delivers a digitally stored 15-second message in the owner's own voice. Additional wireless sensors (which transmit digitally encoded FM signals containing unique identifying codes when they are triggered to pinpoint the source of trouble) are available in the form of window and door switches, "panic buttons," extra motion detectors, and pressure-sensitive mats, and up to 30 of them can be used with one Dicon 3000 system. A backup-battery feature—which also tells the user when the battery needs replacement—is included. Price: $399.

CIRCLE 60 ON FREE INFORMATION CARD

Parabolic Headphone

A parabolic reflector in each earcup is said to allow *AKG Acoustics*' (645 Bryant Street, San Francisco, CA 94107) *K 280* headphones to reproduce the left-right perspective of a concert hall. The apparatus, which weighs 8.8 ounces, has a frequency response of 20 Hz to 20,000 Hz, and its rated 94-dB sensitivity indicates its ability to output lots of sound. The K 280 uses an "integrated open air" design that allows high frequencies to dissipate (making for a smooth frequency response) and that also eliminates heat buildup inside the earpiece. Price: $195.

CIRCLE 61 ON FREE INFORMATION CARD

Compact Music System

As compact discs and prerecorded cassettes gain in popularity and acceptance and LP records decline correspondingly, turntables—at least in some circles—are becoming a thing of the past. Sensing that trend, *Lloyd's* (200 Clearview Road, Edison, NJ 08818-7811) has done away with the turntable in its *SoundCube CS 003* compact stereo set. The bookshelf-size unit includes an AM/FM receiver with PLL-synthesized digital tuning and 20-station preset memories, a six-band graphic equalizer, and a dual-well high-speed dubbing cassette deck with auto-reverse. A large multifunction LCD display shows frequency, band, preset memory position, and signal strength. The unit's remote control can be stored in a concealed front-panel drawer and jacks at the rear allow the use of a line-level device such as a CD player. No place to connect a phonograph, though. Price: $119.95.

CIRCLE 62 ON FREE INFORMATION CARD

SX-y Computer

Intel's 80386 SX microprocessor, used in *Radio Shack's* (One Tandy Center, Fort Worth, TX 76102) Tandy 4016 SX desktop computer, is an economy version of its 32-bit 80386 CPU. It achieves that economy by interfacing to the world around it (which includes the computer's data and instruction buses, as well as peripheral support cards) using a word length of only 16 bits, as compared to the full-blown 386's 32-bit structure. That allows the use of existing—and less expensive—16-bit AT-type hardware. At the same time, however, the 80386 SX's 32-bit internal architecture permits it to run software written for high-end 386 systems (as well as for less sophisticated '286 and 8088 ones, of course). The system includes on its main board 16-bit VGA support, a 16-bit SmartDrive IDE connector (hard-disk drives are sold separately), a math coprocessor socket, serial and parallel ports, and a mouse port. For expansion, there are three full-length 16-bit slots and two device bays, one for 3.5-inch- and one for 5.25-inch drives. Also available is a 5.25-inch CD-ROM drive. Price: $1999.

CIRCLE 63 ON FREE INFORMATION CARD

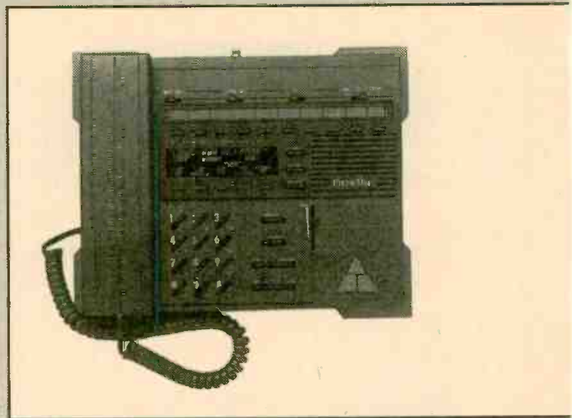
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

DSP Telephone Answering Device

ADAM (All Digital Answering Machine) is, according to its manufacturer, *PhoneMate* (P.O. Box 2914, Torrance, CA 90509-9910) the first TAD to offer digital signal processing. Using a proprietary data-compression algorithm, ADAM's digital-storage system dynamically allocates memory space to store messages, long and short, without wasting valuable RAM. Messages can be speeded up or slowed by 30% during playback to save time or increase intelligibility. Also built into the TAD are a voice-confirmation function for audible verification of commands ("I will save message three"), a large digital display with menu-driven operation, and "handset message retrieval" that lets you play back your messages though the privacy of your phone's handset. Remote-operation features includes a three-digit security code and voice prompts that walk you through remote operation. Price: $299.

CIRCLE 64 ON FREE INFORMATION CARD

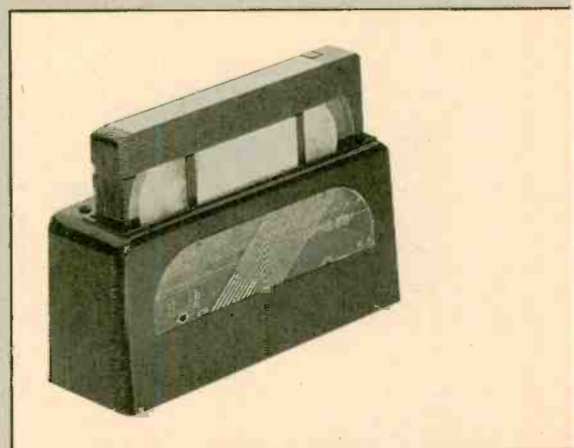


PhoneMate Telephone Answering Device

Toast of the Town?

Many of today's VCR's do not unload the tape entirely from the head drum during rewinding or fast-forwarding; that permits faster access to the tape but also increases wear and tear on it and on the record/playback heads. The solution is a separate rewinder. *Ambico* (50 Maple Street, P.O. Box 427, Norwood, NJ 07648-0427) makes the rewinding process almost as convenient as making a piece of toast. Its *V-0756* drop-in/pop-out rewinder, which is little larger than the tape cassette it holds, has a slot on top into which you insert the tape to be rewound. Approximately three minutes later the job is done (inserting the tape starts the process) and—*pop!*—up jumps the cassette ready for play or storage. A window in the side of the unit allows you see how the process is coming along. Price: $24.95.

CIRCLE 65 ON FREE INFORMATION CARD



Ambico VHS Cassette Rewinder

Maestro de Traduccion

The *Translation Master TMS-500* is the first in what will probably be a long line of electronic foreign-language dictionaries from *Franklin* (122 Burrs Road, Mt. Holly, NJ 08060). The little 13-ounce, 7 × 5 × 1¼-inch, translator recognizes more than a quarter of a million Spanish and English words, using as its source the *Collins Spanish Dictionary*. If you enter an inflected form of a word (the third-person conditional, for example) the device can automatically determine the root form and display the proper entry, and in the event of misspelling it will provide you with a list of the words it thinks you intended to enter from the keyboard. An "inflect" button causes the dictionary to display the conjugated forms of a verb, and there is on-line help available for assistance with such things as "present subjunctive." The Translation Master TMS-500 can also play a variety of spelling and grammar games to help you in learning a language, and even includes a facility for your entering 50 words that you know but that are not included in its ROM's. Price: $299.95.

CIRCLE 66 ON FREE INFORMATION CARD

Franklin Translation Master

Car Cassette-Player/Receiver

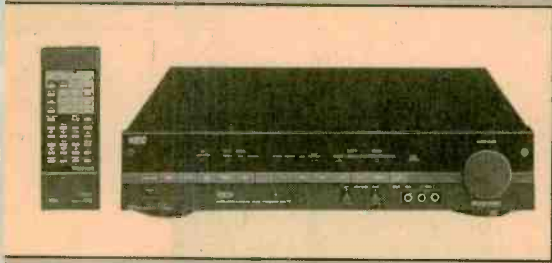
The *KRC-610* is a pull-out, dash-mount, autosound unit whose tuner is especially engineered to combat the intermodulation and multipath distortion often encountered in city-driving situations. The *Kenwood* (2201 E. Dominguez St., Long Beach, CA 90810) unit includes an amplifier whose output is switchable between two channels at 25 watts each and four channels at 15 watts apiece. The cassette mechanism features a special cushioning system and uses a tape head with a double-guttered profile that reduces the tape-contact area to provide more bass and lower surface drag. Front-panel controls include those for the operation of a separate CD player. Other features include parallel speaker fader, Dolby-B noise reduction, and tuner call during fast forward and rewind. The tuner accommodates 16 FM and eight AM presets. Price: $399.

CIRCLE 67 ON FREE INFORMATION CARD

Kenwood Car Radio

ELECTRONICS WISH LIST

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

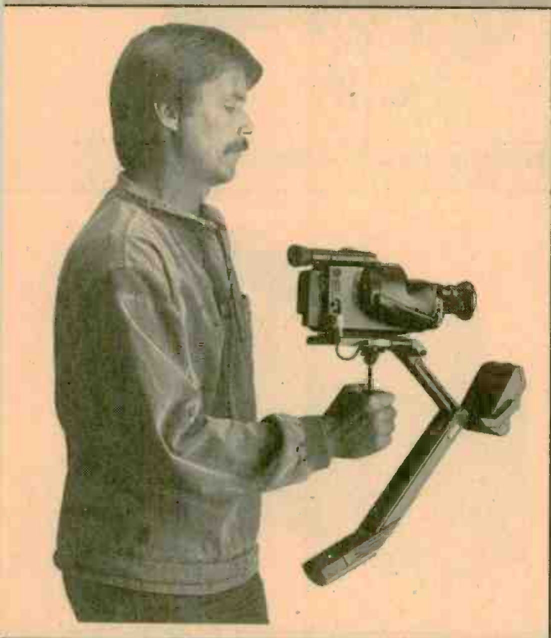


NEC Surround-Sound Decoder/Switcher

Dolby Pro-Logic Decoder with A/V Switching

The *PLD-710*, from *NEC Home Electronics* (1255 Michael Drive, Wood Dale, IL 60191) provides Dolby Pro-Logic surround-sound audio and also serves as an A/V switcher that allows users to link together virtually any home audio/video system. The PLD-710 uses an active decoding system that increases channel separation from the as-little-as-3-dB found in some passive decoders to as much as 26 to 40 dB. Audio information for the rear channel is processed through 16-bit digital delay circuitry that allows independent adjustment of left- and right-channel sound to match room acoustics. A test-tone generator is built in to assist in getting correct Pro-Logic sound balance. A wide variety of input and output connectors is provided, including an auxiliary video input on the front panel for quick camcorder hookup. A handheld remote controls most of the unit's functions, which include a motorized master volume control that lets the user adjust the overall output level of a multi-component system. An on-screen display provides fast and easy reference for input sources, surround-mode settings, and delay times. Price: $599.

CIRCLE 68 ON FREE INFORMATION CARD



Cinema Products Steadicam JR

Steady as She Goes

Next to merciless zooming in and out, probably the most serious videotaping sin is using a camera or camcorder without a tripod. The tremors introduced by even the steadiest of hands can detract from an otherwise flawless shot, and moving shots are next to impossible. Professional filmmakers use a device called a Steadicam to achieve stability in handheld shots. Now, owners of 8mm and VHS-C camcorders (units weighing 3.5 pounds or less) can benefit from the same technology, but a lot more cheaply. The *Steadicam JR*, a product of *Cinema Products Corporation* (3211 So. La Cienega Blvd., Los Angeles, CA 90016) is a 1.8-pound consumer version of the larger 70-pound, $40,000 studio-sized stabilizer, that allows a camcorder mounted on it to float on air and eliminates handheld "shakes." Your camcorder can now become an active participant in the scenes it shoots. The Steadicam JR unit incorporates a low-intensity light for fill, and has a 3.5-inch monochrome backlighted LCD monitor with non-glare screen that frees you from the awkwardness of having to keep one eye glued to the camcorder's viewfinder while you're shooting. Price: $579.

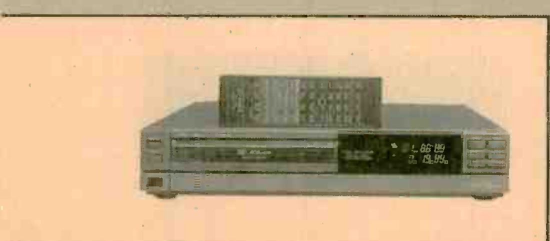
CIRCLE 69 ON FREE INFORMATION CARD

Maxell Formatted Disks

Formatted Disks

Formatting floppy disks is no big deal ... unless you have to do lots and lots of them. To save you time and work, *Maxell Corporation* (22-08 Route 208, Fair Lawn, NJ 07410) is now selling its lines of Gold Standard and RD floppy disks in formatted form as well as "plain." In the 5¼-inch size, 360K MD2-D disks are available to run under MS-DOS 2.0 or higher; the higher-capacity MD2-HD disks, for use with AT-type systems, come formatted for 1.2 Mb. The smaller, hard-shell 3½-inch disks come formatted for 720K (MF2-DD). Finally, at the top of the line are the new 3½-inch Super RD MF2-HD high-density (1.44-Mb, formatted) disks. Those extra-reliable media include such new features as a flex shutter that adheres tightly to the shell to keep out contamination, and an improved outer shell. All these disks can, of course, be reformatted to meet your specific needs, hardware and operating system permitting. Price: Not announced.

CIRCLE 70 ON FREE INFORMATION CARD



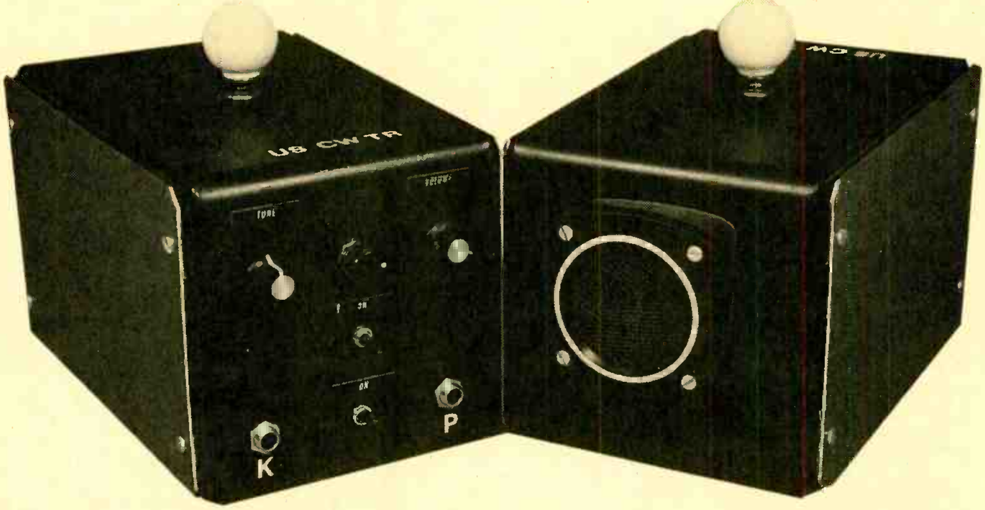
Fisher VCR

Camcorder-Friendly VCR

Intended specifically for camcorder owners who need a full-size VHS deck to meet their dubbing needs, *Fisher's* (21350 Lassen Street, P.O. Box 2329, Chatsworth, CA 91311-2329) *FVH-7400* is a down-to-earth model that, despite its low price, still offers a number of the features that make the difference between good and indifferent transfers. The unit has four double-azimuth heads for optimum performance at all tape speeds, a flying erase head for noise-free transitions from one scene to another, audio dubbing (for adding music or voice after the fact), automatic tracking adjustment, and even a built-in character generator for titling. Front-panel jacks allow convenient connection and disconnection of the playback camcorder or other device. And, naturally, there's a 43-function infrared remote control. Price: $449.95.

CIRCLE 71 ON FREE INFORMATION CARD

ULTRASONIC MORSE-CODE



TRANSCEIVER

Learning the code is the toughest part of earning an amateur-radio license, but this project makes the task much easier and more fun!

BY CHARLES D. RAKES

If I were to tell you that you could travel the world over and meet interesting people and make new friends without leaving home, or spending a bundle on airline tickets, would you be interested? Like to know more?—okay! I'm speaking of a magic carpet that can take you around the world to any location at lightning speeds and the only pilot's license you'll need for these fascinating adventures is a valid amateur-radio license.

Now don't throw your hands up and say "I knew it sounded too good to be true" and go off in a huff, because passing the FCC test is easier now than ever before. The exact questions and answers that will be found on the FCC's written exams are available in a number of study guides. Now it comes down to the last obstacle, learning Morse code.

The code portion of your test need not be the dreaded "thing" that you often hear people complain about. In fact, if the same amount of time was spent practicing code as complaining, the problem would not exist. To begin with, the code is not difficult to learn, and with the "right mental attitude" it can be a real pleasure.

A pair of *Ultrasonic CW Transceivers* can make the chore of learning the code or increasing your speed a lot of fun, and at the same time gives you a hands-on feeling of operating a real radio station. That's right. The design of the Ultrasonic CW Transceiver is very similar in many ways to the transceivers used by licensed amateurs for worldwide communication, except ours operates on the audio, not radio, frequencies so no license is required.

The transceivers offer a QSK (full break-in operation) circuit that makes the transition from the transmit to the receive modes an automatic feature. There's a sidetone generator with tone and level controls built in for self monitoring. The transceiver's ultrasonic output is tunable from about 15 kHz to 25 kHz and automatically produces the same off-set CW audio tone for each receiver.

Outdoors, the transceivers operated at a distance of over 200 feet with a weak but solid signal, and indoors just about everything that was tried worked. The transceivers are basically line-of-sight communicators that work best when facing each other, but indoors the ultrasonic signals can be bounced off walls and other smooth surfaces to work at various angles and even around corners.

Inside the Transceiver. Figure 1 is a complete schematic diagram of the Ultrasonic CW Transceiver. The circuit consists of little more than a pair of 567 phase-locked loop IC's and eight transistors—seven 2N3904 general-purpose NPN silicon transistors and one MPF102 N-channel JFET. The remaining circuit elements serve support functions.

The receiver portion of the circuit is designed around a direct-conversion concept that's used in a number of today's popular, inexpensive receivers designed for CW and SSB (Single-Side Band) only. The incoming ultrasonic signal is picked up via piezo-transducer SPKR1 and fed to the base of Q1

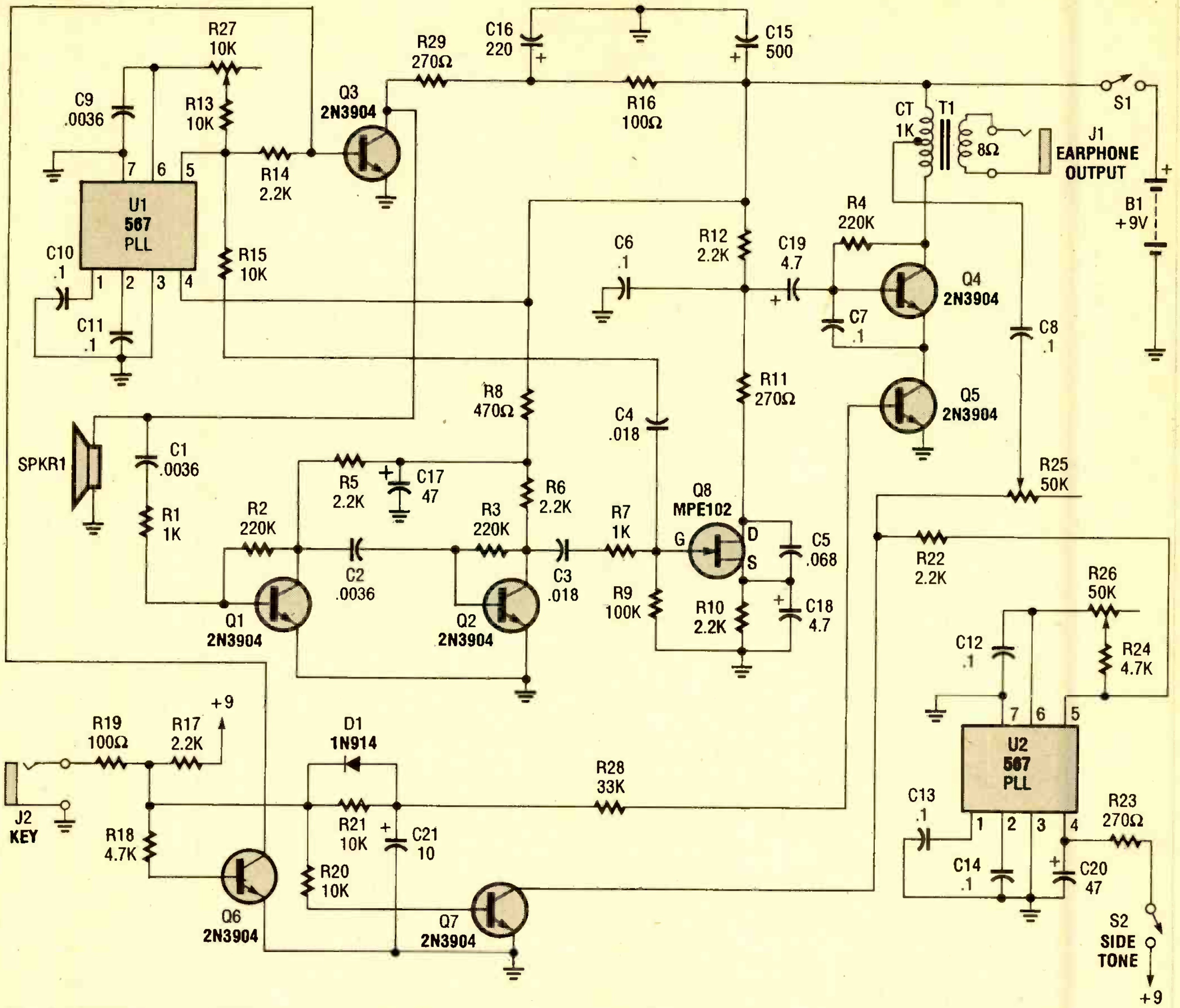


Fig. 1. The Ultrasonic CW Transceivers consist of little more than a pair of 567 phase-locked loop IC's and eight transistors—seven 2N3904 general-purpose NPN silicon transistors and one MPF102 N-channel JFET. The remaining circuit elements are nothing more than support components.

through C1 and R1. Resistor R1 protects Q1's base circuit when the transmitter is operating.

Transistors Q1 and Q2 are connected in a two-stage broadband amplifier circuit tailored to boost audio-frequency signals ranging between 15 kHz and 30 kHz. The JFET (Q8) and its associated components form a product detector, which heterodynes the incoming signal with the frequency of the VFO (Variable-Frequency Oscillator), U1. The signal produced at the drain of Q8 is a combination of the two input frequencies, their sum, their difference, and the two mixing signals.

Components R11, C5, C6, and C7 are selected to roll off the high-frequency content of the detector's output signal, leaving only the difference low-frequency product to pass on to audio-amplifier Q4. The amplifier's output signal is then coupled to the headphones through an impedance-matching transformer, T1.

Phase-locked loop U1 is connected in a VFO circuit that supplies the heterodyne signal for the product detector. Components C9, R13, and frequency-control potentiometer R27 set the oscillator's operating frequency. A second phase-locked loop, U2, is connected in a variable low-frequency oscillator, which is used to supply the sidetone signal to the phones while transmitting. Components C12, R24, and frequency-control potentiometer R26 determine the sidetone frequency.

The transmitter is a combination of the VFO circuit, the QSK circuitry, output-transistor Q3, and piezo-transducer SPKR1. The square-wave output of the VFO at pin 5 of U1 is fed through R14 to the base of Q3. Transistor Q3's output is direct-coupled to SPKR1. Components R16 and C16 decouple the transmitter's high-current output pulses from the power source and other circuitry.

The QSK Circuit. When the transceiver is in the receive mode (that's anytime the transmitter's key is not in a closed position), the base of Q6 is biased on through R17 and R18. The collector of Q6, which is tied to the base of Q3, is switched to ground, removing the drive signal from the base of Q3. As long as Q6 is biased on, the transmitter can not operate.

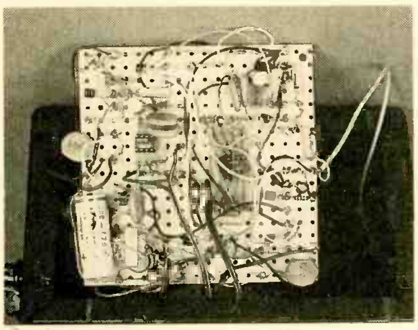
Transistor Q7 is biased on through R17 and R20, clamping the sidetone signal present at the junction of R22 and R25 to ground. That keeps the sidetone from being heard while the transceiver is in the receive mode. Also Q5 is biased on through R17, R21, and R28. The collector of Q5 switches the emitter of Q4 to ground, allowing the audio amplifier to operate in a normal manner.

When the transmit key is closed, the voltage at the junction of R17 and R19 drops to near zero. Transistor Q6 turns off, allowing the VFO's output to reach the base of Q3, turning it on to drive SPKR1. At the same time, C21 is rapidly discharged through D1, R19, and the key contacts to turn Q5 off. Transistor Q5 releases Q4's emitter from ground, disabling the audio-amplifier circuit while in the transmit mode. That keeps any keying or transmitter signals from blasting through the receiver circuit to the headphones.

Components R21 and C21 determine the time delay for the transceiver to automatically return to the receive mode after the key is in the off or up position. A faster or slower response time can be obtained by changing the value of R21. For a faster response time, reduce R21's value and for a slower response time, increase its value.

Also during the time that the key is closed, Q7's forward bias is removed allowing the sidetone audio to pass on to the headphones through the tap on T1. The sidetone frequency is set by R26 and the audio level by R25.

Building the Transceivers. The two transceivers are housed in metal cabinets measuring 8 × 5 × 5 inches, but any similar-size enclosure will do. There's no need to stick with metal cabinets as plastic or wood ones will work just fine. The majority of the circuit components were mounted on a piece of perfboard (measuring 4¾- × 4¾-inches square) using push-in pins. The actual layout of the circuit is noncritical, but it is recommended that sockets be used for the IC's.



The bulk of the Ultrasonic CW Transceiver's circuit components were mounted on a piece of perfboard measuring 4¾- × 4¾-inches square and housed in a metal cabinet measuring 8 × 5 × 5-inches. The actual layout of the circuit is noncritical, but it is recommended that sockets be used for the IC's.

PARTS LIST FOR THE ULTRASONIC CW TRANSCEIVERS

SEMICONDUCTORS

U1, U2—567 phase-locked loop, integrated circuit
Q1–Q7—2N3904 general-purpose, NPN silicon transistor
Q8—MPF102 general-purpose, N-channel JFET
D1—1N914 general-purpose, small-signal, silicon diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units)
R1, R7—1000-ohm
R2, R3, R4—220,000-ohm
R5, R6, R10, R12, R14, R17, R22—2200-ohm
R8—470-ohm
R9—100,000-ohm
R11, R23, R29—270-ohms
R13, R15, R20, R21—10,000-ohm
R16, R19—100-ohm
R18, R24—4700-ohm
R25, R26—50,000-ohm potentiometer
R27—10,000-ohm potentiometer
R28—33,000-ohm

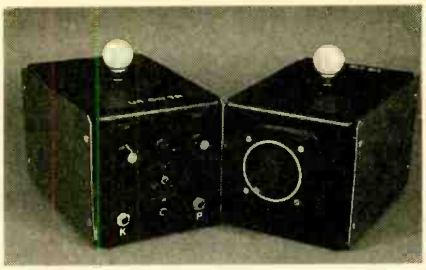
CAPACITORS

C1, C2, C9—0.0036-µF, 100-WVDC, Mylar
C3, C4—0.018-µF, 100-WVDC, Mylar
C5—0.068-µF, 100-WVDC, Mylar
C6–C8, C10–C14—0.1-µF, 100-WVDC, ceramic-disc
C15—500-µF, 25-WVDC, electrolytic
C16—220-µF, 25-WVDC, electrolytic
C17, C20—47-µF, 16-WVDC, electrolytic
C18, C19—4.7-µF, 16-WVDC, electrolytic
C21—10-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—9-volt (6 AA-cell) battery pack
SPKR1—Piezo speaker (Radio Shack 40-1383 or similar)
S1, S2—SPST miniature toggle switch
J1, J2—Monophonic phone jack
T1—1000-ohm to 8-ohm, audio-output transformer
Perfboard materials, enclosure, IC sockets, code keys, headphones, snap-on battery connector, wire, solder, hardware, etc.

To avoid stray pickup, keep component leads and interconnecting wiring as short as possible. Also, to keep the transmitting voltage spikes contained, a short length of shielded microphone cable was used to connect the piezo transducer to the circuit. Assemble the circuit using Fig. 1 as a wiring guide.



All of the transceiver controls, as well as the headphone output, antenna input, and the piezo transducer are mounted to the panels of the enclosure—the controls and input/output jacks on one end panel of the enclosure and the transducer on the opposite end.

Once the perfboard-mounted components have been wired up, connect the off-board-mounted components to the appropriate points on the board. Once that's done, prepare the cabinets that will house the transceivers. All controls, as well as the headphone output, antenna input, and the piezo transducer are mounted to the panels of the enclosure—the controls and input/output jacks on one end panel of the enclosure and the transducer on the opposite end. The piezo transducer is mounted to the cabinet on 1-inch aluminum spacers.

Checking the Transceivers. Set all control potentiometers to mid range, plug in the headphones and key, and turn S1 on; you should hear a "rushing" noise. Flip S2 to the on position and close the key. You should hear the sidetone oscillator, be able to adjust the frequency of the sidetone using R26, and set the level with R25.

It's possible that a low-level sidetone signal might be heard with the key in the up position, but the level should be so low that it wouldn't be a problem. And if the sidetone signal interferes with "DX'ing," simply turn the sidetone oscillator off by opening S2.

DX'ing. Our best "DX" operating frequency turned out to be about 20 kHz, which is about mid-range of R27. Separate the two transceiver units by about 50 feet and have the other operator close the key. Adjust your TUNE control for the desired tone. Then when you transmit back, the other party will hear the same CW tone. Keep the units facing each other and increase the distance between the transceivers to see how far a solid QSO can be made. ■

TELEV

BY JAMES T. HAWES

Grandfather was a clever fellow. His house ran like clockwork, despite its lack of many modern conveniences. It worked smoothly because Grandfather was a doer, and in his "spare" time, he was a do-it-yourselfer. He enjoyed exploring the handyman books stacked in a cubbyhole of his tool shed. And then a different type of magazine appeared on his workbench—a radio magazine. Grandfather had built a run of radio sets, and then he started toying with something new—television!

In the late Twenties and early Thirties, television was transmitted on the shortwave "police" bands. No station required more than 100 kHz of bandwidth. A few required only 5 kHz, one percent of today's TV-channel bandwidth. That's the same width as an AM sound broadcast! In fact, a few narrowband television stations could be tuned in on the AM (medium-wave) broadcast band. Station WRNY (which stood for Radio News, New York City), Hugo Gernsback's New York station, is one example. But when WRNY's flickery signal incited eyestrain, hobbyists turned to the shortwave bands. (To fit its 36-line pictures in the 5-kHz bandwidth, WRNY could only transmit 7.5 frames per second, and the pictures alternated with sound!) Shortwave stations weren't restricted to the bandwidth of AM broadcast-band stations. Furthermore, a partner AM broadcast-band station might provide accompanying sound for a shortwave picture broadcast.

Even so, the November, 1928 cover of *Radio News* featured Hugo Gernsback watching his mechanical television station (see the photo at the beginning of this article). An AM broadcast band receiver resides on the middle shelf of the cabinet, left. The radio's speaker is in the cathedral cabinet atop the bookshelf. The large cabinet on the right is the television scanner. Images appeared behind the top aperture. Apparently the images were magnified. Mr. Gernsback holds the manual framing control (pendant switch) in his left hand. Also notice the cable that carries the picture signal from the radio receiver to the television scanner.

How Grandfather Did It. That's all well and good, but how did an average guy contrive a television receiver in his tool shed? First, he gathered his materials together: an aluminum disc from the five and dime, an old electric fan, a rheostat, a pendant pushbutton switch on a long cable, a large neon "kine" tube (also from the five and dime), electronic parts for a resistance-coupled amplifier, plywood, stain, paint, glue, and varnish.

First he prepared the shiny, 24-inch 20-gauge aluminum disc. Grandfather used a compass to find the center of the disc. Then he marked 45 even pie wedges on the disc. Next, he measured and center-punched the locations for 45 holes. He arranged these holes in three spirals. On a local machine shop's drill press, Grandfather drilled the center hole and the 45 "scanning holes". Then he located a large radio knob with a wide apron in his junkbox. He bolted the apron to the disc (see Fig. 1) with the knob's hole aligned with the center hole of the disc.

Next, Grandfather disassembled the old fan, discarding the cage and blade. He slipped the knob and disc over the fan motor shaft and tightened the knob's setscrew. Then he built an enclosure for the motor and disc assembly. With a keyhole saw, he cut the one and a half-inch window for the picture. He painted the disc, fan motor, and box interior flat black. When the paint dried, he mounted the motor and disc assembly inside the box.

The fan motor was the universal AC/DC type. Its speed could be regulated with a wirewound rheostat. Grandfather installed a 20-watt "Clarostat" in series with the motor to do just that. He also wired the normally-open pendant switch across the Clarostat. Careful adjustment of the Clarostat would set the disc speed at the prescribed 900 rpm. Momentarily pressing the pendant

SION NIGHT

Take a journey back to the days when television required a motor and a shortwave radio to operate!

switch would speed up the disc to frame the picture. 1928 GE television sets designed by prominent inventor Ernst F. W. Alexanderson used that same technique.

Directly behind the disc and visible from the small window, Grandfather mounted the kine tube. The picture would be the size of the neon tube's cathode. From the socket, Grandfather ran wires to a resistance-coupled amplifier he'd assembled earlier. A resistance-coupled amplifier was necessary because of its flat response. Transformer-coupled amplifiers provided more gain per stage, however their response tended to be less than flat, particularly at high frequencies.

Grandfather's amplifier (see Fig. 2) had three stages: Typically, two 01A, 40, or 24A preamp tubes and a 10 or 45 power-amp stage. The preamp ran on 135 to 180 volts DC. Depending on which tubes Grandfather used, the preamp voltage gain ran between 144 and 400. The amplifier's output drove the neon tube. Grandfather squeezed more brilliance from the neon tube by raising the power-amp voltage to 300 volts.

What Viewers Saw. Now the moment of truth. It was a sultry Wednesday evening, a "Television Night," according to the *Chicago Daily News*. The show was to begin in half an hour. Grandfather strode through the door with *the box*. It had a deeply-rubbed finish, matching the radio set on the corner table. Grandfather had matched the faithful Kennedy TRF radio for a reason, which became clear as he set the "vision set" down beside that receiver. With alligator clips, Grandfather connected the television amplifier across the Kennedy's grid-leak detector load resistor. Next, Grandfather adjusted the television amplifier's bias; the kine tube had to just barely glow with no signal present at the amplifier's input.

Grandfather's pocket watch informed him that the time was near. He tuned the receiver to a peculiar shortwave station that produced buzzsaw sounds, then he flipped a toggle switch, fiddled with the rheostat, and grabbed the pendant switch. Grandmother switched off the room lights and everyone focused their attention on the tiny window at the front of Grandfather's cabinet. Behind the window lay the faint red glow of the marvelous kine

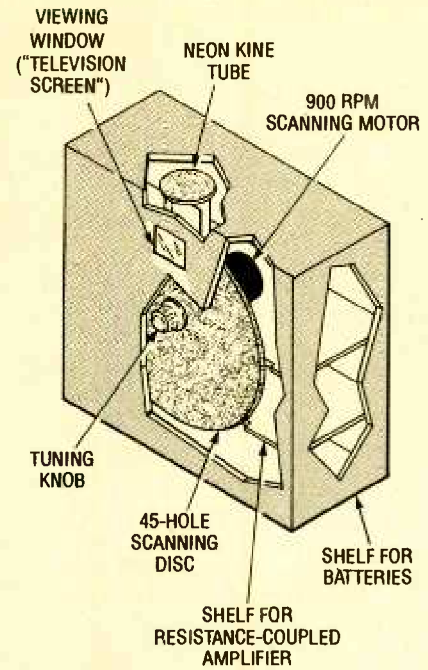


Fig. 1. This is a phantom view of a mechanical television receiver. Notice the relationship between the view screen disc and neon kine tube.

tube. The tube was about four inches long, but its glowing cathode was only an inch and a half square. Grandfather assured the family that soon a picture would glow from within it.

Meanwhile, somewhere in Chicago, other preparations were taking place. There, a man named Ulises Sanabria stood behind a mysterious mighty glowing transmitter console. Grandfather had told the children so many stories about it they could just imagine what that must look like. Sanabria was a brilliant *wunderkind*; in his twenties, he was already a high priest of mechanical television's inner sanctum.

About then, Sanabria must have nodded the go-ahead signal at his chief engineer, because then the children saw something. First a flicker, then a pattern. It wobbled, strayed to one side, then the other, and then it stabilized. At last, the children saw what Grandfather's television had wrought. It was an old cartoon, just like in the movie theater. It was followed by a boxing match, a playet, and a minstrel show. Fleeting images produced by a fleeting technology. An entertainment supernova, the show was over in less than an hour. Then, at last, Grandfather flipped the toggle switch and the miraculous pictures became buzzsaw noises again. Grandfather gave Grandmother a peck on the cheek, and they sent the children to bed.

How It Worked. How could a scanning disc and neon tube replace a picture tube? Imagine looking through the viewing window and disc holes at the neon tube cathode. The neon tube provides the gray tones and the disc arranges them into a picture as follows: Turning the disc slowly, you see one hole at a time pass the viewing window. As the disc moves, each hole that appears is slightly lower than its predecessor. Consequently, each hole scans across one scan line of the television picture. The neon glow varies with the incoming signal to determine the intensity from moment to moment. When spinning, the holes travel so fast that the scan lines merge into a frame of video. Your persistence of vision performs a miracle and merges scan lines into a picture.

Grandfather's disc was a descendant of the one invented in 1884 by Paul Nipkow. Nipkow was a native of Leipzig, Germany. The original scanning disc had one spiral of 24 holes near its rim. In Grandfather's time, some stations still only required one spiral of holes. They didn't employ the Midwestern rage: interlaced scanning!

Which brings us to mechanical interlacing. Sanabria's interlacing scheme worked this way: First, the disc scanned lines 1, 4, 7, 10, 13, 16 and so forth. The second spiral on the disc scanned lines 2, 5, 8, 11, 14, 17 .... The third spiral completed the picture with lines 3, 6, 9, 12, 15, 18 .... However, there were other stations that transmitted non-interlaced pictures with a different number of lines than 45. Grandfather couldn't receive those on his 45-line scanning disc.

Grandfather used the 45-hole scanning disc to pull in Chicago stations W9XAO and W9XAP. Those stations both transmitted 45-line, triple-interlaced pictures at 15 frames per second. Interlacing was purported to reduce flicker between frames. Today's three major world TV standards (PAL, NTSC and SECAM) all include interlacing.

Later, Grandfather built a 48-hole disk for Jenkins' broadcasts from Maryland's W2XAP. A third disc permitted "high-resolution" reception in the early-thirties standard of 60 lines. NBC station W2XBS, Jenkins Television's outlet W2XCR, and CBS station W2XAB all transmitted 60-line pictures from the New York area. All required a 1200-rpm motor for 20-frames-per-second reception. Hollis Baird transmitted 60-line pictures from Boston's W1XAV. His Shortwave & Television Corp. also sold receiving sets.

The Television Station. When Grandfather wanted to chase DX with his 45-hole disc, he tuned-in W9XK. Their signal from Iowa was regularly viewed in Chicago. In fact, it was seen as far away as Texas. Ulises Sanabria's Western Television equipment was used throughout the W9XK facility. The University of Iowa (then the State University of Iowa) sponsored that pioneering educational television station. Experiments commenced in 1933. The picture transmitter put out 100 watts on a channel from 2 to 2.1 MHz. Sound was transmitted by the university's AM station WSUI, where I worked 40 years later.

The W9XK studio was similar to most

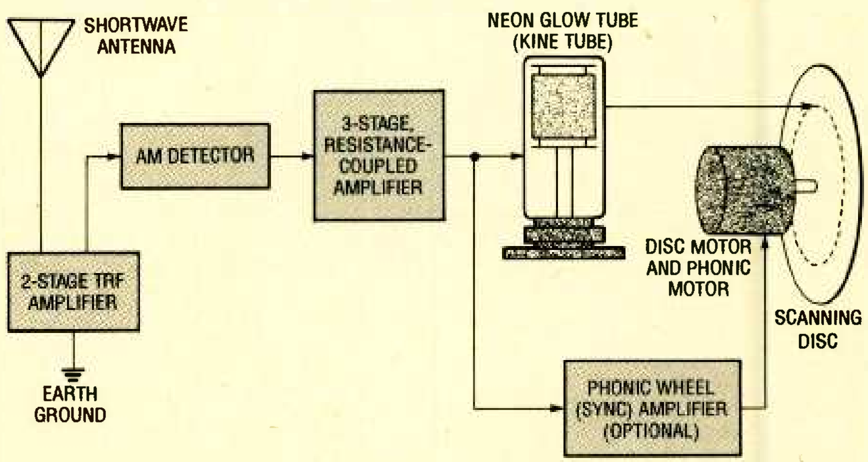


Fig. 2. In a typical mechanical television receiver the TRF amplifier and AM detector were often located within the viewer's shortwave-radio set. A manufactured set might include a synchronizing device called a phonic wheel. That required an additional two-stage amplifier. The phonic wheel shared the motor shaft.

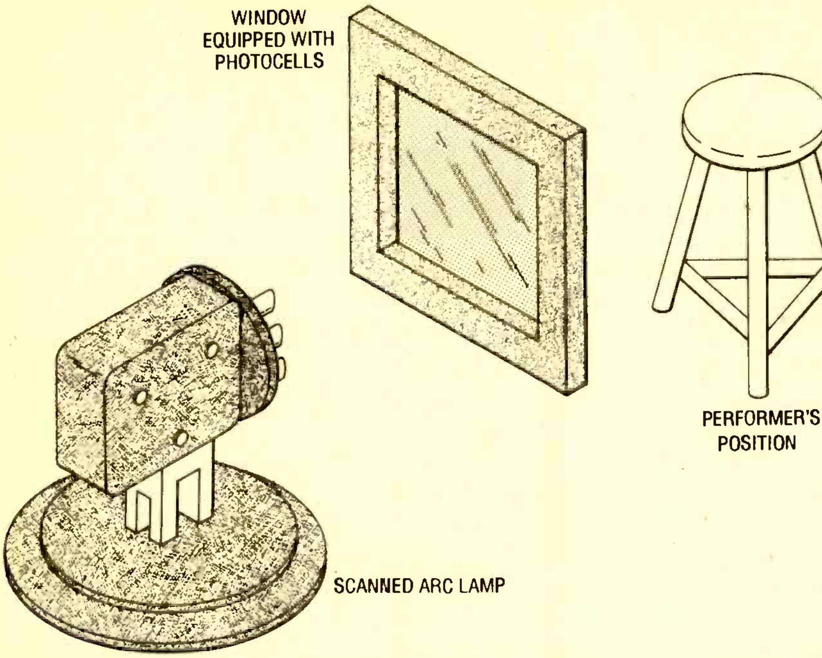
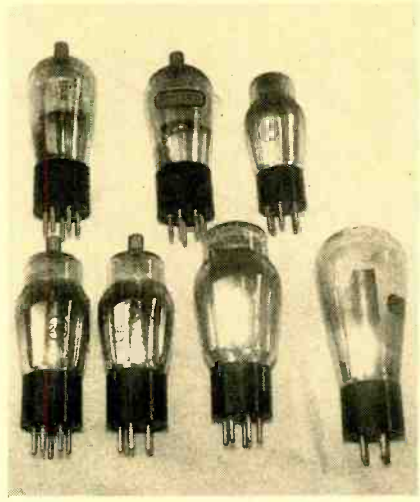


Fig. 3. The scanned arc lamp (left) trained its beam through a window onto the scene to be transmitted. The window (actually much smaller than depicted) was studded with large photocells. Those cells, mounted in plate-sized parabolic reflectors, faced the scene.



Here are some typical tubes a 1930's builder might have used in his television receiver. Moving left to right, on the top row are a 24- and a 35-type RF-amplifier tubes, and a number 27 detector In the second row, again from left to right, are two 24A audio preamplifiers, a type 47 power amp to drive the neon tube, and a model 80 rectifier.

mechanical television installations (see Fig. 3). W9XK's engineers told the course instructor to be seated before a peculiar window. Countersunk into the frame of this window were 10 photodiode tubes. The tubes, wired in parallel, read the light reflected off the instructor. The resulting photocurrent was fed to a sensitive preamplifier. A power amplifier followed the preamp. The fortified signal modulated the transmitter's carrier wave.

The studio's lighting was also unconventional. During a television production, most room lights were switched off. Performers, familiar as they were with classroom light, complained that the studio was inadequately illuminated. Because of the early mechanical camera design used, the situation couldn't be helped.

The "camera" (really a flying-spot scanner) consisted of two parts: the first part was the window just described; the second part was a scanned, point-source arc lamp. A disc with the identical spiral pattern to that in Grandfather's receiver scanned the arc. At the front of the disc housing, a lens turret focused the lamp's beam through the window and onto the instructor. Despite working directly before a powerful arc lamp, the instructor perceived the light as very dim. The reason for this perception is that never more than a thin dot of light struck the instructor at once. Since ambient light would interfere with image reproduction, it was shut out during telecasts.

This is the author, with the scanning disc from his ¾-scale model of a mechanical receiver. The disc has two 24-hole spirals. Antique discs for 24-line pictures were typically 12 inches in diameter.

Later mechanical-television technology produced true, one-piece cameras. They were the precursors of modern cameras. The improved mechanical cameras could be used in ambient light, or even outside.

Other Stations. Two other educational television stations also operated in the thirties, however they had no sound channel. W9XG was located at Purdue University and W9XAK at Kansas State. Each station transmitted 60-line pictures. A special license allowed all three educational stations to continue broadcasting on the shortwave bands. Other stations converted to higher-resolution, wideband electronic equipment and had to transmit on VHF. While electronic television experimentation proceeded in the rest of the world, Iowa concentrated on producing television programming.

W9XK's programming consisted of academic lectures, cooking demonstrations, and related fare. The shows lasted only fifteen minutes. Throughout the Depression, W9XK transmitted programs to Grandfather's scanner. But good things must eventually end. The last show "spun out" of the W9XK facility in 1939. Today, all the station equipment is gone. Apparently it was dismantled long ago.

Grandfather's Heritage. Before the Great Depression made it a lost art, Grandfather's television machine left a legacy. Our modern sets still scan from left to right, like most U.S. mechanical sets. The vertical rate, once based on line frequency, is still about 60 Hz. Pictures are still transmitted in AM. Furthermore, mechanical video devices still exist. Facsimile and videotape recorders are two. Videodisc players are a third. Other technologies also borrow from mechanical-television technology. Some fishermens' depth gauges and guitar-tuning aids contain a spinning disc and neon bulb.

(Continued on page 96)

RADIO'S FORGOTTEN PIONEER

Lodge demonstrated the existence of electromagnetic waves independently of, and at the same time, as Heinrich Hertz.

BY JAMES P. RYBAK

Oliver Lodge felt the sharp emotional pain that accompanies profound disappointment and frustration as he read the July 1888 issue of Wiedemann's *"Annalen der Physik."* He read about how the young German scientist, Heinrich Hertz, recently had generated electromagnetic waves (or "ether" waves as they were called at that time) and even had measured their wavelengths. That was precisely what Oliver Lodge, himself, had accomplished in his own laboratory at University College in Liverpool, England!

Lodge had heard rumors of Hertz' success some months earlier but had not let those rumors affect the pace of his own work. But the rumors were true and the world would recognize Heinrich Hertz, as the one who first established the existence of the electromagnetic waves predicted by James Clerk-Maxwell's equations.

However, Lodge was not bitter. He was enough of a true scholar and gentleman to recognize, respect, and acknowledge the elegance of the approach taken by the young German. Hertz's experimental approach was more sophisticated than Lodge's. Lodge had used discharges from Leyden jars to produce standing waves along wires. Hertz's waves were not confined to wires but traveled in free space. Lodge wondered why he, himself, had not thought of Hertz's technique.

That major disappointment was not to affect Oliver Lodge's future research. He was already recognized as an accomplished scientist and his later achievements would earn him even more respect. In the course of attempting to produce electromagnetic waves, Lodge had discovered the phenomenon of electrical resonance and was the first person to send a signal by true radio-telegraphy. He later patented the world's first wireless telegraphy system.

The work of Oliver Lodge, like that of Hertz, Marconi, and many others, came to be widely recognized as critically important in the development of "wireless" communication techniques. A pleased King Edward VII even knighted him for his achievements.

Beginnings of a Career in Science. Oliver Joseph Lodge was born on June 12, 1851 in the English village of Penkhull. As a boy he attended a rigorous boarding school, which he strongly disliked despite his desire to learn. When he was about sixteen, an aunt had invited him to come to London for a few months of schooling. Lodge's enjoyment of learning flourished while there after having been almost totally extinguished during his boarding-school days.

Oliver took a variety of classes in London but found the physical sciences, with their fascinating demonstrations, to be the most interesting. He returned home to help with the family business, but was able to take classes in science and mathematics in nearby towns. Inspired by a magazine article, Oliver found performing experiments in electricity to be particularly enjoyable.

Oliver eventually returned to London where he became a full-time student in the science program at University College. While he was quite good in chemistry, physics was clearly his chief interest.

Oliver passed the examinations for a degree with the highest possible honors in physics. He continued his pursuit of physics, concentrating his efforts on the study of electricity, and was awarded a Doctor of Science degree in 1877 at the age of 26.

Lodge discovered that he had the ability and desire to give talks, complete with interesting demonstrations, on scientific topics to virtually any kind of audience. Those were the kind of lectures that initially got *him* interested in science. In fact, in 1879 he published his first book, which was a text written for those with little scientific background. In the years to come, he would become highly sought after as a lecturer.

Off to Liverpool. Oliver Lodge wanted to obtain a position as a professor in the physics department of an established university, but was unsuccessful. He had to settle for a professorship in experimental physics and applied mathematics at the new University College in Liverpool, which was being formed to provide supporting courses for an already existing medical school. The entire faculty at first consisted solely of Lodge! After the first term, however, additional faculty were hired in literature, history, and philosophy.

The building was formerly an insane asylum and part of Lodge's laboratory was once a padded cell. There was, as yet, no equipment for teaching physics. Lodge convinced the governors of the new college to allow him to visit the major universities of continental Europe to obtain ideas and equipment for his new assignment.

Among the places on Lodge's itinerary was the University of Berlin where he met the famous Professor von Helmholtz and his assistant, Heinrich Hertz. After returning to England, Lodge failed to maintain close contact with Hertz even though both had similar research interests and considered themselves friends; that clearly proved to be a mistake on Lodge's part.

Administrative and teaching duties kept Oliver Lodge busy in Liverpool, but he also found time to pursue his interests in electrical research. One topic involved examining why a dust-free region exists in the air around a heated body. In the course of that study, Lodge applied a voltage to a conductor in a smoke-filled enclosure and observed that an extremely large dust-free region was produced with the dust being deposited on the walls of the enclosure. That finding eventually resulted in the development of the electrostatic precipitator for removing particulate matter from chimney smoke.

Another of Lodge's research interests involved lead-acid storage batteries. He studied the effects of various charge and discharge rates on the performance of storage batteries. Lodge also developed an understanding of how the internal resistance of a battery changes as discharge occurs and how internal resistance affects the terminal voltage of the battery. Further, He was able to explain how voltage is actually produced in a lead-acid battery, something that was not very clearly understood back then.

The results of both those research projects were presented by Lodge to scientists from throughout the British Empire at a meeting of the British Association for the Advancement of Science, a highly respected scientific society, held at Montreal in 1884. Speaking to that group gained the 33-year-old Lodge world-wide recognition and respect as an outstanding researcher.

Lightning Strikes! In 1887 the Royal Society of Arts asked Oliver Lodge to give two lectures on lightning conductors. At the time, Lodge, like most, knew very little about the topic. Lodge was asked to give the lectures because he was a recognized authority on electricity in general. The research he would do concerning the behavior of lightning discharges would ultimately result in his establishing the existence of electromagnetic waves and in his discovery of resonance.

It was widely recognized that a lightning discharge is produced when the potential difference between a cloud and the earth increases, due to the accumulation of electric charge, until the intervening air electrically breaks down and becomes a conductor.

Lodge theorized that that is identical to how voltage across a capacitor can be increased until breakdown of the dielectric occurs. He, as most other scientists at the time, knew that the discharge of a Leyden jar (capacitor) produced an oscillatory current rather than a direct current. Using that observation, Lodge astonished the scientists in his audience by claiming that a lightning discharge is oscillatory, too.

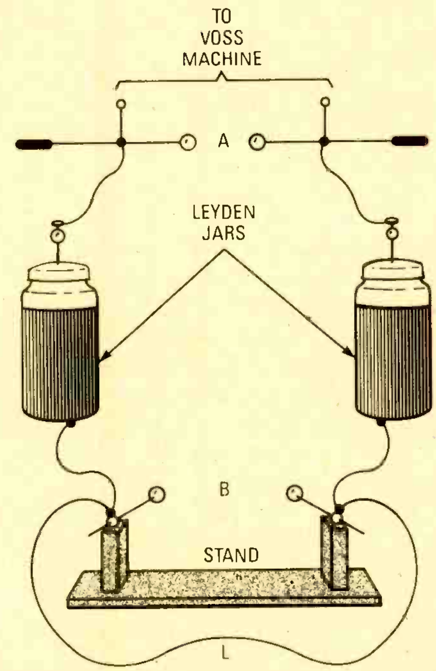


Fig. 1. This is a depiction of the apparatus used by Lodge to demonstrate that lightning is a high-frequency discharge. It would rather flow through the high DC-resistance air gap (B) rather than the low DC-resistance wire (L).

The designers of the lightning protection systems of that time had assumed that lightning is a direct-current discharge. Accordingly, lightning protection systems consisted of a good electrical conductor being placed as high on a building as possible and connected to an earth ground by a conducting cable with a very low DC resistance. Consequently, they could not understand why lightning discharges often did not flow through the low resistance cable from the roof-top to ground. Frequently, the lightning discharge would jump from the cable and follow an alternate, much higher resistance path to ground.

When Lodge gave his lectures in March of 1888, he argued that since lightning discharges have a very high oscillatory frequency, it is necessary to take inductance into account. Unfortunately, inductance was not a very well understood or accepted concept in those days.

Lodge maintained that, at the frequencies involved in lightning discharge, the inductance of the conducting cable could result in a very high opposition to alternating current flow. Therefore, the path actually followed by the lightning discharge did indeed exhibit the lowest opposition to the current flow, even if its DC resistance wasn't the lowest.

Oliver Lodge had spent only about two weeks performing some preliminary "alternate-path" experiments to confirm his theories prior to the lectures. He had used Leyden-jar discharges to simulate lightning flashes. The Leyden jars were usually charged using a "Voss machine" that generated static electricity through friction. The experimental arrangement used by Lodge is shown in Fig. 1.

The Voss machine was connected to the terminals marked "A." Those, in turn, were connected to the inner conductors of two Leyden jars. The outer conducting surfaces of the jars were connected to an adjustable spark-gap (denoted "B"). Then a long loop of very low resistance wire (L) was connected between the spherical terminals of the spark-gap.

The electrical charge stored in the Leyden jars could flow either through the very low DC-resistance path provided by the loop of wire, or it could flow across the very high resistance path through the air across the spark-gap. It would seem that the obvious path for the charge to follow would be through the wire. Nonetheless, Lodge was able to produce very large sparks across the gap, even though the DC resistance of the wire was much less than 1 ohm. Most astonishing was the fact that the sparks produced at the spark-gap, B, were larger than those that could be produced at the terminals, A, by the Voss machine.

Lodge insisted that the reason the flow of charge chose the obviously higher DC-resistance path across the spark-gap was due to the inductive reactance of the wire loop. Those in attendance who did not subscribe to Lodge's inductance theories were quick to question the accuracy of simulating lightning with Leyden-jar discharges. Particularly questionable, they argued, was the idea that a lightning discharge is oscillatory. The critics wanted more convincing experiments to be performed. The issue could not be resolved satisfactorily at the March lectures. Further discussions were scheduled for the September 1888 meeting of the British Association.

Oliver Lodge continued his alternate-path experiments during the spring and summer of 1888 with the purpose of determining why the sparks produced at B were more intense than those that could be produced at A. He now replaced the loop of wire he had been using with a pair of long wires terminated in a spark-gap, as shown in Fig. 2.

Lodge found that the Leyden jar discharged in the usual way at A, but that a longer spark was simultaneously produced at B (the three "B's" in Fig. 2 indicate that the location of spark-gap B could be varied). The discharge at B he referred to as the "recoil kick."

It turned out that oscillatory currents were produced in the part of the circuit consisting of the Leyden jars and the spark-gap at A. The frequency of the oscillations was determined by the capacitance of the jars and the inductance of the spark-gap wires at A.

What's more important, Lodge determined that the discharge at B was the most intense when the lengths of the two wires (W1 and W2) were an integral multiple of a half wavelength for the oscillations produced. Lodge had discovered a resonance effect (or "syntony" effect, as he called it) between the two parts of the circuit.

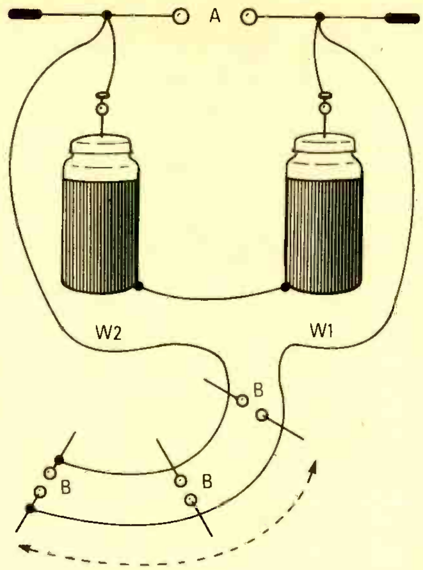


Fig. 2. By moving the spark gap (B) Lodge was able to determine the voltage maximums of standing waves on the wires W1 and W2.

Lodge was also able to demonstrate that standing waves existed along the wires; In a darkened room, he was able to observe a visible glow along the wires at the points corresponding to voltage peaks.

Oliver Lodge knew full-well that he had produced and detected the electromagnetic waves predicted some twenty years earlier by Clerk-Maxwell. Before he presented those observations, however, Lodge went on vacation. It was while on vacation that Lodge read of Hertz's similar work. Lodge then added a postscript to his own paper acknowledging Hertz's work in a most positive way.

Lodge presented his findings to the British Association meeting in September of 1888. The meeting was chaired by the well known theoretician, G.F. Fitz-Gerald, who reported on the results Hertz had recently published. Interestingly enough, Fitz-Gerald had told Lodge several years earlier that it would never be possible for anyone to produce the electromagnetic waves predicted by James Clerk-Maxwell.

Those in attendance who were knowledgeable concerning the topic, recognized that Lodge's findings were equivalent to those of Hertz and that his experiments had been done independently and at approximately the same time. Heinrich Hertz, however, would always receive the lion's share of the recognition and the glory.

The Coherer as a Detector. In the course of his lightning-conduction experiments, Lodge observed what he called the "coherer effect." He found that two metal spheres, barely touching each other, ordinarily did not make sufficient contact to allow a flow of current. However, when a spark discharge occurred through them, or even near them, they became joined so that current could easily flow. The spheres would remain joined until lightly tapped.

Lodge, at first, saw no practical use in his work for that phenomenon. In addition, he was unaware of the fact that Edouard Branly, a French scientist, had encountered the same effect, at approximately the same time, while working with a tube filled with fine metal filings. Branly, too, saw no use for the effect.

Eventually, Lodge came to realize that the coherer would be useful as a detector of electromagnetic waves. With it, he demonstrated the phenomenon of electrical resonance in a very convincing manner in his "syntonic Leyden jars" experiment, the basic form of which is depicted in Fig. 3.

The Leyden jar in the primary circuit was discharged across the spark-gap, A. The sliding contact, S, could be moved to tune the secondary circuit to resonate with the primary circuit, resulting in a discharge across the secondary spark-gap, B.

Lodge incorporated a spherical-ball coherer (not shown in Fig. 3) that was activated by the spark produced when the secondary circuit was tuned to resonance with the primary circuit. The ac-

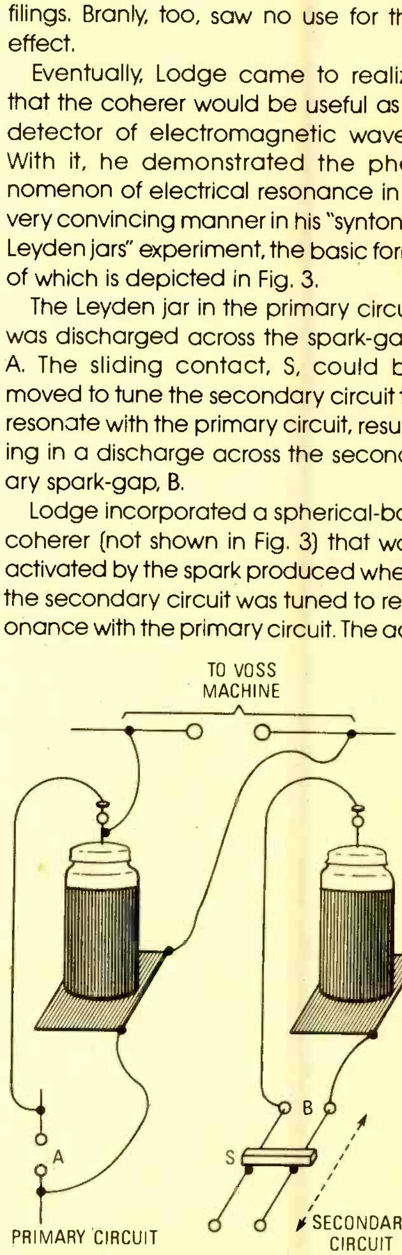


Fig. 3. This is the apparatus used by Lodge to demonstrate resonance or syntony.

tivated coherer, in turn, caused a bell to ring. That made demonstrating the concept of electrical resonance to large audiences feasible.

In his wireless-telegraphy experiments that were to come later, Lodge would use a metal-filings coherer, similar to the one that Branly had experimented on. That form of detector was often referred to as the "Branly-Lodge" coherer.

The coherer was not convenient to use due to its need for tapping between every telegraphic dot or dash to reset it. Nevertheless, it *was* widely used as a detector in the early days of wireless telegraphy, once automatic tapping mechanisms were devised. Marconi used a version of the coherer in his initial transatlantic experiments.

The Stage is Set. Lodge now had at his disposal most of the technology that would be needed to produce a system for sending and receiving wireless-telegraphy signals. He had developed an improved detector of electromagnetic waves and had discovered resonant electrical circuits. Hertz had demonstrated that electromagnetic waves could be propagated through space and need not be confined to wires. Soon those ideas would be united into a system of wireless telegraphy.

The world would give Marconi credit for having the clear vision needed to carry out that task and dramatically demonstrate its effectiveness in his successful and widely heralded transatlantic transmissions of 1901.

No Interest in Commercial Applications. In the early 1890's, Oliver Lodge was not thinking in terms of directing his experiments toward any commercial application, such as "wireless telegraphy." Lodge was a teacher and scientist interested, almost exclusively, in achieving a better understanding of the world in which he lived. As far as Lodge was concerned, the necessary time required for refining science for commercial applications could be spent more effectively investigating some aspect of science not then understood.

If someone, at that time, had asked him if his experiments could be adapted for signaling without wires, Lodge probably would have responded affirmatively, but without any sense of excitement or even much interest. That attitude would change. For the time being, however, Lodge kept busy with his teaching and with experiments designed to see if the rotation of the earth had any effect on the speed of light and electromagnetic waves.

Lodge also continued to give lectures and demonstrations related to electromagnetic-wave phenomena and attended the important scientific meetings in England. He was rather amused at a meeting of the British Association held at Liverpool in 1896 when some "news" was announced. It was declared, rather excitedly, that a Mr. Marconi from Italy had succeeded in sending telegraphic messages without wires. Most people there knew (or understood) little about Lodge's work and probably had never heard of Hertz.

This announcement was no great news to Lodge or to several others at that British Association meeting. Lodge had demonstrated the same thing at the British Association meeting held two years earlier!

First Demonstration of Wireless? At that earlier meeting held in 1894 at Oxford, Lodge had presented a lecture to a group of physiologists and physicists. He had attempted to show the similarity between how his electromagnetic-wave detecting apparatus worked and how the human eye responds to visible light.

Lodge had included a demonstration with his talk in which a simple detecting circuit with a metal-filings coherer caused a mirror galvonometer to produce a deflection of a light beam in response to electromagnetic waves produced in another building, some sixty yards away. The generator or transmitter of the electromagnetic waves was activated by a telegraph key. Lodge was able to demonstrate to his audience the different responses of the galvonometer produced by long and short key closures.

Whether or not the operator of the telegraph key actually was sending letters in Morse code is not clear. Lodge and his supporters maintained that even though his purpose at the time was not the demonstration of "wireless telegraphy" as such, Lodge had, in fact, effectively demonstrated it in 1894. Previous experiments by others in which electrical signals were transmitted without the use of intervening wires had involved induction effects. Lodge's signaling, due to the frequency and the distance involved, utilized radiated waves.

Despite Lodge's achievement at the Oxford lecture, the first English patent related to wireless telegraphy was awarded to Marconi based on an application filed in 1896. However, before the awarding of the patent and a description of the apparatus were announced in 1897, Lodge applied for a patent on a wireless telegraphy system of his own that was fundamentally different from Marconi's. That was the first of numerous patents for which Lodge would apply. He was encouraged to obtain patents on his work by a newly acquired associate, Alexander Muirhead.

Lodge had become acquainted with Alexander Muirhead, operator of a company that manufactured instruments for undersea-cable telegraphy, in 1894. Muirhead had supplied some of the equipment used by Lodge in his demonstration at Oxford and had witnessed the demonstration.

Muirhead and Lodge formed an association that eventually developed into a formal "syndicate" or partnership. The cooperative effort resulted in a company that manufactured equipment for sending wireless-telegraph messages. The Lodge-Muirhead enterprise was in direct competition with the company organized by Marconi because they both manufactured wireless-telegraph equipment and provided the personnel to operate that equipment.

Lodge and Muirhead didn't formally become a limited-liability (incorporated) company until 1901. By then the highly aggressive Marconi Company was well established. Lodge and Muirhead sold very little equipment in Britain. Its few customers were chiefly in the Caribbean, West Africa, the Far East, and India.

For both Lodge and Muirhead, wireless-telegraphy equipment was a sideline business. Both had other interests that took precedence. For Lodge, it was university teaching and administration coupled with research. The manufacturing of equipment for submarine telegraph cables still held Muirhead's chief interest.

The Patent in Question. Legal disputes over patents, however, ultimately arose between the smaller Lodge-Muirhead organization and the larger, much more successful, Marconi enterprise. To understand the legal disputes that developed, it is necessary to understand the differences between the Marconi and Lodge systems.

Marconi's wireless set was untuned.

The combination of a damped spark-discharge transmitter together with an antenna that was non-frequency selective resulted in a transmitted signal that consisted of many different frequencies. Since the radiated signal was not limited to one frequency, there was certainly no need to have a receiver that responded to only one frequency. That system, though crude, was acceptable as long as only one transmitter was in operation at any given time.

Lodge's success with resonant circuits had led him to attempt a similar tuned design for wireless telegraphy. He wanted to produce a transmitting station that emitted signals at a particular frequency of oscillation and a receiving station that responded only to that particular frequency. If all wireless stations were so designed, many could operate simultaneously! Indeed, that concept was revolutionary at the time.

In the design of his frequency-selective wireless-telegraphy system, Lodge needed to combine the best features of two, fundamentally different, spark-discharge systems. He had found from his work with syntonic Leyden jars that "closed systems," as he called them, were capable of quite good frequency discrimination, but radiated poorly. The commonly used "open" transmitting systems, in which (following the method developed by Hertz) the Leyden jar had been opened up and reformed into a dipole antenna, radiated quite well, but exhibited very poor frequency discrimination.

The dipole antenna had to supply the capacitance required for energy storage in the spark-discharge system. To produce that needed capacitance, conducting sheets or spheres were often used at the ends of the dipole elements.

The form of the antenna recommended by Lodge, however, achieved the required capacitance through construction of the dipole elements using multiple wires, or sometimes sheet metal, in the form of cones as shown in Fig. 4. Lodge then made the antenna frequency selective by adding a coil at the apex end of each of the two cones.

The added inductance combined with the capacitance of the antenna produced a resonant circuit that, Lodge maintained, responded well to signals of only one frequency. Lodge, however, did not realize that his tuned-antenna system would also radiate well at harmonics and sub-harmonics of the

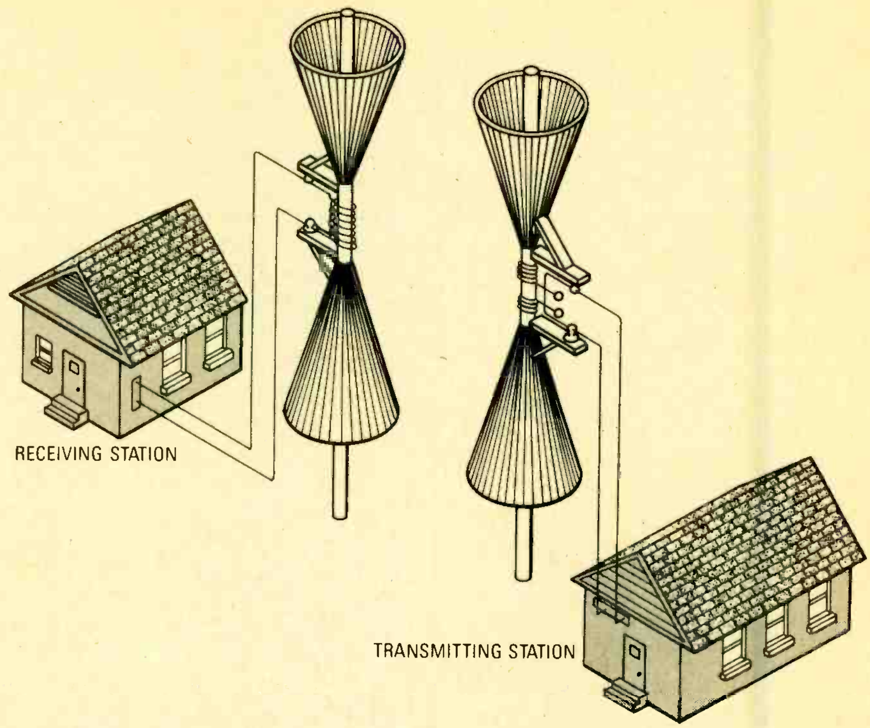


Fig. 4. Lodge's antenna designs provided frequency selectivity. The transmitter contained inductive coupling also.

intended frequency. The spark discharge occurred at the gap between the two sections of the transmitting antenna. No spark-gap existed in the receiving antenna.

The fact that the resonant frequency of the antenna could be varied by changing the number of turns in the coils was clearly apparent to Lodge. That ability to change the resonant frequency of, or "tune," the antenna was the second unique feature strongly emphasized in Lodge's patent application.

Another interesting aspect of Lodge's design concerns the use of inductive coupling. In his receiving-station design, Lodge had the resonant antenna inductively coupled to the detector circuit through the use of a high-frequency transformer. The transformer kept the detector circuit from "loading" or detuning the receiving antenna. The coil, which determined the resonant frequency of the antenna, also served as the primary side of the transformer.

What is puzzling, however, is that Lodge did not use inductive coupling in his transmitter circuit. The antenna was coupled to the transmitter through capacitors or, occasionally, even directly. Only the antenna, itself, was tuned in Lodge's transmitting circuit. He did not seem to realize, as Marconi would in 1900, that inductive coupling would achieve even better frequency selectivity in the transmitter.

Those three unique features of Lodge's system were protected, in principle, by the patent that was awarded to him in 1897. It is not completely clear, then, why Lodge and his partner Muirhead apparently did nothing for over ten years to prevent the infringements on Lodge's patent rights that were perpetrated by the Marconi Company as well as others.

The reason no action was taken might have been that Lodge was becoming heavily involved in political and social reform causes. In addition, Lodge became the head of a new university in Birmingham. Muirhead's principal business activities still involved the manufacturing of undersea cable telegraphy equipment. They were both distracted.

Lodge and Marconi Tangle. In 1900, Marconi was so bold as to seek a British patent on a tuning system that incorporated all three of the features supposedly protected by Lodge's patent. While Marconi's system did have the novel feature of using inductive coupling between the transmitter and the antenna, most of its features were copied from Lodge's patented system. British patent procedures at that time did not include a search to see if the granting of a new patent would violate existing patent rights. Consequently, Mar-

(Continued on page 95)

Add a Headphone Output to your CD player

Add a stereo headphone amplifier to your CD player and get all the highs and lows that a CD can deliver without disturbing your entire household!

BY HOMER L. DAVIDSON

Ever since the first compact-disc (CD) players made their way into the marketplace they've been touted as the best thing to happen to audio since the victrola (turntable to those too young to remember). And boy, were those early units expensive! Nonetheless, those who could afford to take the plunge, did. After all, they did provide superior sound reproduction over conventional record players.

Unfortunately, many of those early CD players did not come with a headphone jack for private listening. That meant that whenever anyone cranked up the volume on the stereo system, the house shook and everyone complained, and so down went the volume. But as everyone knows, when the volume is turned down low (low enough for the sound to be confined to your listening area), the music loses a lot of its flavor.

Of course, you could always adjust the tonal quality of the sound (bass, treble, mid range). But, when that's done the music never quite sounds the same—something in the music is lost along with the volume. If you are among those who purchased one of those early units that lacked a headphone, then the *CD Headphone Amp* described in this article may be just the thing you need to restore domestic tranquility to your home.

The Stereo Circuit. Figure 1 shows the complete schematic diagram of the CD Headphone Amp. The circuit, which is built around a pair of inexpensive LM386 audio power-amplifier IC's, takes its input from the line-out jacks of the CD player. (Note that the left and right channels of the circuit are identical; therefore we'll describe the operation of the left channel only, giving the equivalent right-channel component in parenthesis.)

The signal from the CD player is fed to the circuit through PL1 (PL2) to C1 (C2), a 4.7-µF capacitor, which is used to block any DC voltage that might be riding on the CD's audio. The signal is then routed through potentiometer R1 (R2), which serves as a volume control.

The audio signal is fed to pin 3 of U1 (U2), where it is amplified and output at pin 5. The output of U1 (U2) is coupled through C6 (C9) to stereo headphone jack J1. Capacitor C3 (C7) is included in the circuit to filter out the DC component of the audio-output signal, and to prevent the amplifier from breaking into oscillation.

The CD Headphone Amp can be powered from any 4–12-volt DC source, making it ideally suited to battery operation. Because of its minimal power requirement, its operating power may be derived from a 9-volt battery or the CD player's internal DC supply.

Construction. The author's prototype of the CD Headphone Amp was assembled on a small printed-circuit board, measuring about 2⅝ × 3 inches. The printed-circuit template used in the production of the author's

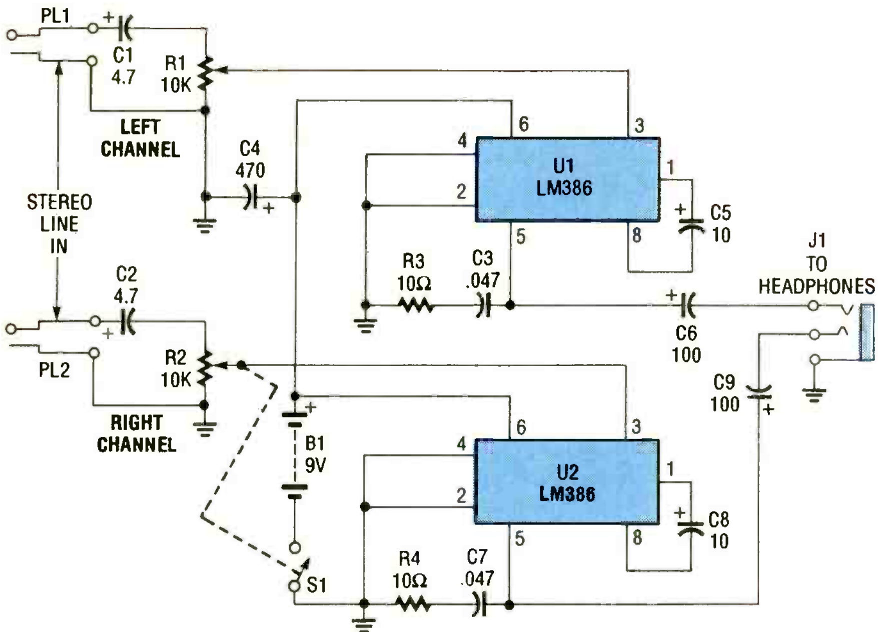
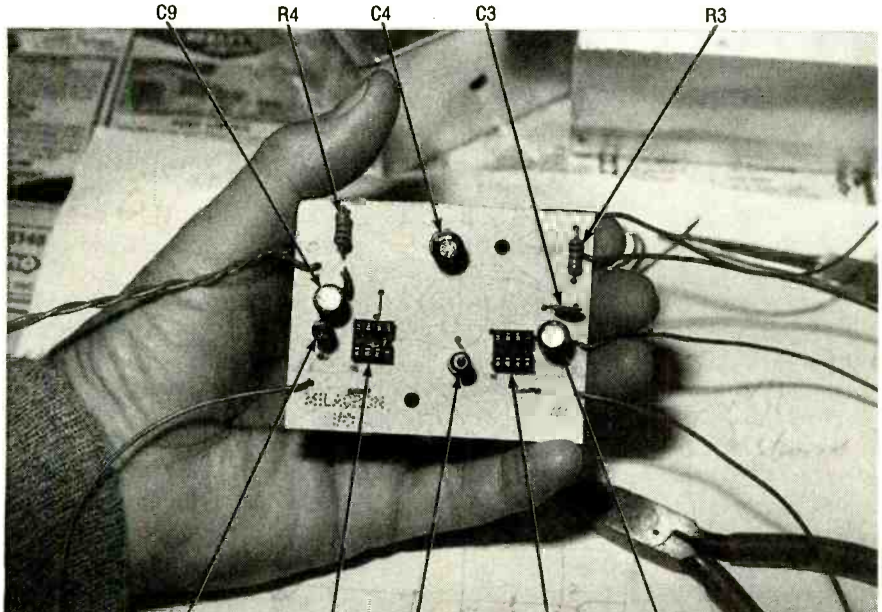


Fig. 1. The CD Headphone Amp is built around a pair of inexpensive LM386 audio power amplifier IC's. The two volume-control arrangement used in the circuit allows you to vary each channel individually for different ear reception and balancing the two stereo channels.



Here is the assembled printed-circuit board for the CD Headphone Amp. Even with its rather small size, the board is sparsely populated.

prototype is shown in Fig. 2. After etching the board, construction can begin. Start by placing IC sockets at the positions reserved for the IC's, using Fig. 3 as a guide. But **do not** install the IC's in their sockets at this time.

Once that is done, install the PC-mounted components on the board, starting with the resistors and capacitors. Be sure that the electrolytic capacitors are oriented correctly. Afterward, install the three jumper connections.

Next, connect 3- to 4-inch lengths of wire to the appropriate points on the printed-circuit board for connection to the off-board components. Set the printed-circuit board to the side, and then turn your attention to the enclosure.

Prepare the enclosure by drilling holes for the panel-mounted components. A total of four holes will be needed; one each for the two volume-control potentiometers (R1 and R2) on the front panel, one on the right side of the enclosure for the input leads, and the final one on the left side of the enclosure for the output jack. Note that the two input leads (one each for the left- and right-channel inputs) are fed through a single hole in the side of the enclosure.

Once the holes have been drilled, loosely mount the panel-mounted components in the appropriate holes. Now connect a 4.7-µF capacitor to one end of each potentiometer (R1 and R2), as shown in Fig. 3, and the other ends of the capacitors to the plugs (PL1 and PL2). Next, wire J1 to the appropriate points on the printed-circuit board. It will be necessary to tack solder J1's ground connection to the board's ground bus.

Next you must decide how the circuit is to be powered. Power for the circuit can be derived from a 9-volt transistor-radio battery, a DC power supply, or power can be pirated from the CD player itself. If the circuit is to be powered from a battery or a separate DC supply, simply connect a battery connector or the output of the DC supply to the points indicated in the parts-placement diagram and you are almost finished. But if power for the circuit is to be derived form the CD player itself, you must first locate the +V and ground buses of the DC player's power supply.

Most CD players are powered from 5-

PARTS LIST FOR THE CD HEADPHONE AMP

RESISTORS

R1—10,000-ohm, audio-taper potentiometer
R2—10,000-ohm, audio-taper potentiometer, with SPST switch
R3, R4—10-ohm, ¼-watt, 5%

CAPACITORS

C1, C2—4.7-µF, 25-WVDC, electrolytic
C3, C7—0.047-µF, ceramic-disc
C4—470-µF, 25-WVDC, electrolytic
C5, C8—10-µF, 25-WVDC, electrolytic
C6, C9—100-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

U1, U2—LM386 low-power audio amplifier, integrated circuit
J1—Miniature stereo jack
PL1, PL2—Shielded phono plug
B1—9-volt transistor-radio battery (see text)
S1—Part of R2
Perfboard materials, enclosure, AC molded power plug with line cord, battery holder and connector, wire, solder, hardware, etc.

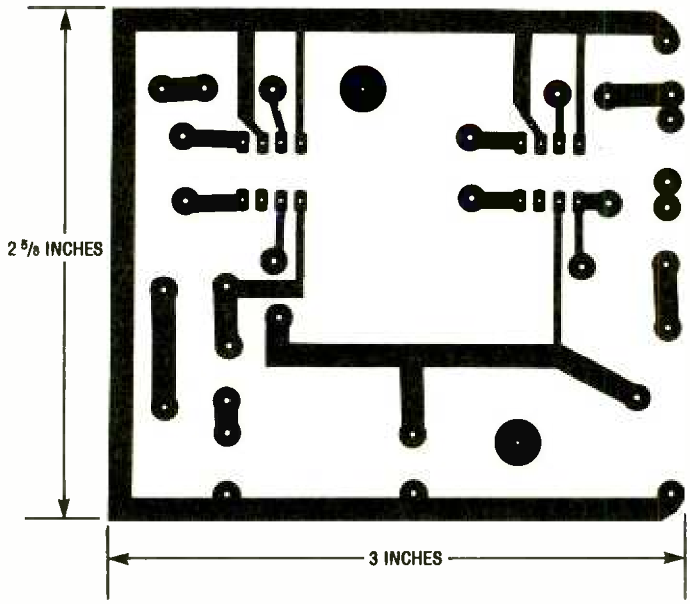


Fig. 2. The author's prototype of the CD Headphone Amp was assembled on a small printed-circuit board, measuring about 2⅝ × 3 inches.

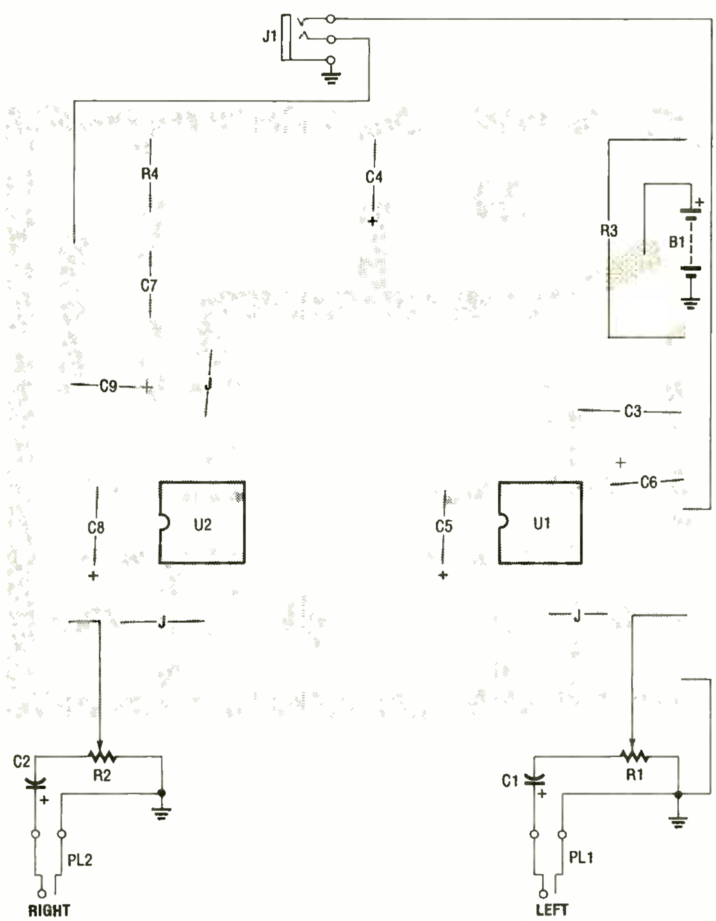


Fig. 3. Begin assembly by placing IC sockets at the positions reserved for the IC's, and then installing the resistors and capacitors (making sure that the electrolytic capacitors are correctly polarized), and the three jumper connections.

to 9-volt regulated power supplies, which are often bipolar (having both negative and positive output voltages). To power the circuit from the CD's internal supply simply tap into the positive supply rail and ground and connect those points to +V and ground in the circuit. It is a good idea to place a fuse

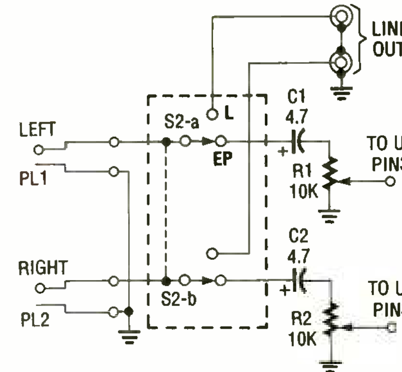


Fig. 4. As an option, you may want to add a DPDT switch between the output line of the CD player and the input to the circuit to allow you to select either your stereo headphones or your stereo system's speakers as the output device.

in series with the +V line to protect the CD player's circuitry. If the CD's power supply is used, you can mount the CD Headphone Amp to the rear of the CD's enclosure.

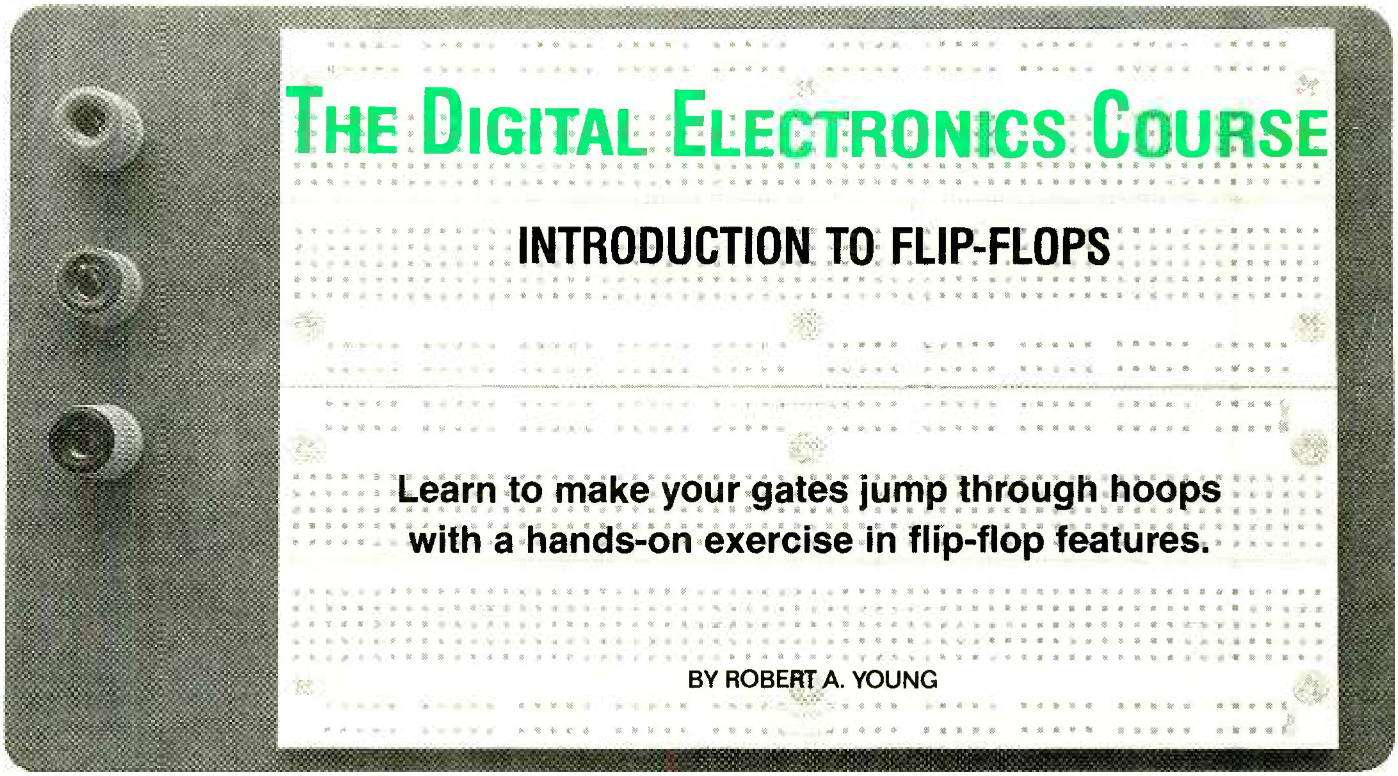
As an option, you may want to add a DPDT switch to the circuit-board assembly (as shown in Fig. 4) to allow the amp to be switched into and out of your stereo system. That arrangement allows you to select either your stereo headphones or your stereo system's speakers as the output device.

Afterward, visually inspect your work; look for all of the common construction errors—cold solder joints, solder bridges, misoriented components etc. Once you are satisfied that everything is okay, install the IC's and proceed to test the circuit.

Testing. To check the circuit's operation, plug a pair of headphones into J1 and connect the battery (provided that you've configured the circuit for battery operation). Apply power to the circuit and turn R1 and R2 to about midway of their rotation. Place a finger on each audio-input cable; you should hear hum or some sort of noise in the headphones. If a hum can be heard, connect the input of the CD Headphone Amp to the LINE OUT jacks of your CD player.

If one or both channels are dead or distorted, trace the cable back to the defective channel, and check that channel's amplifier IC (U1 or U2) and its associated components.

If the circuit begins to oscillate, tie all input grounds to a single point on the printed-circuit board ground bus. It's possible that a ground loop is causing the circuit to oscillate. ■



THE DIGITAL ELECTRONICS COURSE

INTRODUCTION TO FLIP-FLOPS

Learn to make your gates jump through hoops with a hands-on exercise in flip-flop features.

BY ROBERT A. YOUNG

A bistable multivibrator is a device that uses cross-coupled feedback between inverting gates (NAND and NOR) to function very differently from the logic-gate circuits that we've discussed so far. The bistable multivibrator, commonly called a flip-flop, can be defined as a device capable of storing a single bit of information. It has two outputs (Q and $\overline{Q}$), which are normally in opposite logic states.

There are several types of flip-flops: the R-S (set-reset) flip-flop, the T (toggle) flip-flop, the D flip-flop, and the J-K flip-flop. The simplest form of flip-flop is the R-S.

Figure 1A shows an R-S flip-flop produced from a pair of NAND gates. Figure 1B shows a NOR-gate based R-S flip-flop. The R-S flip-flop is represented schematically by the symbol shown in Fig. 1C. The R-S flip-flop in any form has few applications, thus it is not offered as an IC, but can be easily fabricated from NAND or NOR gates when needed.

The R-S flip-flop does serve one very important function, however: it is the basis for other more useful devices.

Toggle Flip-Flop. The toggle or T flip-flop is so named because its outputs toggle (changes states) with each input clock pulse. That means that it takes two pulses to complete one output cycle, so the frequency of the output is half that of the input. A T flip-flop can be produced by simply gating the set and reset inputs of an R-S flip-flop, as shown in Fig. 2; thus, it is often referred to as an R-S-T flip-flop.

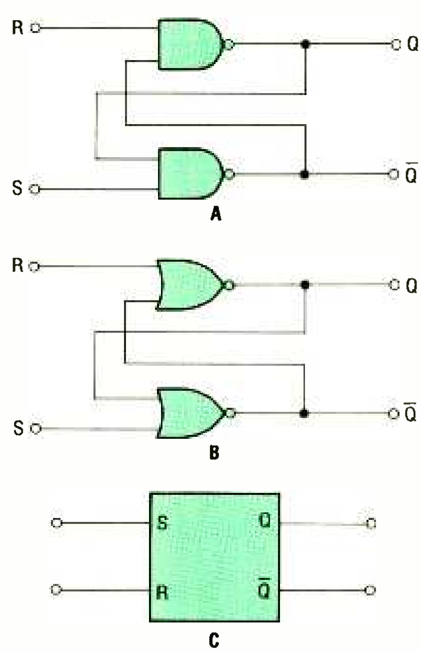


Fig. 1. There are several varieties of flip-flop. The simplest form of flip-flop, shown in A, is a NAND-implemented R-S flip-flop; B is the same function implemented using NOR gates. The R-S flip-flop is represented schematically by the symbol shown in C.

Figure 2A shows the T flip-flop implemented using NAND gates; Fig. 2B is an equivalent circuit using an R-S flip-flop and a pair of NAND gates. The T flip-flop finds application in simple asynchronous (non-clocked) counting and dividing circuits, timers, etc. The T flip-flop can be made to trigger from both positive-going and negative-going edges of the input signal, with negative-edge triggered devices being the most common.

D Flip-Flop. Many circuits operating at high speeds require synchronization (clocking). That's because many operations are occurring at the same time throughout a circuit, and if they are not coordinated, the various functions being performed will not complement each other. The clock-pulse source is most often a crystal-controlled, square-wave generator, whose output is distributed throughout a system. That allows all actions within the circuit to be carried out in concert.

Sychronization means that a change in output can only occur during a clock pulse. Any signals at the circuit's inputs must be ignored in the absence of a clock pulse. The D-type flip-flop has that feature.

The D flip-flop is often called a latch, because of its ability to capture (latch on to) data, and is a major component in the structure of many other logic circuits. Figure 3A shows a NAND-imple-

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

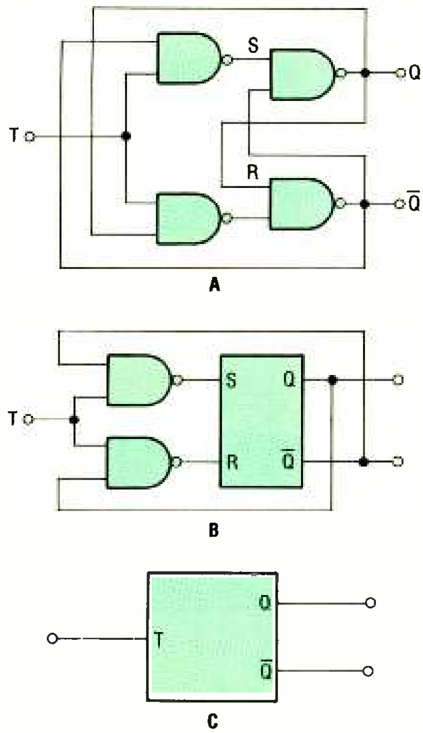


Fig. 2. The toggle or T flip-flop is so named because its outputs toggle (change states) once for each input clock pulse. A T flip-flop can be produced by simply gating the set and reset inputs to an R-S flip-flop, as shown in A. Note that the basic R-S configuration is retained in the architecture of the T flip-flop, which is further illustrated in B. Shown in C is the schematic representation of the T flip-flop.

mented D flip-flop; Fig. 3B is its schematic symbol.

It is often desirable for the D flip-flop to have set/reset capabilities. That's most easily handled by making U1-c and U1-d 3-input NAND gates, and using the unused input on each as the set (preset) and reset (clear) inputs. The schematic symbol of for a (7474) D flip-flop with preset (PR) and clear (CLR) inputs is shown in Fig. 3C.

The clock input acts as a control, in that data may be transferred only during the positive-going transition of the clock input signal. So any data at the D input of the flip-flop is not transferred to the output in the absence of a clock pulse.

If the PR input is made low and the CLR input is made high, the Q output of the device is forced high. And if PR is made high and CLR is made low, the Q output of the flip-flop goes low. But if PR and CLR are simultaneously brought low, both the Q and $\overline{Q}$ outputs of the device assume a logic-high output state, which is an illegal condition in flip-flop operation. So care must be taken in the design of a circuit to avoid the possibility of that condition occuring. When both PR and CLR are made logic high, the Q output of the flip-flop assumes the logic state of the D input when clocked (during the positive-going transition of the clock pulse).

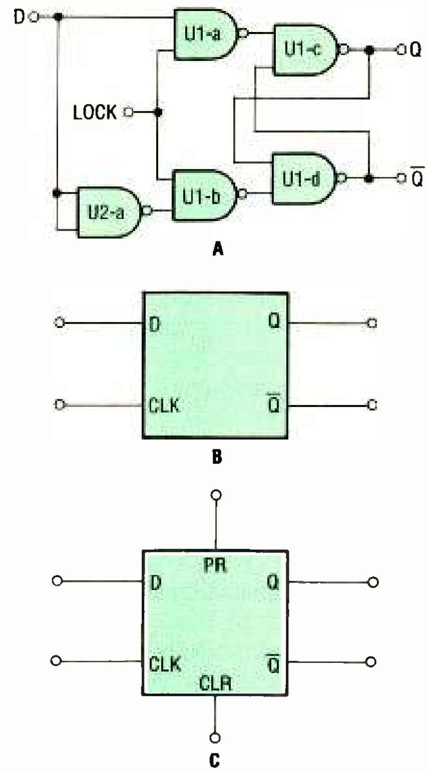


Fig. 3. The D flip-flop is often called a latch, because of its ability to capture (latch on to) data. Shown in A is a NAND-implemented D flip-flop; B is its schematic symbol. Shown in C is the D flip-flop with set/reset capabilities, however, the set and reset inputs are now called preset and clear.

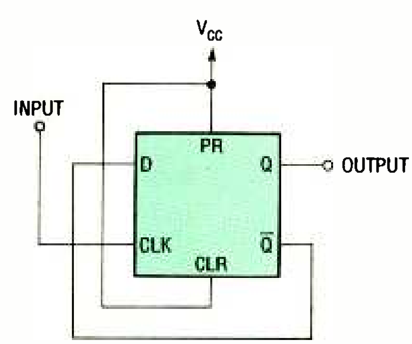


Fig. 4. The D-flip-flop can be configured to function as a toggle (T) flip-flop by connecting the D input to the $\overline{Q}$ output, and connecting both the PR and CLR inputs to the positive supply rail, as shown here.

The D flip-flop can also be configured to function as a toggle (T) flip-flop by connecting the D input to the $\overline{Q}$ output, and connecting both the PR and CLR inputs to the positive supply rail, as shown in Fig. 4. The clock (CLK) input of the D flip-flop then becomes the equivalent of the T input of a T flip-flop. When operated in that mode, the D flip-flop (like the device it emulates) toggles (changes states) once for each input clock pulse. As with the T flip-flop, it takes two full pulses to complete one output cycle, so the frequency of the output is half that of the input.

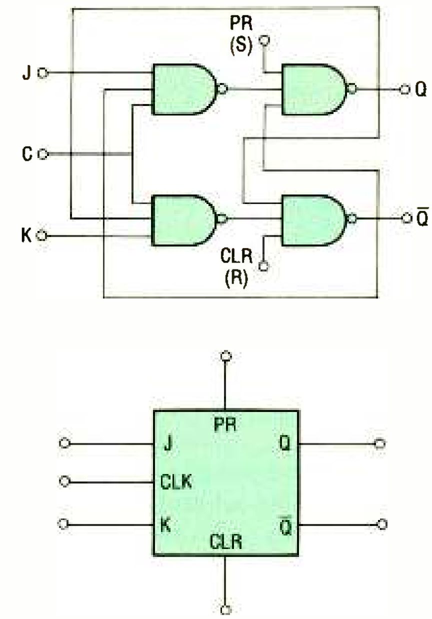


Fig. 5. The J-K flip-flop can be fabricated from a number of gate combinations. A J-K flip-flop assembled from NAND gates is shown in A. Note that the set (S) and reset (R) inputs are now called the preset (PR) and clear (CLR). The schematic symbol for a J-K flip-flop is shown in B.

J-K Flip-Flop. The J-K flip-flop is simply a clocked flip-flop, whose inputs (J and K) can be manipulated to produce predictable output conditions. Another property of the J-K flip-flop is that if both inputs are high, the output will toggle in accordance with the state of the clock signal.

The J-K flip-flop can be fabricated from a number of gate combinations, each having different characteristics to meet differing circuit requirements. Figure 5A shows a J-K flip-flop assembled from NAND gates. Note that the set (S) and reset (R) inputs are now called preset (PR) and clear (CLR). As we have seen throughout the flip-flop family, the basic R-S design has been retained in the architecture of the J-K flip-flop.

Figure 5B shows the schematic symbol for a 7476 J-K flip-flop. When a negative-going pulse is applied to the clock input of a J-K flip-flop, its output might or might not change states, de-

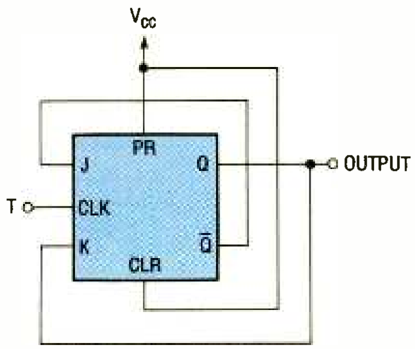


Fig. 6. The J-K flip-flop, like the D flip-flop, can be configured for T flip-flop operation as shown here.

pending upon the logic applied to its J and K inputs. The set and clear inputs are triggered by active lows.

When CLR is high and PR is low, the Q output of the J-K flip-flop goes high. When the CLR input is at logic low and PR is high, the device's Q output goes low. But when both the CLR and PR inputs are made low simultaneously, both the Q and the $\overline{Q}$ outputs of the device go high. That's an illegal state and should therefore be avoided. If both the CLR and PR inputs of a J-K flip-flop are made high simultaneously, the Q and $\overline{Q}$ outputs will assume specific logic states, as determined by the logic levels presented to the J and K inputs, and that only takes place when the flip-flop is clocked (during the negative-going transition of the clock pulse).

The J-K flip-flop, like the D flip-flop, can be configured for T flip-flop operation (see Fig. 6), and as such its output state toggles once for each input clock pulse. And so, like the T flip-flop, it requires two pulses to complete one output cycle, so it has an output frequency of half that of the input.

Flip-Flop Exercise. Flip-flops, like the logic gates that comprise them, are used as the basic building blocks of more complex logic systems. As with all other things, it is necessary to gain a full understanding of their individual characteristics to properly design flip-flop based circuits. Thus, the object of this exercise will be to familiarize you with the operational characteristics of flip-flops with an eye toward building more useful circuits based on the devices later on.

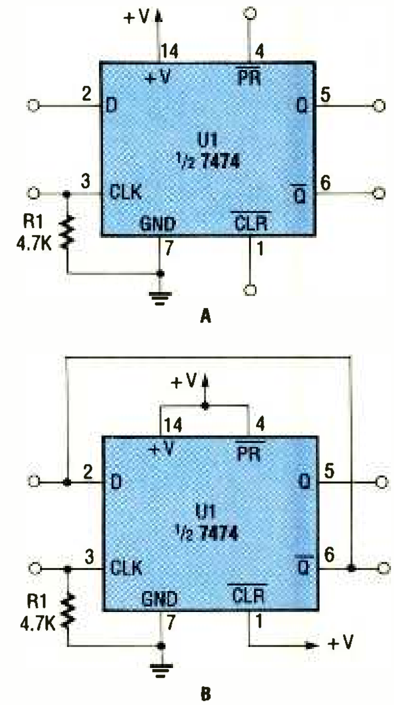


Fig. 8. You will need to duplicate these circuits to follow our experimental procedure. The circuit in A will help you learn about normal D-type flip-flop operation, while the one in B will turn the IC into a T-type.

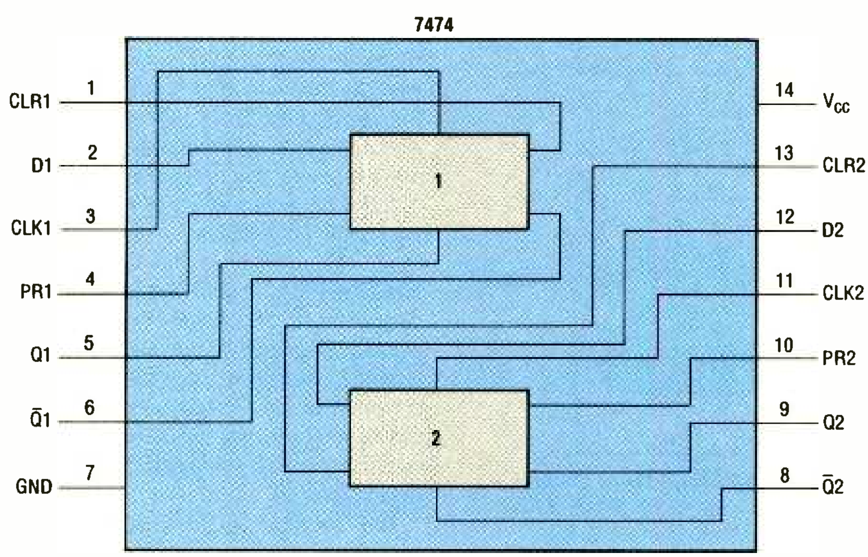
Install a 7474 dual-D flip-flop in the breadboard. A block pinout diagram for the 7474 is shown in Fig. 7A; its function table is shown in Fig. 7B. Connect pin 7 of the device to ground, and connect pin 14 to the +5-volt bus (see Fig. 8A). In addition, connect a 4.7k resistor

PARTS LIST FOR THE FLIP-FLOP EXPERIMENT

U1—7474 dual D flip-flop, integrated circuit
U2—7476 dual J-K flip-flop, integrated circuit
R1—4700-ohm, ¼-watt, 5% resistor
Breadboard, +5-volt power source, wire, etc.

from the clock input of the flip-flop to ground. Connect an oscilloscope to the output of the flip-flop. A logic probe can also be used. While it is best to use an oscilloscope or a logic probe if neither one is available a "home-brew" indicator can be used; to build the indicator, simply connect the output to a 270-ohm resistor wired in series with an LED connected to ground.

Apply power to the circuit, and tie PR high and CLR low. The output of the flip-

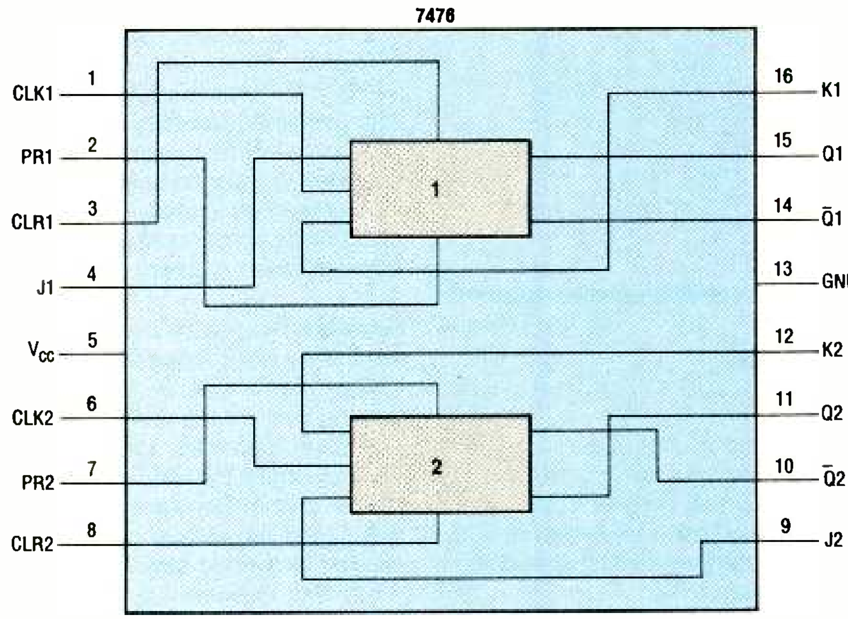


A

INPUTS				OUTPUTS	
PR	CLR	CLK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H*	H*
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\overline{Q}_0$

B

Fig. 7. A block pinout diagram for the 7474 is shown in A; function table is shown in B.

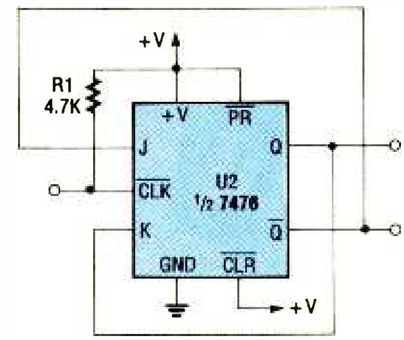


A

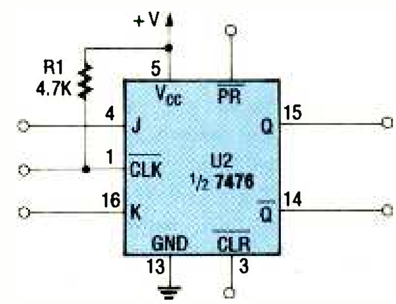
INPUTS					OUTPUTS	
PR	CLR	CLK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↑	L	L	Q_0	$\overline{Q}_0$
H	H	↑	H	L	H	L
H	H	↑	L	H	L	H
H	H	↑	H	H	TOGGLE	

B

Fig. 9. A block pinout diagram of the 7476 is shown in A; its function table is shown in B.



A



B

Fig. 10. The circuit in A will introduce you to J-K operation, and the one in B illustrates a toggle version of the J-K flip-flop.

flop should go to the logic-low state. Now reverse the signals applied to the PR and CLR inputs, so that the input to PR is now low and the input to CLR is now high. The Q output of the flip-flop should now go high.

Next, place either an oscilloscope, logic probe, or a resistor/LED combination across the $\overline{Q}$ output, apply a logic low to both the PR and CLR inputs, and observe the outputs of the circuit. Both should be high. Recall that that is an illegal state.

Tie both PR and CLR high; under those conditions the D input and the CLK input take control of the circuit. Tie the D terminal high and apply a pulse to the CLK input of the circuit. Use a logic pulser to supply the clock pulses. The Q output should go to a logic-high state. Now tie the D input low, and apply a pulse to the clock input of the flip-flop. The Q output should become a logic low, and the $\overline{Q}$ output should assume a logic-high output state.

Now breadboard the T-configured D flip-flop as shown in Fig. 8B. Leave the 4.7k resistor and the LED/resistor combination, logic probe, or oscilloscope connected to the IC. It will be necessary to connect the $\overline{Q}$ output to the D input. Pulse the clock input several times with a logic pulser and observe the circuit's output. How does the circuit behave? If everything is wired correctly, the flip-flop should act exactly like a toggle flip-flop.

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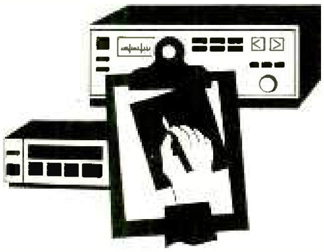
Next, install a 7476 J-K flip-flop in the breadboard, and connect the +V terminal to the positive supply rail, and the GND pin to ground. (A pinout diagram of the 7476 is shown in Fig. 9A; its truth table is shown in Fig. 9B.) Connect the clock input of the flip-flop to the positive supply rail through a 4.7k resistor (see Fig. 10A). Monitor the Q output as you did for the 7474.

Connect the CLR terminal to ground and the PR terminal to the positive supply. The output of the flip-flop should be low. Connect the CLR terminal to +V and the PR input to ground. The Q output should go high.

Connect a second resistor/LED combination across the $\overline{Q}$ output. Tie both CLR and PR low. Both outputs should go high, lighting both LED's. Remember that's an illegal state and should be avoided when designing.

Now tie both PR and CLR high; under that condition, the J, K, and CLK inputs take control of the flip-flop. Set both J and K low and apply several pulses from a logic pulser to the CLK input of the flip-flop. Did the Q and $\overline{Q}$ outputs change? Set J low and K high, and apply several pulses to the CLK input. Did the outputs of the flip-flop change?

Repeat that procedure, this time with J high and K low. What occurs at the output? Finally set both J and K high, and repeat the exercise. Describe the behavior of the Q output. Configure the J-K flip-flop as a toggle flip-flop (see Fig. 10B) and see if it operates as the D-derived T flip-flop did. ■



Product Test Reports

By Len Feldman

SONY SLV-757UC VIDEO CASSETTE RECORDER

It was only recently that Sony (Sony Drive, Park Ridge, NJ 07656) began making and selling VHS-format video recorders. After all, it was Sony that first introduced the Betamax VCR, a full year or more before JVC unveiled the first competing VHS-format video recorder. While many experts maintain that the Beta format produced somewhat better pictures than the VHS format, the fact is that VHS is now the dominant system in use, at least in the United States. So, rather than continue to fight, Sony has switched, and in doing so they have come up with an excellent, full-featured VHS recorder that is the subject of this report.

The Sony SLV-757UC has features we haven't seen before in any VCR and it also incorporates most of the features found in other top-of-the-line units. For example, it has a unique edit-monitor function that allows you to see the editing process at a glance because both the picture being played back and the one being recorded are displayed simultaneously on screen. The unit is equipped with input connections that are accessible from the front, allowing you to connect a camcorder easily. A flying erase head eliminates color streaks and blurs that occur when you do insert editing with conventional VCR's. If you use another compatible Sony VCR, you can remotely control its tape transport from this unit while doing synchronized editing.

Using a feature called "Auto Menu," you can select any one of several functions on the screen of your TV set. You can, for example, watch a small TV picture inset in the VCR playback picture, or *vice versa*. Tape-counter readings, tape speed, remaining tape length, and channel number can all be displayed on screen. Timer recording can be preset on your TV screen using the supplied remote control. Just before timer recording starts, the date, time, and channel of the program are recorded onto your tape.

Other convenient functions include automatic tracking, a full loading mechanism that quickly switches tape-transport functions, and a swing shuttle ring that lets you play-back tape in either direction at various speeds. The unit's timer can record up to six different events over a month's time. Audio- and video-insert editing are easily accomplished. Audio recording using the hi-fi recording mode provides flat frequency response over the entire audio spectrum as well as wide dynamic range and extremely low wow and flutter.

The VCR's tuner is equipped with an MTS (stereo-TV) decoder and can be programmed to tune only to those channels (regular and cable) that are available in your area. Programmed channels can be added or erased from the tuner's memory at will.

Controls. Despite the number of functions, Sony has managed to give this VCR a clean look by cleverly concealing many of the controls behind a pull-down flap on the front panel. With the flap closed, the only features visible on the front of the unit are the power switch and the display area, which is located on the flap itself. When the flap is opened, it reveals two surfaces (one horizontal and one vertical) full of controls, as well as the cassette slot. On the vertical surface there is an eject button to the right of the slot, while further to the right there are synchro-edit and edit-monitor controls, as well as a command-mode switch that must be set appropriately so that the remote control will operate this VCR and not some other component. Audio- and video-input jacks are found at the left end of the exposed vertical surface of the front panel, as are a microphone-input and a headphone jack. Also in that area is a 5-pin connector that can be used to interface with other Sony components such as their editing controller that allows you to automatically assemble edit up to 8 programs. A picture-sharpness control and a pair of audio-recording level slider controls are found at the right end of the vertical panel.

Controls found on the horizontal control panel include the usual TV/VCR selector, an input-selector switch, a recording-speed selector, an edit-on/-off button, a timer-recording on/off button, a quick-timer or one-touch recording button, the previously mentioned swing-shuttle ring, a record button, tracking controls, channel-up/-down buttons, and the usual tape-transport buttons.

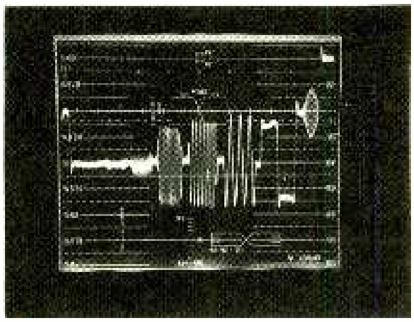
The rear panel of the Sony SLV-757 is equipped with antenna input and output connectors, an additional set of audio and video inputs, audio and video outputs, a Channel-3/-4 selector switch, and monitor audio and video output jacks. In addition, there are control-in and -out terminals for connection to a Sony TV set or tuner, if you own one. An AC convenience outlet is also provided.

CIRCLE 120 ON FREE INFORMATION CARD

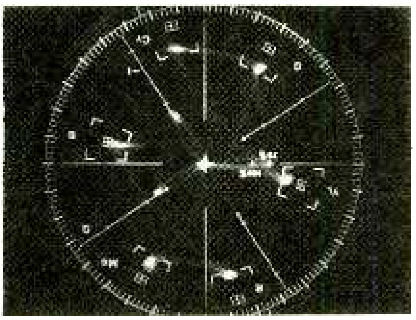
Sony SLV-757UC VHS VCR

TEST RESULTS—SONY SLV-757UC VHS VCR

Specification	APEL Measured
Video Frequency Response	
at 2.0 MHz	−0.64 dB
at 3.0 MHz	−13.4 dB
Video Signal-to-Noise Ratios	
Chroma, AM	46.4 dB
Chroma, PM	44.8 dB
Luminance, 100 IRE	44.8 dB
Luminance, 50 IRE	44.6 dB
Luminance, 10 IRE	44.6 dB
HiFi Audio Reference Level for 3% THD	2.7 volts
HiFi Audio Signal-to-Noise Ratio	96.6 dB
HiFi Frequency Response (−3 dB)	20 Hz to 20 kHz
HiFi Distortion @ −10 dB, 1 kHz	0.18%
Regular Audio Reference Level	0.3 volts
Regular Audio Signal-to-Noise Ratio	47.3 dB
Regular Audio Response (−3 dB)	94 Hz to 8.6 kHz
Stereo TV Signal-to-Noise Ratio	64.7 dB
Stereo TV Distortion @ −20 dB	0.38%
Stereo TV Separation	30 dB
Mono Signal-to-Noise (via MTS Decoder)	68.0 dB
Mono Distortion (via MTS Decoder)	0.31%
Power Requirement	31.5 watts
Fast Rewind Time (T-120 Tape)	3 min. 23 sec.
High Speed Rewind Time (T-120 Tape)	2 min. 10 sec.
Fast Forward Time (T-120 Tape)	3 min. 20 sec.
Dimensions (H × W × D, inches)	4 5/16 × 16 15/16 × 15 1/8
Weight	16 1/4 lbs.
Suggested Retail Price	$1200



Video frequency response at 2.0 MHz was off by only −0.64 dB, and there was even measurable output at 3.0 MHz.



While color accuracy was just about perfect, the colors in the yellow, green and cyan areas were very slightly undersaturated as indicated by the fact that the light spots for those colors are somewhat inboard of the target cross marks.

The remote control supplied with this recorder is used to access and control all of the special features found in this VCR such as the on-screen programming, editing, index-point marking and erasing, picture-in-picture, and direct access of channel by number rather than by having to scan up and down through the entire range of channels.

The Test Results. As in our previous video-product test reports, all laboratory performance measurements were made by Advanced Product Evaluation Laboratory (APEL). The results of their tests, along with the sample actually tested, were then sent to my lab where subjective testing and evaluations were done.

Although this VCR operates at two speeds (SP and EP), best performance of any VCR, regardless of its format, will always be obtained when the VCR is used at its fastest speed—in this case, the SP speed. Accordingly, all of APEL's measurements were made at that faster tape speed.

Video frequency response at 2.0 MHz was off by only −0.64 dB. That is better than average for a conventional VHS machine, and there was even a measurable output at 3.0 MHz, although at that frequency video response was down by just over −13 dB.

Video signal-to-noise ratio is measured in two ways: chroma AM and PM (phase modulation) noise is measured relative to a red field and, for this VCR, the S/N ratios were 46.4 dB and 44.8 dB respectively. The more familiar type of noise, noise with respect to the brightness signal, is also measured using reference luminance levels of 100, 50, and 10 IRE. In all three cases, the signal-to-noise ratio was better than average, measuring between 44.6 and 44.8 dB.

Using the hi-fi recording mode, audio output voltage for a 3% Total Harmonic Distortion (THD) reference point was 2.7 volts. Signal-to-noise ratio for the hi-fi audio channels was an impressively high 96.6 dB. That's as good or better than what we have come to expect from digital-audio recorders, even though VHS HiFi is a purely analog recording process.

By way of contrast, it should be noted that using the conventional audio-recording tracks, signal-to-noise measured only 47.3 dB. Similarly, while audio frequency-response using the hi-fi audio-recording mode was flat from 20 Hz to 20 kHz, if the conventional audio-recording mode was used, response extended only from 94 Hz to 8.6 kHz. Frequency response using the hi-fi recording mode in a VHS HiFi recorder remains virtually the same regardless of tape speed, whereas the conventional audio-recording mode would have yielded even poorer response had we switched to the slower (EP) tape speed. The stereo-decoder section of this VCR yielded excellent separation of approximately 30 dB at mid-frequencies.

To test color reproduction, color bars were recorded and played back on a tape and the recorder's output was examined using a vectorscope. While the vectorscope showed that color accuracy was just about perfect, it also revealed that the colors in the yellow, green, and cyan areas were very slightly undersaturated. In our own subjective tests, during which program material of all sorts was recorded and played back, we were not at all bothered by this slight undersaturation. In fact, picture quality as well as color purity was excellent as judged by our own viewing panel. A summary of all of the measurements made by APEL can be found in the Test Results box elsewhere in this report.

Hands-On Tests. It took us only a few minutes to familiarize ourselves with the many features found in this VHS VCR from Sony. The on-screen menu and the ease of on-screen timer programming were especially welcome since we, like almost everyone we know, has made

(Continued on page 94)

A Hands-on Electronics REPORT

AMERICAN RELIANCE AK-140K DMM

CIRCLE 119 ON FREE INFORMATION CARD

You can really get to know the in's and out's of your multimeter if you build it yourself.

Electronics experimenters, both old and new, are fascinated by kits. There appears to be a desire to assemble products that could simply be purchased. It could be because the successful assembly of a device gives the builder the assurance that since he made it he can repair it should it fail.

This report is on the assembly and testing of the AR-140K Digital Multimeter distributed by ARI/American Reliance, Inc. The AR-140K is a compact, hand-held instrument designed to professional standards for hobbyist and student use. Test functions include DC-voltage, AC-voltage, DC-current, and resistance measurement, and diode checking. All instrument functions are protected by diodes, transistors, or are fused against overload.

The AR-140K Digital Multimeter is battery operated. The unit's low power consumption (typically 0.2 mA) allows a single 9-volt transistor-radio battery to last for 1000 hours. (Our test unit was still working after 550 hours.)

The AR-140K multimeter has a large LCD display that's easy to see, offers polarity indication, and has a built-in low-battery warning that comes on to indicate that the battery has only 20 percent of its life remaining.

Building the Kit. The AR-140K multimeter is palm size so you can expect the parts to be tiny, too. The ¼-watt fixed resistors are small and it can be troublesome to read the color-coded markings on them with the naked eye. The markings of capacitors and other parts also offer a visual challenge. Unless your eyesight is exceptionally sharp, the use of a large magnifying glass or stereo-vision headset is recommended.

The tools required to assemble the kit are standard: a 25-watt soldering iron with a fine pencil tip, a diagonal cutter, long-nose pliers, ⅛-inch blade screw driver, rosin-core solder, and some solder braid to sop-up excess globs of solder. I also found that a high-wattage (40-watt) soldering iron makes installing the unit's input jacks a lot eaiser (but do not use that iron to assemble the rest of the circuit). A plated iron tip is recommended.

The small parts for the AR-140K multimeter kit came in six sealed packets. Each packet has a parts list in the manual and each packet supplies the parts for a group of instructions. That may sound like oversimplification, however, when dealing with very small parts, it is a valuable time saver and confidence builder.

After completion of each section, a builder should take the time to look it over. A close inspection of each soldering joint on the printed-circuit board is suggested in order to detect unwanted solder bridges. Also, should any parts for a section be left over you know you goofed!

Connecting the 3-⅓-digit LCD readout to the board was quite interesting. No solder connection was needed. A metal frame (something like a chrome license-plate holder) secured the LCD readout to the printed-circuit board. Two conductive rubber strips cushioned the LCD in the frame for a snug fit and provided electrical connection between the terminals on the LCD and the foils on the printed-circuit board.

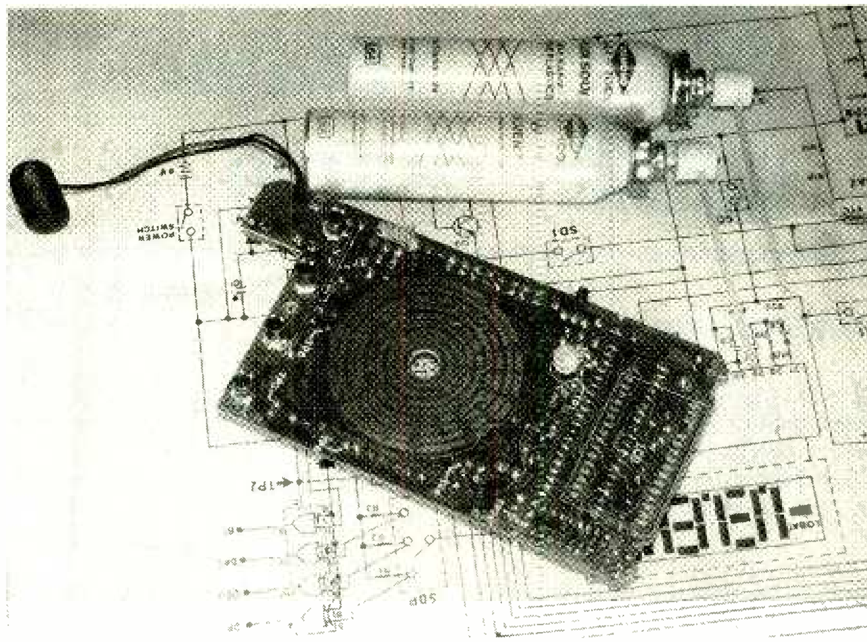
Soldering the four input jacks to the printed-circuit board required the use of a 40-watt soldering iron, as mentioned, but even then, it took considerable heat to get the solder to flow evenly around the circular joint. Since the metallic part is relatively large, it holds its heat for several minutes, so put the work down after soldering the jacks in place and take a short break.

Calibration. DC voltage calibration requires either a standard voltage, or another DC voltmeter that is accurate to within a ½ percent. The latter was available and the unit was calibrated using a voltage divider across a 5-volt regulated-DC source knocked down to approximately 190 mV. Just follow the simple directions in the manual and adjust one potentiometer. That's it for DC voltage calibration.

DC current calibration was a bit more involved than voltage. A 2-ampere DC source was made from a car-battery charger and a 12-volt regulator. The load used was a precision 1-percent resistor that provided 1.2 amperes.

The adjustment was made by relocating a wire attached to a copper-wire bus. The wire must cool to room temperature before a reading can be made. It took some positioning of the wire to bring the unit into calibrction within 1 percent—the accuracy of the standard used. The calibration results were good.

No adjustment was required for the resistance and AC-voltage ranges because precision resistors were used throughout the unit. The AR-140K displays AC-voltage as an *rms* value for a sinewave. Measurement errors are introduced when the input waveform is not sinusoidal. The amount of inaccuracy depends on the type of waveform. The manual gives conversion factors for waveforms that must commonly be measured.



As with any project, the printed-circuit board was cleaned using professional solvents to remove solder fluxes and other contaminants. Lacking professional chemicals, the builder can use warm water and scrub the surface with an old tooth brush.

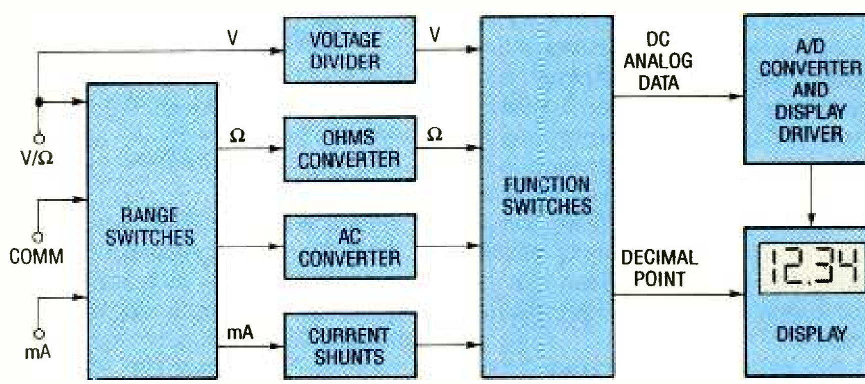


Fig. 1. This block diagram of the AR-140KDigital Multimeter illustrates the functional segments of the circuit's operation. Note: the AC converter is used whenever an AC signal is being processed.

Theory of Operation. LSI chip U1 contains a dual-slope A/D (analog-to-digital) converter, display latches, decoder, and the display driver. Look at Fig. 1. Any input (whether measuring voltage, current, or resistance) are routed by the FUNCTION and SELECTOR switches to produce a DC output voltage between 0 and ±199mV. For example, if the input signal is 100 volts DC, it is reduced to 100 mV DC by selecting a 100:1 divider. Should the input be 100 mV AC, then the divider is assisted by the AC converter to produce 100 mV DC. If current is to be read, it is converted to a DC voltage via an internal shunt resistor. For resistance measurements, an internal voltage source supplies the necessary 0–199-mV signal.

Finally, the processed signal is fed to an A/D converter. Here the DC voltage is digitized. The resulting signals are processed in the decoders to light the appropriate LCD segment.

Timing for the overall operation of the A/D converter is derived from a 48-kHz external oscillator. In the A/D converter, the frequency is divided by 4 before it clocks the decade counters. It is further divided to perform other functions within the IC. The final readout is clocked at one reading every 0.4 second. The digitized measurements appear on the LCD readout as four decoded digits (with seven segments each) and a polarity indication. The decimal-point position on the display is determined by the selector-switch setting.

On the Whole. The AR-140K Digital Multimeter is a handy pocket meter that can be toted about the job on your person, stored in a tool box, or kept in the glove compartment of your car. It can tolerate temperatures from -4°F to 176°F, so except for extreme conditions, the AR-140K can go where you go.

Putting the multimeter together was a stimulating experience. When you're done building it you'll have a practical and useful measuring device that will be there when you need it. The kit may be purchased for $39.95. For more information on the AR-140K DMM, write to American Reliance, Inc., 9241 East Valley Blvd., Rosemead, CA 91770, or circle 119 on the Free Information Card. ■

Antique Radio

By Marc Ellis

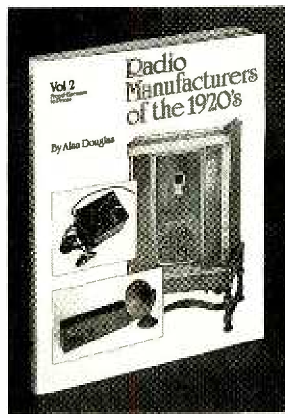
MORE FROM THE MAILBAG

Last month, we covered most of the items that were reposing in *Antique Radio's* overflowing mailbag, but there's still quite a bit of interesting material left. So, without further ado, let's plunge right in!

Sequel to a Winner. A few years ago, I had the pleasure of reviewing Volume 1 of The Vestal Press' projected 3-volume set *Radio Manufacturers Of The 1920's*. Author Alan Douglas' goal for the series was to profile each major manufacturer that produced sets during that pioneering decade. In the preface to the first volume, he tells us that almost every company in business for 3 years or more will be represented among the 70-odd manufacturers covered in the complete set. In addition to presenting the business history of those companies, Douglas has set out to describe every one of the set models that they advertised—whether common or scarce.

The volumes are set up in encyclopedia style, with the manufacturers arranged in alphabetical order. Volume 1 covered A-C Dayton through J.B. Ferguson, Inc., and a few weeks ago, I was pleased to receive Volume 2—which begins with Freed-Eiesemann and continues through Preiss. Once I unwrapped this addition to the set, it was hard to put down. Like Volume 1, it's not only a definitive reference book, but also a browser's delight.

In compiling this series, Douglas has pulled together a vast array of material from hard-to-find contemporary trade publications, popular literature, and manufacturers' brochures. He's created a powerful reference tool of unique value to the radio collector and historian, and Vestal Press has backed him up by providing attractive page layouts and top-notch reproduction. I really can't wait for Volume 3, which completes this set, and I hope Douglas and Vestal will then go right on to do a similar job for the 1940's!



Alan Douglas' Radio Manufacturer's of the 1920's: Volume 2 *meets the same high standards set by Volume 1. It's a definitive reference that's also a browser's delight.*

Volume 2 of Radio Manufacturers of the 1920's (266 pages) sells for $24.95 in soft cover or $39.95 hardbound. It's available from many dealers in antique-radio materials and also directly from The Vestal Press Ltd., P.O. Box 97, Vestal, NY 13851.

Reprints of the Golden Oldies. A few weeks ago, I received one of the most interesting mail-order book catalogs I've ever seen. It arrived quietly, along with a routine delivery that included the usual sale flyers, investment opportunities, easy credit schemes, and bills. In fact, I would have overlooked it if my eye hadn't been caught by the shots of the Tesla coil and Wimshurst machine on the cover.

The catalog came to me courtesy of Lindsay Publications (P.O. Box 12, Bradley, IL 60915-0012), a reprint house that specializes in republishing interesting old out-of-print books. And this particular catalog, *Lindsay's Electrical Books*, is largely devoted to electrical and electronic titles. I say "largely" because, in keeping with his breezy, "off-the-wall" selling style, the publisher couldn't resist also offering volumes on such things as embalming techniques, spiritualism, perpetual motion, witchcraft, and how animal behavior can be used to predict earthquakes.

But getting back to the subject of major interest to readers of this column, the catalogue definitely includes a gold mine of reprint books from every era of early radio—including the 1910's, '20's, '30's, and '40's. The collection even includes my own personal childhood favorite from the forties, Popular Science Magazine's *Radio For The Millions*. That compendium of build-it-yourself projects dates from a time when radio receivers were just being freed from their heavy cabinets and downsized to the point where they could be built into such things as pocket notebooks, flour canisters, and satin-covered boudoir lamps.

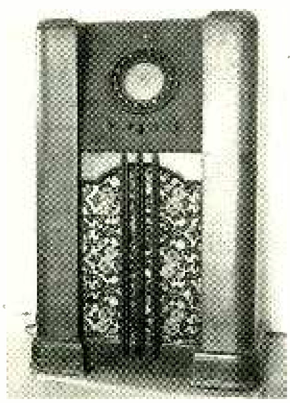
I think I'll always remember the distinctive photographic illustrations that were used to show the completed projects in use. Part of their charm, I'm sure, came from the fact that the most imposing and serious-looking individuals were used to demonstrate some of the goofiest, most implausible projects.

But I digress. Lindsay is obviously an antique-radio fan himself, has a great eye for vintage-radio publications, and has discovered and illustrated some great ones. You'll find all 10 volumes of Gernsback's *Short Wave Library* (1930's), *Henley's 222 Radio Circuit Designs* (1924), Radio & Television Magazine's *Shortwave Beginner's Book* (1940) and ... but why should I spoil your fun? Write for this lively, profusely-illustrated catalog and check it out for yourself!

From the Young Collectors. I was really pleased to find letters from a teenager and a pre-teen among the correspondence in this month's *Antique Radio* mailbag. Kevin Bakar, age 15, has just gotten interested in restoring antique radios. He's kicked off his collection with three interesting old sets: a *Truetone* 10-tube floor model (model *D-697*), an *RCA-Victor* 5-tube-plus-ballast table model (model *96T5*), and a *Hallicrafters* double-conversion general-coverage receiver (model *SX-71*).

Kevin sent along some very nice pictures of his discoveries, and I'm including a few in this column. His problem is that none of them work, and he'd like some help diagnosing the problems. Kevin's description of the difficulty with the Truetone sounds like the classic symptoms of a bad electrolytic capacitor in the filter circuit ("The only thing I could hear when the Truetone was turned on was a loud buzz which kept getting louder and louder as the tubes heated up. This noise could not be controlled by the volume control or any other controls.")

Kevin, it's easy to spot the electrolytic in the good shot you included of the *Truetone's* innards. It's undoubtedly the can-like unit all the way over to the right of the chassis and just behind the front panel. Replace it with an electrolytic of similar ratings and you will have gone a long way toward solving your problems. Of course, the capacitor may have already been replaced at some time in the past (such components fail more often than any others in a radio receiver). In that case the can on top of the chassis may be disconnected, and the more recent replacement (which now, in turn, must be replaced) may be found underneath.



Reader Kevin Bakar's 10-tube Truetone console. The boldly patterned grille cloth may not be the original.

Rear view of Truetone chassis. The tuning-eye socket is visible just above the dial drum.

Kevin didn't carry his exploration of the other sets far enough for me to attempt a diagnosis, but I'm sure he'd appreciate it if an experienced reader would be willing to write him with some suggestions on how to proceed. Contact Kevin Bakar, 2490 Pico Ave., Clovis, CA 93612.

Josh Sprague (Yakima, Washington), who just turned twelve last November, bets he is the youngest reader of this column. Anyone care to challenge him? Josh's collection began with a *Silvertone* console (model *1915*) given to him by his grandmother. Josh fixed that unit with the help of a radio-repairman friend, who showed him how to install the necessary replacement power transformer and filter capacitors. Since then, Josh has restored an *Emerson* model *503* and an *RCA* model *96T*. And, at the time he wrote, he was just beginning work on a new set!

Tube Talk. Mike Sciascia (Austin, TX) had a couple of questions about tubes with battery-operated filaments. First, he wondered about the tubes used in the old battery sets that had rheostats to control filament voltage. Were they operated at slightly lower voltage to make them last longer?

Well, that might be so, Mike. I'm sure that the prudent battery-set operator turned up the filament voltage just high enough to get decent results. But the real point is that the tubes used in that service were deliberately designed to operate at somewhat less than full battery voltage. That way, they could continue to function normally even after battery voltage began to fall.

For example, the filament of the ubiquitous 01-A tube, which was designed to operate from a six-volt auto battery, was rated at just five volts. With a fresh battery, the filament rheostat had to be turned down a bit to cut the voltage. But as the battery discharged, the rheostat was (as you pointed out) slowly turned up to maintain filament voltage near the rated value for as long as possible.

Mike's other, equally interesting, question refers to more modern battery tubes—those identified by the standard coding system that indicated filament voltage (minus any fractional amount) by the first digit(s) in the designation. Why were the filaments of tubes such as the 1C7G or the 1H4G actually rated at two volts? And why did later generations of those "1-volt" tubes (such as the 1A7G) have filaments rated at 1.5 volts (or 1.4-volts, to be exact)?

Mike is really asking several questions at once here, and I'll try to sort them all out. Tubes such as the 1C7G or 1H4G were designed to be used in farm sets powered by 2-volt lead-acid storage cells. Those cells were rated at a full 2 volts, rather than something less, because the cells were kept more-or-less constantly charged by wind generators and rarely dropped in voltage.

The digit "1" was used as the voltage designator for those 2-volt tubes because (I surmise) "2" was already in use to indicate tubes with 2.5-volt AC (or DC) cathode-type heaters such as the 2A5. Tubes such as the 1A7 were intended for use in personal portable radios whose filament power came from 1.5-volt carbon-zinc cells (such as flashlight batteries). Although no filament rheostat was used, the 1.4-volt filaments worked fine with fresh batteries and were also perfectly happy as the batteries began to drain and the voltage dropped slightly.

Kevin Bakar (see previous section) also had a question about tubes. Most of the tubes in his *Truetone* console are large glass types having "G" suffixes in their code designations. Could those tubes be replaced by their metal equivalents (which carry the same designation without the "G" suffix)? Specifically, could he replace a 6H6G (which he priced at $3.50) with a 6H6 (which can be obtained for $1.00)?

The answer to that one is a definite "maybe." The metal and glass tubes that have the same basic designation are functionally the same. However, in most metal tubes, pin 1 is connected to the metal outer shell. And that pin is normally grounded at the tube socket so that the shell can act as a shield. In the corresponding glass tube, there may be no connection to pin 1. Thus, the solder lug for pin 1 on the tube socket—not being needed for connection to the tube—might be used as an electrical tie point, perhaps carrying some dangerous voltage.

Plug a metal tube into the socket instead of the glass one, and not only would the outer casing be ungrounded, it might also become a serious shock hazard through its connection with the tie point. So careful study of a tube manual, as well as the connections to pin 1 of the tube socket, is indicated before making the substitution.

In the case of the 6H6, there should be no problem making the substitution. Even the glass types show pin 1 as being connected to an internal shield, so it should always be found grounded at the tube socket.

Tubes having a small-size glass bulb (they have a "GT" as the suffix of their code designation) sometimes sub-

(Continued on page 97)

Circuit Circus

By Charles D. Rakes

CIRCUIT ROUND UP

Our first entry this month is a circuit that will go a long way in improving the performance of any shortwave receiver that uses a longwire or similar untuned antenna. The antenna tuner—or *transmatch* as it is called when used with a transmitter—takes an antenna of unknown impedance and matches it to the input impedance of the receiver to which it is connected.

To obtain the maximum energy transfer from one circuit to another, the impedance of both circuits must match. If you connect an antenna that has an impedance of 500 ohms to a receiver with a 50-ohm input impedance, the majority of the signal will never reach the receiver because of the enormous impedance mismatch between the two devices. If you plan to receive DX signals and if your antenna system is still in the planning stage, build the antenna tuner and turn that random length of wire into a more than respectable signal grabber.

Antenna Tuner. Figure 1 shows a schematic diagram of an antenna tuner in its simplest form. In that circuit, two variable tuning capacitors and a single variable inductor make up the T-type, impedance-matching network. That circuit is basically a variable RF transformer that's designed to match two different impedances (much the same as an audio output transformer is used to match the output impedance of an amplifier to that of a loudspeaker).

When the antenna tuner is adjusted for a match between the antenna and the receiver's input circuit, maximum RF-energy transfer occurs, giving you the best possible opportunity with a given antenna to catch that rare DX station. Figure 2 shows a slightly more involved variation of the scheme outlined in Fig. 1.

In Fig. 2, the two inductors (L1 and L2) are wound on a single coil form and are made variable by the taps positioned at various points along the coil. Each coil's inductance can be changed by changing the tap connection. With the large inductance and capacitance values used, the tuning range of the circuit is from below the standard AM-broadcast band to beyond the 10-meter band.

Switch S1 allows the signal picked up by the antenna to be either fed through the antenna tuning circuit or to bypass the tuner, feeding the signal directly to the receiver. The real worth of the tuner can be demonstrated by flipping the bypass switch back and forth during the receive operation. In many instances, a DX station may not even be heard when S1 is in the BYPASS position.

When building the antenna tuner, the coils and the two capacitors can be mounted on an 11- × 8- × 1-inch piece of hardwood in breadboard fashion. A piece of aluminum, measuring about 11- × 3½-inches in area, can serve as the front panel with the three switches mounted in the center. The panel should be connected to circuit ground. When assembling the circuit, be sure that the capacitors do not touch or make electrical contact with the metal panel. If you choose to build the tuner in an all-metal cabinet, be sure that the two capacitors are isolated from the enclosure, and that there's at least a 1-inch clearance around the coil. Use any construction scheme desired, but in all cases keep the interconnecting wiring as short as possible. At 30 MHz, a few inches of wire becomes a significant part of the total inductance of the circuit.

The two inductors (L1 and L2) were wound on a 4½-inch length of 2⅜-inch O.D. (2-inch I.D.) PVC schedule 40 plastic water pipe. Figure 3 gives details on the construction of the two coils. Using number 18 enamel-covered copper wire, wind 36 turns of wire in a solenoid fashion on one end of the form without any spacing between turns. Locate the center winding of that coil and carefully remove about ¼-inch of enamel from the top side of the copper wire. Then solder 5-inch lengths of hookup wire to the center tap and to the coil ends as well. That coil is now complete and will serve as L1.

Next, starting about an inch down the coil form from L1, begin winding L2 (winding in the same direction). Apply 20 turns of number 18 enamel-coated copper wire with about a ¹⁄₁₆-inch spacing between turns. Mark off 12 positions

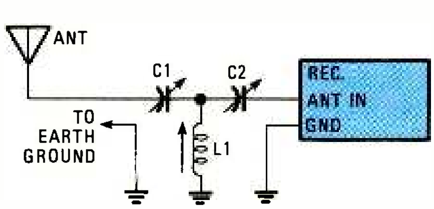


Fig. 1. Shown here is a schematic diagram of an antenna tuner in its simplest form; two variable tuning capacitors and a single variable inductor make up the T-type, impedance-matching network.

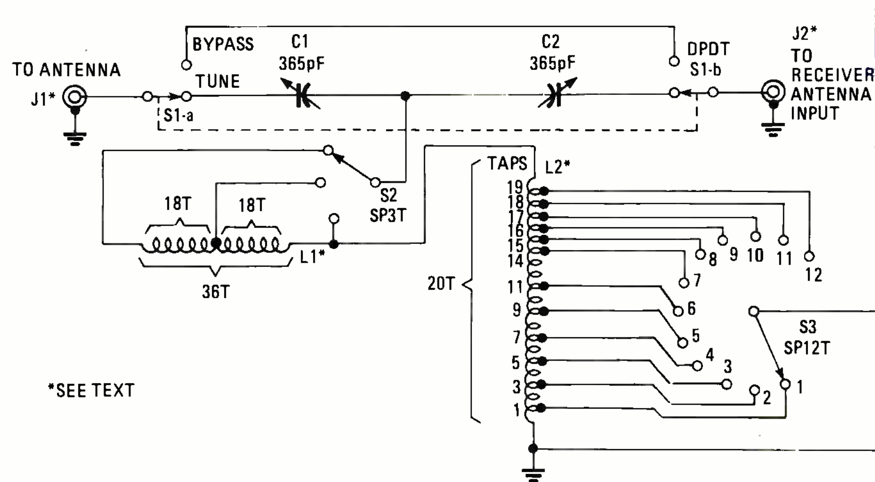


Fig. 2. Here is a slightly more involved variation of the Antenna Tuner, again incorporating two capacitors in its design, while substituting two hand-wound tapped coils for the variable unit used in Fig. 1.

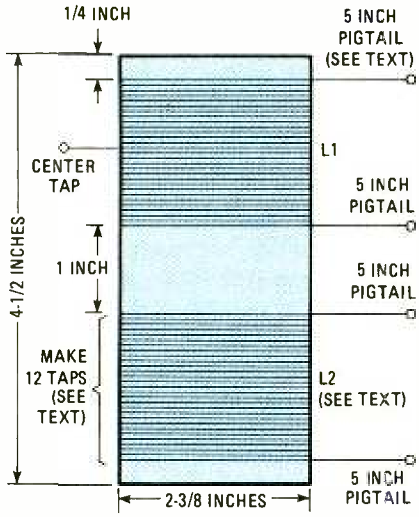


Fig. 3. The two inductors (L1 and L2) were wound on a 4½-inch length of 2⅜-inch OD (2-inch ID) PVC schedule-40 plastic water pipe. Using number 18 enamel-covered copper wire, the coils were wound in solenoid fashion on the form.

along coil L2, and carefully remove ¼-inch of enamel from each of the tap positions. Then solder a 5-inch length of hookup wire to each of the 12 taps and to the coil ends. That completes the winding of coils L1 and L2.

When connecting the coil's tap wires to the terminals on switches S2 and S3, cut each wire to a minimum length, allowing no more than ½ to ¾ inch of slack between the coil and switch. Connect sockets to the input and output of the circuit. Use SO-239 chassis-mount sockets for the input/output connectors if the tuner is to be used with equipment using similar RF connectors. But, if you intend for the circuit to be used as a general-purpose tuner just about any type of terminal or binding-post connector will suffice.

A good Earth ground will greatly improve the performance of the tuner; but if one isn't available, you can run a length of wire around a baseboard or under a rug and connect it to the tuner's ground circuit to create a counterpoise ground system. You can experiment with a variety of real and contrived ground systems to obtain the best reception.

A good place to test the tuner is on the standard AM-broadcast band. To do so, place S1 in the bypass position and tune in a weak station anywhere on the dial between 600 kHz and 900 kHz. Set C1 and C2 to about mid position and S2 and S3 in their NUMBER ONE position. Switch S1 to the TUNE position and rotate S3, changing tap positions until the strongest signal is received. Then, peak the signal by adjusting C1 and C2. You may have to jockey back and forth on the capacitor and inductor settings to obtain the greatest signal strength.

With inductor L1 in series with L2, the tuner circuit will cover the frequencies below the 160-meter band; L2 alone will cover 80 through 10 meters. For the best signal transfer between the antenna and receiver, always use the inductor tap that requires both C1 and C2 to tune for the maximum signal strength with their rotor plates at least 25% meshed.

PARTS LIST FOR THE ANTENNA TUNER

C1, C2—365-pF, broadcast-type tuning capacitor.
J1, J2—Input/output terminals, see text.
S1—DPDT toggle switch
S2—SP3T rotary switch
S3—SP12T rotary switch
L1—See text
L2—See text
Enclosure, connector, wire, solder, hardware, etc.

PARTS LIST FOR THE CAPACITANCE BRIDGE

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R9—10,000-ohm
R2, R3—2200-ohm
R4, R5—47,000-ohm
R6, R7, R8—100,000-ohm
R10—10,000-ohm, linear-taper potentiometer

CAPACITORS

C1–C6—0.1-µF, 100-WVDC, ceramic-disc
C7—100-pF, 100-WVDC, 5% polyester, Mylar, or mica
C8—0.02-µF, 100-WVDC, Mylar
C9—100-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

U1—567 phase-locked loop, integrated circuit
U2—MC1458 dual op-amp, integrated circuit
S1—SPST toggle switch
Perfboard materials, 9-volt transistor-radio battery, small piezo speaker, test terminals, etc.

Capacitance Bridge. Our next circuit can be a handy item if you are into building projects that require small fixed or variable capacitors. If your luck is anything like mine, you probably have a box just chock full of little unmarked capacitors that are probably worth a kings ransom—that is, assuming that they could be identified. And have you ever seen a variable capacitor with the value printed anywhere on it? Not on your life!

Build this micro-value Capacitance Bridge and save big bucks by pressing those otherwise useless unmarked capacitors into service in your future projects. The Capacitance Bridge is capable of identifying the value of any capacitor with a value ranging from less than 10 pF to over 2000 pF, using a single 0–300 degree calibrated scale. You will find that determining the minimum/maximum value of variable capacitors couldn't be easier. And if you find yourself faced with larger value capacitors, the circuit can easily be modified to cover just about any range required.

Let's take a look at the circuit in Fig. 4 and see how the bridge operates. Integrated circuit U1—a 567 Phase-Locked Loop (PLL)—serves as a low-frequency

(Continued on page 90)

Computer Bits

By Jeff Holtzman

GETTING ORGANIZED

You don't have to hang around computers for very long to hear the buzzword "database". What is a database? The answer to that question is rather complicated; in this issue I'll give a basic definition and an overview of several things you must consider when designing a database. Next time, I'll talk about a specific database manager for the PC that allows you great flexibility in setting up a database, maintaining it, and getting reports out of it. Better yet, it's easy to get started with, and it's inexpensive.

Organization. At the simplest level, a database can be viewed as an organized collection of information. Organization implies order; without order, the information contained in the database would be difficult if not impossible to find.

Order may be inherent in the structure of the database itself. For example, a telephone book is a database of names, addresses, and telephone numbers; the database is ordered alphabetically by last name. Ordering it by name is not the only possibility, however. It could just as easily be ordered by address or by telephone number. The telephone company, of course, can access its subscriber database by name, by telephone number, and by address. And companies who sell mailing lists often maintain their databases by ZIP codes and even street addresses.

In the telephone book, the structure of the database itself represents the desired order. But often you'd like to get at information stored in a database other than by the order in which information is stored. Sometimes you don't even know ahead of time exactly how you might query the database (ask it questions).

For example, when you move into a new house, you call the telephone company to tell it to turn on the phone. In that case, the company asks you for the address. Later, you have trouble and call for service; then you have to give your phone number. The point is that there is a central repository of information that you might want to access in various ways. However, you don't want to keep three copies of the database, one sorted by name, one by address, and one by telephone number.

Records and Fields. Like a telephone book, a database is stored in an organized format. In the phone book, each line contains a name, an address, and a telephone number. In database terminology, each line is a record; each distinct type of information in each line is a field.

Records and fields are abstract concepts; they don't necessarily correspond to lines and columns of ASCII text in a disk file—although they could. There are many different ways of storing each field in a record, as well as the entire collection of records. In fact, there are products and even companies whose sole purpose in business is to convert among various database formats.

How the information in a database is stored might not seem to be very important. Actually, storage format is crucially important for two reasons: storage efficiency and speed of access. For example, one simple database format (called fixed-length) assumes that all records are the same length, and that each field in each record is the same length.

Assume, for example, that you allot 20 characters to the name field of the telephone-book database. Lots of people have names shorter than 20 characters. Every time you see "Jones," for example, you know that you've wasted 75% of the name field. And how do you know that 20 characters is enough? Surely someone has a name longer than that. Maybe 25 characters would be a safer length. Of course, every Smith and every Jones will then waste 80% of the field length.

On the other hand, for a local telephone book, all the number fields will be the same length. But street addresses could vary widely just like names.

What Do You Do? For a small database, it may not make a whole lot of difference. For example, suppose you want to create a database of friends and co-workers. After inspecting your old hand-written books you find 100 names you want to keep. And assume that you want to make sure you've got room for a total of 500. For the sake of discussion, provide 20 characters for the name field, 20 for the address field, and 10 for the telephone number field.

That makes a total of 50 characters per record; for 100 records, that's just 5000 bytes; for 500 records, that's 25,000 bytes. No big deal. Even if you double the lengths of the name and address fields, a 100-record database would consist of 100 × 40 + 40 + 10 = 9000 bytes, or 45,000 bytes for 500 records.

Assume now that you're planning the database for a local telephone company. You live in a town like mine, population about 100,000. Assume that only one in four persons requires a listing; at 50-bytes per record, you require 50 × 25,000 = 1,250,000 bytes of storage. That's not a huge amount, especially since most people these days have a hard disk. If you double field lengths as above, you would require 25,000 × 90 = 2,250,000 bytes. Still easily storable on any hard disk.

Performance. Storage space, however, is not the only issue. There is also the question of performance. A typical AT hard disk is the ST-251, which has a track-to-track seek time of about 8 ms. Each track consists of 17 sectors × 512 bytes/sector = 8704 bytes. At 50 bytes/record, you could store 8704/50 = 175 records (approximately) in one track. Assume that all records are stored on sequential tracks, and ignore the time it takes the head to get to the first track of the database.

A customer calls, requesting service. You get his phone number, and start searching the database. If the database is not sorted on the number field, you must conduct what is called a sequential search: start at the first record and examine every record until you reach the desired one. If the desired

LISTING 1

```
program Search;

Const
  TestFileName : String[12] = 'TEST.DAT';
  SearchString : String[20]  = 'Natalia
  NumberOfRecs : Word        = 25000;

Type
  TestRec = Record
              Name    : string[20];
              Address : string[20];
              Phone   : string[10];
            end;

Var
  F : file of TestRec;
  T : TestRec;

begin
  assign (F, TestFileName);
  reset (F);
  repeat
    read (F,T);
  until T.Name = SearchString;
  close (F);
end.
```

record is in the first track, great: you'll get there essentially instantaneously. But if the desired record is in the last track, you'll have to bump the disk head track by track for 25,000 records; at 175 records/track that's 142 tracks. Just moving the head in that fashion would take 8 ms/track × 142 tracks = 1.1 second.

Certainly by itself, that's not much. But remember that we assumed that all records are stored on the disk contiguously; if they are not, we would have to jump around from track to track at random. Therefore, we would have to use the average seek time, which for an ST-251 is 40 ms. Since the average seek time is five times the track-to-track seek time, that would bump the worst case seek time to 5.5 seconds, which is worse, but not too bad.

However, you also have to allow time to examine each record in each track to see if it's the desired one. The general procedure is seek to a track, read a record off it, see if the desired telephone number is contained in it. If so, terminate and report the results to the operator. If not, read the next record and continue.

The problem is that during the period of examining the record, the next record might go by the disk head, so you would have to wait for that record to come around again. A hard disk spins at 3600 RPM, so you would have to wait a little less than 1/3600 second (0.2 ms) after reading each record. To get to the very last record (assuming again a contiguous file) would thus require 1.1 second (for head seeking) + 25000 × 0.2 ms = 8 seconds.

Whoops! Processing time just increased eight-fold, even with a contiguous data file! And that's very optimistically assuming that you can process a single record in the file in less than 0.2 ms.

Theory and Practice. To verify that theory, I wrote the Turbo Pascal 5.5 programs shown in Listing 1 and Listing 2. The first program—Create—creates a database consisting of 25,000 records, each field of which has the length discussed above. The very last record has a special search word—"Natalia"—in the name field. The second program—Search—reads records from the file sequentially until it comes to the record with the search word. (Both programs were compiled with range- and stack-checking off.)

I ran those programs on an AST Premium/286, a 10-MHz AT clone with an ST-251 hard disk, after booting MS-DOS 3.30 with no CONFIG.SYS and no AUTOEXEC.BAT. It took Search nearly 50 seconds to find "Natalia" in the last record. To put that in perspective, if you divide

(Continued on page 94)

DX Listening

By Don Jensen

SHORTWAVE BROADCASTER TOPPLES DICTATORSHIP

There are not many radio-broadcast stations that, by devotion to truth, democracy, and justice, can legitimately claim to be instrumental in toppling a dictatorship. But that is the record of *Radio Veritas Asia*, one of the most respected shortwave broadcasters in the Far East. It was that Roman-Catholic station in the Philippines whose news broadcasts had such an impact on the people of that nation and helped to spur the peaceful revolution in February, 1986, leading to the downfall of the corrupt Marcos regime.

Radio Veritas Asia had its origins some 30-years ago when the late Archbishop of Manila, Cardinal Rufino J. Santos, while visiting Germany, proposed a Catholic Church radio station for Asia. Then German Chancellor Dr. Konrad Adenauer offered financial assurances. Construction began in 1965 with the assistance of German Catholics and civic agencies.

The overseas shortwave service went on the air in 1969 with programming from Radio Veritas Asia studios in Quezon City, near Manila. The station had its share of difficulties with Philippine authorities over the years and, in fact, stopped shortwave operations from 1972 to 1975. But, with the strong support of the newly appointed Archbishop of Manila, Cardinal Jaime Sin, Radio Veritas Asia's overseas transmissions resumed in May 1975. Its valiant devotion to the truth was never better demonstrated than during the days before the popular uprising in 1986.

Today Radio Veritas Asia operates two services—domestic broadcasts to the Philippine audience and the overseas service—primarily aimed at other Asian nations and broadcasting in 15 languages. The station's impact increased greatly in 1986 with the installation of the first of two powerful 250-kilowatt shortwave transmitters, donated by the late German Cardinal Hoeffner of Cologne. It allowed the station to beam a strong signal into China, Burma, North Korea, and Vietnam.

Pandas in a bamboo grove, one of the attractive QSL cards sent to listeners by China's Radio Beijing.

In 1989, the 20th anniversary of the start of Radio Veritas Asia broadcasts, a second 250-kilowatt station became active at Palauig, a small coastal town in Zambales province. That transmitter carries programs for Indian and Southeast Asian audiences, plus broadcasts for Ukranian Catholic Church members in Soviet Siberia.

Although programming primarily is beamed to Asia, North American listeners can hear Radio Veritas Asia, too. The station airs English broadcasts from 0130 to 0200 UTC on 15,220 and 15,360 kHz, but perhaps a better time for tuning that station would be from 1500 to 1530 UTC on 9,525 and 15,445 kHz.

Reception reports may be sent to Radio Veritas Asia, P.O. Box 939, Manila, Philippines.

Coming of Age? For more than 30 years, when one spoke of shortwave broadcasting in the United States, chances are it was the government-operated *Voice of America* that came to mind. Besides the VOA, there were only a couple of religious SW broadcasters on the air. But in the last decade that has changed. Today there are 17 private shortwave stations licensed by the Federal Communications Commission, several of them are commercial broadcasters, with the rest having religious affiliations.

Private shortwave broadcasting—from continental U.S. transmitters and from outlets on American territory overseas—have grown to the point that some 13 of those stations joined together last September in New Orleans to form a new broadcasting organization designed to promote their specialized regulatory, technical, and programming interests.

The new organization, the "Association of Shortwave Broadcasters," appointed as its president, Edward J. Bailey, vice president and chief executive officer of *World Christian Broadcasting Corp.*, which operates KNLS at Anchor Point, Alaska.

Other officers selected by the new group were Vice President, W.E. "Ted" Haney, of KGEI/KFBS, *Far East Broadcasting Co.*, with SW stations in California and on the Pacific island of Saipan, and Secretary, Tulio Haylock, representing KSDA, *Adventist World Radio* on Guam. Larry Blosser (of Fisher, Wayland, Cooper, and Leader) was named legal consultant, and George Jacobs, technical and regulatory consultant.

The main purpose of the Association of Shortwave Broadcasters is to make the FCC more aware of the specialized needs of FCC-licensed shortwave-broadcasting stations, and for the Commission to be more responsive to meeting those needs than it had been in the past. The ASB plans to act as a focal point for private-sector participation in national planning for International Telecommunications Union conferences dealing with shortwave broadcasting. Planning also has begun to push for the updating and redrafting of the FCC rules and regulations dealing with international shortwave-broadcasting stations.

Feedback. Your letters with comments, questions, and loggings are always welcome. I also look forward to receiving photos of you and your listening

Credits: Richard D'Angelo, PA; Dan Sheedy, CA; Robbie Reeves, OR; Tom Laskowski, IN; Robert Zilmer, NM; North American SW Association, 45 Wildflower Rd. Levittown, PA 19057.

equipment for this section of our monthly column. The address is *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

At the top of the letter stack is a note from Bruce Phillips of New York City. Over the past year or so, he has been closely following the dramatic developments in eastern Europe on shortwave. "It has been fascinating to tune the English-language broadcasts from the eastern bloc capitals—Warsaw, Prague, Budapest, Berlin and, especially Romania's *Radio Bucharest*. The change in content, tone, and candor has been nothing less than breathtaking, especially for one who has been a rather faithful listener to those stations."

The exception, Bruce notes, remains (at least as of this writing), Albania's *Radio Tirana*. "Tirana is still the unreconstructed Cold Warrior of Eastern Europe." Bruce points out a few program highlights from Radio Tirana's World Service schedule to illustrate this continuation of the station's longtime hard line. For example, "Leafing Through Our Marxist-Leninist Press;" "Outstanding and Revolutionary Figures;" "Socialism and the Youth;" "Culture and Arts in Socialist Albania;" "Marxism-Leninism: An Ever Young Scientific Doctrine", and "Introducing You to Albania."

Another approach to following the events in Eastern Europe was offered by John Ralph, a member of the "British World DX Club." In a letter he focused on his shortwave observations on one dramatic date, last September, 11, when Hungary opened its border to Austria, allowing thousands of East German "tourists" to escape to the West.

John tuned various SW stations to note the way in which they covered the event, East Germany's *Radio Berlin International*; West Germany's *Deutsche Welle; ORF* Austria; and *Radio Budapest*, Hungary. He pointed out that the East-German broadcaster reported "the exodus as an illegal man-smuggling activity, carefully orchestrated by West German authorities for political purposes, and the escapees would soon regret their actions..." Deutsche Welle rejected that theme, saying the West German government was urging the East German leadership to initiate democratic reforms.

Austrian Radio focused on personal stories from the escapees and Radio Budapest noted the great relief felt by the German refugees waiting in Hungary. "Different stations, differing interpretations of the news, differing opinions...," John noted. "Condemnation from East Berlin; personal stories from Austria. One day that will have changed some lives forever!"

An excellent and pointed example, John, of what listeners can find on shortwave when important news events occur.

Down the Dial. Here are some of the stations listeners are hearing on shortwave. What are you hearing?

Albania—11,835 kHz. Try here around 2350 UTC for Albania's *Radio Tirana* and its English-language programming.

India—17,725 kHz. India's *Air Delhi*, has been logged on this frequency at 0000 UTC, with Indian music, identification and news in English.

Nicaragua—5,999 kHz. *La Voz de Nicaragua*, which had been operating around 6,200 kHz more recently moved here, where it was logged around 2330 UTC and again around 0400 UTC in Spanish. The station has been noted identifying, simply, as "La Voz."

Pakistan—21,740 kHz. *Radio Pakistan* signs on at 1556 UTC, with its English identification and slow speed news from 1600 UTC. ■

Ham Radio

By Joseph J. Carr, K4IPV

WHERE DOES MY SIGNAL GO?

Understanding antenna-radiation patterns helps hams understand where our signals go for any given design and installation configuration. It also helps explain why one ham can work many stations in one part of the country (or world) while another one located close-by can work stations in other areas using the same band.

Figure 1 shows a basic half-wavelength dipole antenna. We are using the dipole as our example because it is both simple and very popular. The overall length of the a half-wave dipole is given by:

$$L_{ft} = 468/f_{MHz}$$

The dipole is erected such that the radiating element, usually a wire or aluminum tubing, is horizontal with respect to the Earth, and is fed from the transmission line in the center (as shown in Fig. 1). The radiation patterns of various antennas are discussed in any good antenna book. Some basic theory of patterns is repeated at each discussion, not to fill space, but rather to drive home a point and refresh the reader's memory.

We keep harking back to the concepts of directivity and gain because they are so important. Antenna theory uses an artificial point of reference called the *isotropic radiator*. Such a device is a theoretical construct (*i.e.*, it's not real) consisting of an omnidirectional source of RF radiation. When discussing antenna "gain," the isotropic radiator serves as the 0-dB reference.

The concepts of directivity and gain are essentially the same. An antenna gets its gain over an isotropic radiator by focusing the RF power into a limited number of directions. For example, a dipole is bidirectional in the horizontal plane, so it focuses energy into only two directions instead of in all directions.

But one must always keep in mind that directivity and gain are specified in three dimensions—not two. Too many times authors (including myself) oversimplify the topic by publishing only the horizontal part of the radiation pattern. But a signal does not propagate away from an antenna in an infinitely thin sheet, as such presentations seem to imply. Therefore, to properly evaluate an antenna pattern, you must consider both the horizontal- and the vertical-plane patterns.

Radiation Patterns. Figure 2 shows the three-dimensional radiation pattern of a dipole antenna in free space. In the horizontal plane (Fig. 2A), when viewed from above, the pattern is a classic figure-8 that illustrates the dipole's bidirectional radiation effect. It consists of two main lobes that contain the RF power from the transmitter, and sharp nulls of little (or no power) that are located off the ends of the antenna axis. That pattern is the standard dipole radiation pattern published in most antenna books.

The vertical-plane pattern for a dipole antenna in free space is shown in

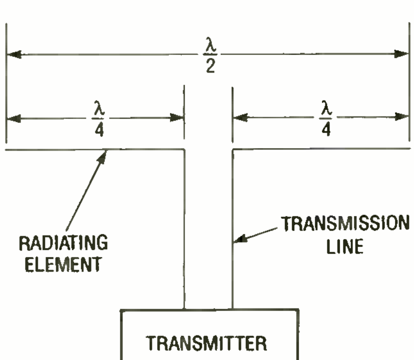


Fig. 1. Here is a basic half-wavelength dipole antenna. Its overall length is given by: $L_{ft} = 468/f_{MHz}$ + .

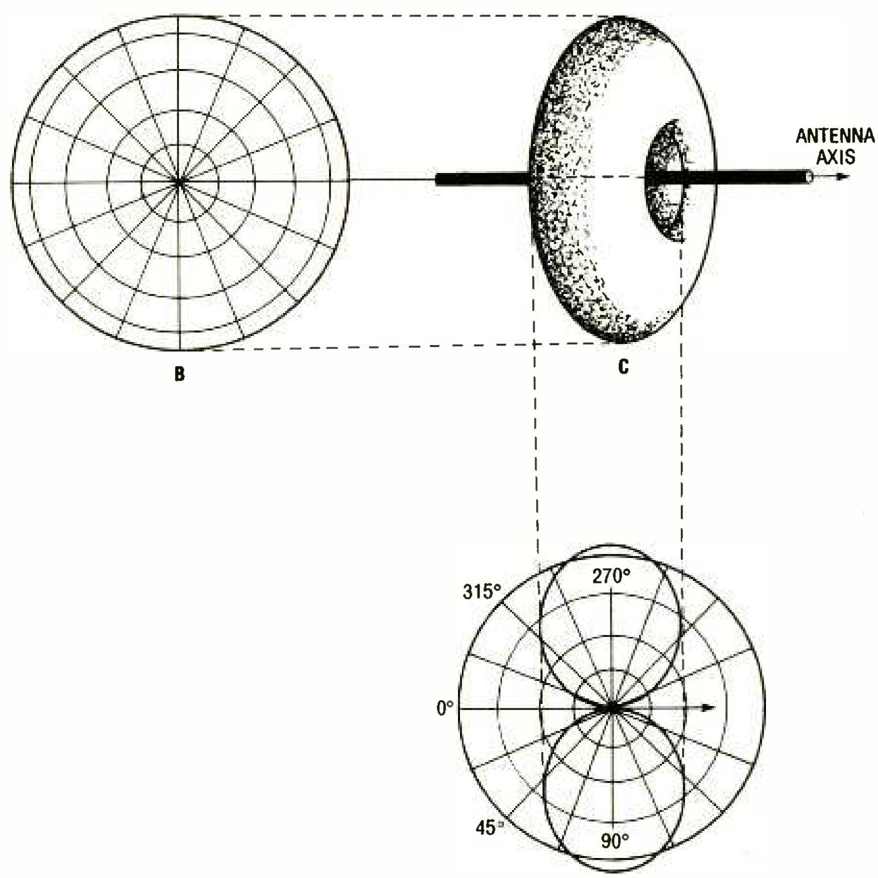


Fig. 2. When viewed from above, the dipole's horizontal-plane pattern (A) appears as the classic figure-8; when sliced in the vertical plane (see B), the radiation pattern is circular; when the two patterns are combined, we see a dimensional doughnut-shaped pattern (C) that most nearly approximates the true pattern of an unobstructed dipole in free space.

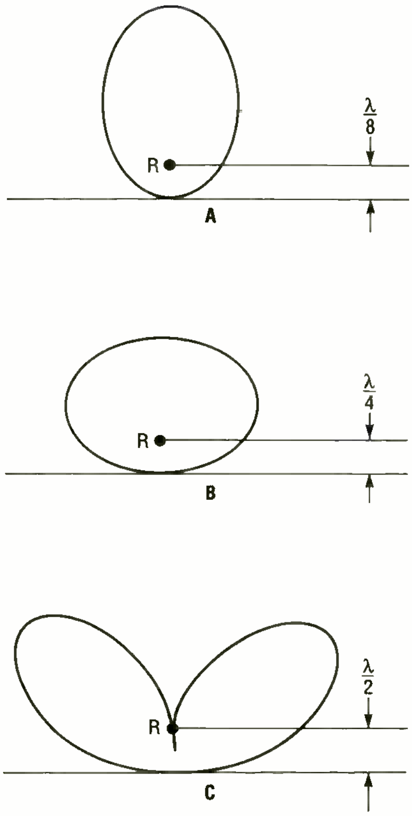


Fig. 3. Here we see the radiation patterns typical of dipole antennas installed close to the Earth's surface. Shown in A is the radiation pattern for a dipole installed at one-eighth wavelength above the Earth's surface; B shows the pattern when the antenna is a quarter wavelength above the Earth's surface; and C is the pattern obtained when the antenna is installed a half wavelength above the Earth's surface.

Fig. 2B. Note that the vertical radiation pattern is circular as shown. When the two patterns are combined, we see the three-dimensional, doughnut-shaped pattern shown in Fig. 2C. That view most closely approximates the true pattern of an unobstructed dipole in free space.

When a dipole antenna is installed close to the Earth's surface (not in free space) as is the case at most ham stations, the pattern is distorted from that shown in Fig. 2. Two effects must be taken into consideration. First, and most important, is the fact that the signal from the antenna is reflected from the Earth's surface and then bounces back into space. That signal will be phase shifted both by the reflection and by the time required for the transit to occur.

At points where the reflected wave combines in-phase with the radiated signal, the overall signal is reinforced, but where the two signals combine out of phase, the signal is attenuated. Thus, the signal reflected from the ground alters the pattern of the antenna. The second factor is that the ground is lossy; not all of the signal is reflected—some of it is absorbed into the Earth, heating the ground beneath the antenna. Thus, the signal is attenuated at greater than inverse square law, $1/D^2$ (D is distance), would indicate and so further alters the expected pattern.

Dipole Radiation Patterns. Figure 3 shows patterns typical of dipole antennas installed close to the Earths's surface. The views seen in that illustration show the vertical plane along the antenna axis. The antenna is designated "R" in each case and is shown with a dot representing the antenna element.

Figure 3A shows a dipole installed at one-eighth wavelength above the Earth's surface. For that antenna most of the RF energy is radiated almost straight up (how very useful). That type of antenna is basically limited to ground wave and very short skip (when available) communications. The second case (Fig. 3B) shows the pattern when the antenna is located at a quarter wavelength above the Earth's surface. As shown, the pattern is flattened, but still shows considerable energy in the vertical direction (where it is useless).

In Fig. 3C, we see the pattern obtained when the antenna is installed at a half wavelength above the Earth's surface. That radiation pattern is best for long distance work because energy is redirected away from straight up into lobes at relatively shallow angles of radiation.

When building a dipole antenna (or any other antenna for that matter—dipoles are merely our example here), it pays to consider not only construction materials and physical length, but also the antenna's height above ground (which affects the angle of radiation). Obviously, shorter skip zones result from dipoles mounted closer to the ground, and maximum-length skip occur when the antenna is somewhat higher.

Where to Point the Dipole. For many amateur-radio operators, the decision of which direction to point the dipole is moot: The geography of the terrain makes the decision for you. But for

(Continued on page 93)

Scanner Scene

By Marc Saxon

UP-TO-THE-MINUTE WEATHER INFORMATION

The key words for the next few months are: "Whether it's cold or whether it's hot, we're gonna have weather, whether or not!" This is the time of year when rapid—and sometimes even violent—changes in weather can bring about major upsets in our plans for the day, or even longer. Last year, the weather blew in Hurricane Hugo, and that one put a crimp in the lives of many for quite a while.

So now is a good time to begin to keep an ear poised on VHF, and keep it there for at least the next four critical-weather months.

The National Oceanic and Atmospheric Administration (NOAA) broadcasts weather information more-or-less continually from about 390 locations. The three main frequencies used for those broadcasts are Channel 1 on 162.55 MHz, Channel 2 on 162.40 MHz, and Channel 3 on 162.475 MHz. In some selected areas, there is also limited use of Channels 4 through 7, which consists of: 162.425, 162.45, 162.50, and 162.525 MHz, respectively. The NOAA transmissions have a normal service range of 50 miles and provide information on existing readings and predictions, and also special alerts relating to tornadoes, thunderstorms, hurricanes, high winds, and other expected severe-weather situations. Special tones are sent out to trigger alarm sensors that can set off sirens, lights, or other alert modes in weather-only VHF receivers.

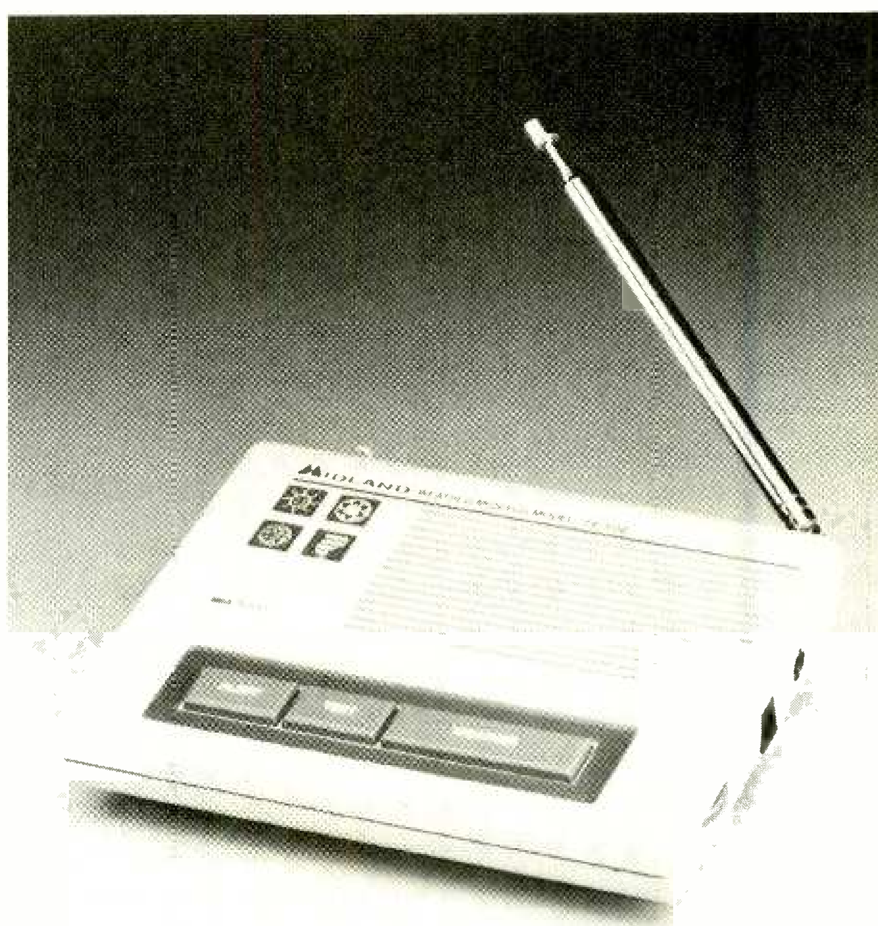
Weather-only VHF receivers are available from a number of different manufacturers, with a wide range of prices and features (not all can automatically respond to alerting tones). Most sets permit the user to switch to any of the three main channels. A good basic receiver is Radio Shack's *Weatheradio*, which is regularly $24.95, but sometimes that unit goes on sale for a lot less than that.

A more deluxe unit that we happen to like is the *Midland 74-102*, which comes from Midland International (1690 North Topping, Kansas City, MO 64120), and offers the automatic severe-weather-alert feature (siren, light, or voice). Of course, the alert feature is a very useful benefit. While the Midland 74-102 comes with its own attached telescoping antenna, it also will accept an external antenna so (during periods of tranquil weather—you certainly wouldn't want to do that during a lightning storm) you can plug in your main VHF antenna and see if you can pull in any distant NOAA stations on the channels that are not used in your particular local area. Using that arrangement, I've pulled in no less than nine distant NOAA stations on one of these sets.

The unit operates from a single 9-volt battery, or an optional AC accessory power supply. The manufacturer's suggested retail price of the compact set is $79.95, and Midland tells us they'll send you more information if you write to them and mention the Model 74-102.

Skipping In. Mike Sanders writes from Averill Park, NY that the solar cycle has made the lower scanning frequencies very hot. He set his PRO-2004 to search through the 25- to 26-MHz range (AM mode) and one day picked up *Radio For Peace International* from Central America on 25.945 MHz. Other frequencies produced London, West Germany, South Africa, and elsewhere. He suggests readers listen to those frequencies during daylight hours; AM mode, 5 kHz spacing is best.

From Carbondale, IL we received a



The Midland 74-102 weather monitor radio automatically uses a siren, a voice, or a light to alert the listener to severe-weather conditions.

note from Bryan Hash advising that listeners in southern Illinois can tune for TV news crews as follows: KFVS-TV on 461.675 MHz; and WSIL-TV on 461.25 MHz. We'll take Bryan's word for those unusual listings, since news crews are usually found in the 450- to 451-, and 455- to 456-MHz bands.

Last January we noted that 123.45 MHz is a frequency where airline pilots are often found chatting with one another. That brought us a letter from Jim Weir of Radio Systems Technology (Grass Valley, CA) pointing out that such use of that frequency, while widespread, is also a violation of FCC regulations inasmuch as 123.45 MHz is reserved for testing and development of aircraft and aircraft components. Jim's company happens to be duly licensed to operate on 123.45 MHz, and in the past ten years he has filed dozens of complaints with the FCC concerning interference on the channel!

"What's the big secret?" That's the question asked by Pat McGuire. He has gone to enormous effort to obtain the security frequency used at the Palisades Nuclear Power Plant in Covert, MI. All attempts have failed and he now turns to us as his "last resort." You should have come to us first, Pat. Listen on 451.15, 451.175, 451.35, 451.375, and 456.15 MHz. The remote-controlled emergency-warning speakers operate on 154.205 MHz.

Performance Enhancement Modifications. Every time this column mentions modifications to upgrade the performance of scanners, the mail comes pouring in asking for more. Now, an exciting new 160-page book is available devoted to that practice. The *Scanner Modification Handbook*, by Bill Cheek, has easy step-by-step instructions (with photos and diagrams) for more than twenty improvements that can be made to some scanners. The majority are for the Realistic PRO-2004 and PRO-2005, but there are also some for the PRO-34, Bearcats-200/205XLT, BC-750XLT, and BC-950XLT. With some imagination and ingenuity, modifications described for one particular scanner might be adapted to others.

For all the scanners mentioned, there's information on restoring blocked-out cellular bands. For the PRO-2004 and PRO-2005 you can also add more memory channels (as many as 6,400!), add S-meters, improve squelch action, disable the "beep," speed up search/scan rates, improve tape/headphone audio quality, interface the units with communications receivers (to add SSB reception, fine tuning, etc.), plus other useful modifications. You can modify a Realistic PRO-34 handheld to give it 3,200 memory channels. These modifications can be readily accomplished by the average hobbyist who has a few readily available tools (soldering gun, wire cutters, etc.), and the ability to follow the explicit instructions given. Of course, some prior experience with a soldering gun and circuits makes it all the more simple.

There's more, too: The book explains how laws affect scanner monitoring, how cellular systems are assigned frequencies, how to get emergency power for your scanner, etc.

The *Scanner Modification Handbook* is $17.95, plus $2 postage to addresses in USA/Canada. (NY State residents add $1.35 sales tax.) It's available from CRB Research Books, P.O. Box 56, Commack, NY 11725.

We are always seeking your loggings, questions, thoughts, photos, and suggestions. Write to us at: *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Boulevard, Farmingdale, NY 11735. ■

CIRCUIT CIRCUS

(Continued from page 81)

signal generator, which supplies a varying signal to the bridge circuit. Components C7, C_X (the unknown capacitance), and R10 make up the actual bridge circuit. If the value of C7 equals that of C_X, then the bridge will be balanced when R10 is set at approximately its mid position.

Half of an MC1458 dual op-amp (U2-a) is configured as a differential amplifier circuit and, in this application, electronically takes the place of an isolation transformer. That op-amp stage is used to couple the varying signal from the output of the bridge to a null amplifier (U2-b) without loading or unbalancing the bridge circuit.

The null amplifier (U2-b) increases the null signal by a factor of ten to provide sufficient power for the piezo speaker (SPKR1). When the bridge is balanced, the varying signal at points "A" and "B" of the bridge circuit are of equal level and phase. That balanced alternating signal drives both inputs (pin 2 and 3 of U2-a) of the differential amplifier in the same direction and level for a zero signal output at pin 1. When the bridge is slightly unbalanced, the differential amplifier produces an output signal that corresponds in level to the degree of the unbalanced input.

The capacitor identifier can be built breadboard style in either a metal or plastic enclosure, but in any case all of the component leads in the actual bridge circuit should be kept as short as possible. Any stray capacitance around the C_X test terminals will limit the minimum value of capacitance that can be checked.

To calibrate the circuit, first locate a few 5% capacitors with values ranging between 10 pF and 2000 pF. If you have an extra 100-pF capacitor that's identical to C7, connect it to the test terminals (C_X) and the bridge should balance at R10's mid position. Record the capacitance value on the dial. Take the smallest capacitor value and balance the bridge and record its value on the dial. Do the same with the largest value and as many of the in-between values as you have on hand at the time.

All you need do to increase the circuit's capacitance range is to increase the value of C7 and re-calibrate the dial. When using the higher capacitance ranges of the circuit, you may need to remove C8 and reduce the gain of U2-b by reducing the value of R8 to 47K or lower. Once those changes are made, you'll also have to experiment with the amp's gain until a good, sharp null is obtained.

Tone Generator.

Our last entry will probably stand as the simplest tone-generator circuit you'll ever see. A piezo sounder, like those found in just about everything these days, can be used to generate an alternating signal voltage at its tone frequency.

The tone generator circuit in Fig. 5A will produce a tone output signal with an adjustable level of less than 50 millivolts to over one volt. Of all of the piezo sounders checked, none produced a perfect sine-wave. Many that were checked produced a ragged output. The circuit in Fig. 5B can be used to generate a *touch-tone* like two-tone signal.

Good experimenting until we meet here again next time. ■

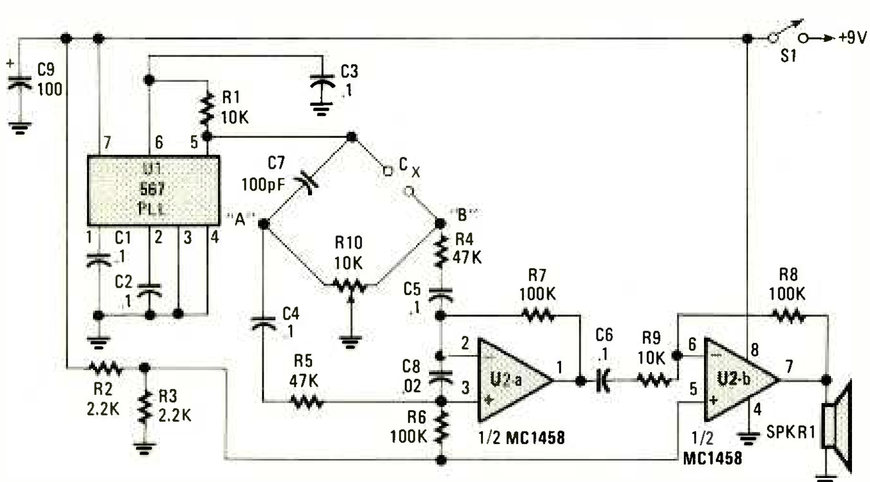


Fig. 4. The Capacitance Bridge is a simple circuit built around two IC's and a few additional components, and is designed to help determine the values of unmarked small-value capacitors.

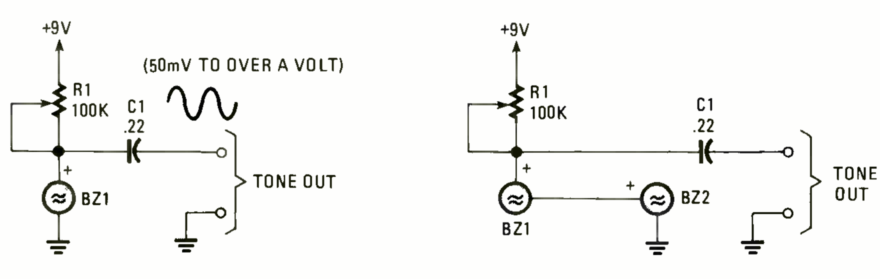


Fig. 5. These two Tone Generator circuits make use of the piezo buzzers' internal oscillators to produce a tone signal output.

PC PATTERNS

(Continued from page 36)

from office supply stores and places that have to seal documents like licenses, ID cards and the like—can be used instead of TEC-200. But if you decide to go with laminating film, be sure to get heat-fused type and not the glue backed type. The toner is fused to the film sheets by heat created in the copy machine, so anything you use must be able to withstand the heat.

Heat-fused (or sealed) laminating film has to be fused together before use. If a laminating machine is not available to you, try putting a laminating sheet in the cardboard envelope that comes with the sheets, or a manila folder, and iron it with lots of pressure on a flat surface, flipping it over once or twice; and iron until the film gets flat and stiff. You may find that laminating film sheets will need to be cut down before use in some copy machines.

With the iron-on printed-circuit technique, and a special sheet of film, you can greatly reduce the task of making printed-circuit boards, leaving us more time and money to spend on the more fun aspects of our hobby. ■

HAM RADIO

(Continued from page 87)

others, it is possible to determine in which direction to aim the antenna. There are two things to consider in aiming a dipole: First, in what direction do you want to transmit your signal? If you are looking for a lot of European DX, then aim the antenna in the direction indicated by the Great Circle Chart (*i.e.*, direction of maximum power is perpendicular to the run of the wire).

Second, from what direction is interference coming? If a lot of it arrives from a specific direction, then it may be better to place the null of the dipole (off the ends of the wire) in that direction and accept a small penalty in signal strength at the other end.

Placing the null in the direction of offending signals is, perhaps, the greatest use of directional antennas. Unfortunately, too many amateurs waste their money on large antenna arrays without realizing that that neat trick makes their operating a lot better.

Rotatable Dipoles. Most dipoles are made of wire, and are fixed as to direction. But some people do use rotatable dipoles, especially on the upper HF bands. Some manufacturers offer single-band and trap, multi-band, rotatable dipoles made of aluminum tubing. At least two companies offer 40-meter band add-on dipoles for their three-band beam antennas.

It is relatively easy to make single-band rotatable dipole antennas from aluminum tubing. Keep in mind that the outside diameter (O.D.) of each tubing size is a slip-fit for the next higher inside diameter (I.D.) tubing. You can use adjacent-size tubing to make longer runs. In addition, the slip-fit feature makes it easier to tune the dipole by adjusting its length.

Tuned rotatable dipoles can also be made. One could, for example, insert inductors in each leg of the dipole. A better method is to use a pair of mobile antennas back to back, and mounted horizontally. A piece of 1- × 2-inch lumber makes a dandy mount for the mobile antenna dipole.

The rotatable dipole can usually be turned with a TV antenna rotator (except for the larger dipoles used below 20-meters). Alternatively, buy an antenna rotator, intended for used with multi-element beam or quad and then wait for the day when you can put one on top of the tower. ■

COMPUTER BITS

(Continued from page 83)

LISTING 2

```
program Create;

Const
  TestFileName : String[12] = 'TEST.DAT';
  SearchString : String[20] = 'Natalia
  NumberOfRecs : Word       = 25000;

Type
  TestRec = Record
              Name    : string[20];
              Address : string[20];
              Phone   : string[10];
            end;

Var
  F : file of TestRec;
  i : integer;
  T : TestRec;

begin
  assign (F, TestFileName);
  rewrite (F);
  T.Name    := '                    ';
  T.Address := '                    ';
  T.Phone   := '          ';
  for i := 1 to NumberOfRecs-1 do write (F,T);
  T.Name :=SearchString;
  write (F, T);
  close (F);
end.
```

50 seconds by 25,000 records, you find that it took about 2 ms to process each record. That's ten times the amount of time it takes for the record to rotate past the disk head.

The point is that if you tried to make each customer wait 50 seconds to locate his or her record, you probably wouldn't have very many customers before long.

Better Ways. Obviously there's gotta be a better way. Well, there is. Actually there are many other ways, all of which involve various trade-offs between processing speed and storage overhead. Deciding what is best in any given circumstance means finding an acceptable set of compromises.

For example, you could maintain the file in sorted order. Then you could search it quickly by jumping to the middle of the file and seeing if the record there was greater or less than the target. If it was greater, you would jump to a point halfway between the middle and the end; or if less, to a point halfway between the middle and the beginning. After checking the record at that location, you would again jump halfway in the indicated direction. Eventually you would arrive at the desired record (or discover that it wasn't in the database). That procedure is called a binary search.

However, the binary search is not without problems either. For one, you've got to maintain the file in sorted order. Every time you add or delete a record, you would have to sort the file—and that time could quickly add up to more than the sequential search time. In addition, which field do you select to sort on? Whichever you choose, you can perform binary searches on it, but the other fields must still be searched sequentially.

If you need to search on more than one field, and you need efficient searching, one solution is to use an index, an auxiliary file that by definition is maintained in sorted order, so is amenable to efficient searching. Instead of data, however, an index file contains pointers to records in the main database.

Of course there is overhead in maintaining the index, but there are several important advantages. For one, you can add and delete records from the main database more or less at random. In addition, you can maintain several indexes, one for each fieldin the database. That way, you could search any field efficiently.

Conclusion. This discussion hardly scratches the surface of the subject of database design, but I hope it gives you a feel for some of the issues involved. Even if you don't intend to go into the telephone-book business, you probably have some information that you'd like to organize. Next time when we get together, we'll look at some of the practicalities of doing so.

In the meantime, you may want to order a copy of PC-File 5.0 and start looking it over. It's available as both shareware and as regular commercial software. You can get it from shareware houses including those mentioned in the December, 1989 "Computer Bits" column, or for $129.95 plus $5 for shipping directly from ButtonWare, Inc., P.O. Box 96058, Bellevue, WA 98009-4469; Tel. 206-454-0479, or (800) JBUTTON. ■

SONY VCR

(Continued from page 75)

mistakes in timer programming when the results of our scheduling are not displayed as we perform the programming steps. With this Sony unit you practically can't make a mistake. The picture-in-picture feature is another welcome item in that it enabled us to switch to TV while watching a tape being played back. On more than one occasion, we were able to stop the tape and let the TV picture occupy the major portion of the viewing screen. Without this feature we might well have missed a program we wanted to catch but might have overlooked because we were watching a tape instead.

Sony must have agonized long and hard before electing to join the VHS bandwagon; after all, they insisted for many years that Beta was the one and only format for them. Having finally reached the decision to go with VHS after all, it is gratifying to see that they did the best job possible in this, their newest VHS VCR; it ranks with the very best of them.

For more information on the Sony SLV-757UC VHS VCR, contact the manufacturer directly, or circle 120 on the Free Information Card.

OLIVER LODGE

(Continued from page 66)

coni received a patent on what was basically Lodge's system.

While Lodge did little initially to protect his patent rights, the situation changed in 1911. In that year, Lodge's initial 14-year patent normally would have expired. However, a 7-year patent extension was permitted if the holder could show that insufficient reward had been received during the initial 14-year period. That Lodge was able to do successfully.

The granting by the court of the 7-year patent extension, clearly put the Lodge-Muirhead Syndicate in a strong legal position to sue the Marconi Company for patent infringement. Further, the Marconi Company was having its patent positions challenged in both the United States and Germany at the very time when it was hoping to expand its worldwide position.

To avoid a long, drawn-out court battle and to ensure a strong worldwide-patent position, the Marconi Company chose negotiation, rather than legal confrontation, to resolve the dispute with Lodge and Muirhead. That choice undoubtedly reflected the Marconi Company's doubts concerning their ability to win the lawsuit.

The Marconi Company made an annual payment to Lodge during the remaining 7 years of his patent extension in exchange for ownership of that patent. The strength of the patent would be reaffirmed in 1943 when a U.S. Supreme-Court decision upheld only Lodge's original patent among the three patents then held by the Marconi Company.

Lodge was named a scientific advisor to the Marconi Company, although there is no evidence that he ever did or was ever expected to make any significant scientific contributions to them. In addition, the Lodge-Muirhead Syndicate agreed to disband. Because of those developments, the patent position of the Marconi Company was now much stronger.

Later Years. After 1911, Lodge no longer was seriously interested in developing wireless-telegraphy technology. In addition to his university duties, his time was spent writing numerous books and articles. He wrote on topics ranging from the purely scientific to the philosophical and political. Many of Lodge's writings were intended to be read by the general public and not just by scholars. Oliver Lodge still had the ability to interest a wide range of people with his ideas.

Lodge also had been developing another, much more unusual, interest over the years. He was intrigued by the subject of psychic phenomena. His interest in establishing communication with the dead began solely out of scientific curiosity. Lodge, however, soon became a firm believer in spiritualism and devoted increasing amounts of time and effort to trying to raise its status to that of a legitimate science.

Oliver Lodge retired from university teaching and administration in 1919, at the age of 68. Rather than withdraw from public view, he sought it even more vigorously, lecturing extensively in England and North America. The lectures often dealt with topics related to psychic phenomena in addition to more conventional scientific and philosophical topics. The lectures were combined with radio broadcasts and publications until he was well into his eighties.

In many respects, the death of Lodge in 1940 at the age of 89 marked the closing of an era when outstanding scientists would be involved with significant topics in fields other than science, and would be popular celebrities with the general public. Today, unfortunately, Oliver Lodge's name is recognized by relatively few persons, but his work is still central to virtually all electronic-communications systems. You can find the names of more material on Lodge in the boxed text entitled "Books of Interest" accompanying this article. ■

Books of Interest

"Syntony and Spark—The Origins of Radio," by Hugh G.J. Aitken, Princeton University Press, 1985.

"Sir Oliver Lodge: Psychical Researcher and Scientist," by W. P. Jolly, Fairleigh Dickinson University Press, 1974.

"Lightning Conductors and Lightning Guards," by Oliver J. Lodge, Whittaker & Co., 1892.

"Past Years: an Autobiography," by Oliver J. Lodge, Hodder and Stoughton Ltd., 1931.

"Signaling Through Space Without Wires," by Oliver J. Lodge, Third Edition, The Electrician Printing and Publishing Co. Ltd., 1902, reprinted by Arno Press, 1974.

"Talks About Radio" by Oliver J. Lodge, George H. Doran Co., 1925.

TV NIGHT
(Continued from page 61)

The mechanical era provided other lasting contributions. John Logie Baird of Britain (no relation to Hollis Baird) invented the videodisc in 1928. Baird's machine played modified 78-rpm records. They were called "Major Radiovision" discs.

Also in 1928, Herbert E. Ives rolled the first picturephone out of AT&T. As World War II commenced, Germans installed similar devices in Berlin, Munich, and Leipzig phone booths. Baird and Alexanderson share the invention of projection television. Charles F. Jenkins created modern facsimile in 1925. Baird also developed the first infrared night scope, called noctovision.

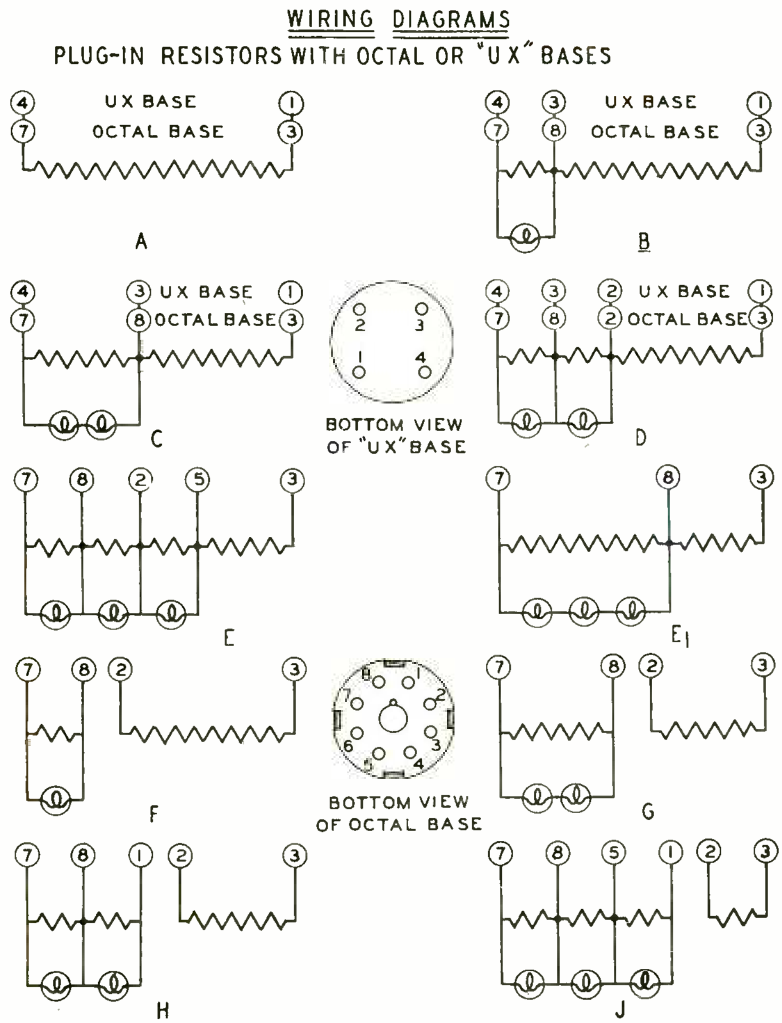
A few of the early inventions have yet to be implemented on a large scale. The picturephone is one example. John Baird created another video invention way ahead of its time: Stereoscopic or 3-D television. Baird's simple device included a disc with two spirals separated by the distance between the eyes. (Contemporary 3-D videogames employ a similar process, although it's achieved electronically.)

Some historians claim that mechanical TV's limited resolution prevented its widespread acceptance. Those historians must not have seen mechanical television pictures. Resolution might have been one of their shortcomings, but it was by far not the drawback it was purported to be. Indeed, mechanical television's rendition of a head-and-shoulders shot produced a very recognizable image. However, the farther the camera pulled back, the more the jagged lines dominated the image. Consequently, in early mechanical television, long shots weren't intelligible.

Still, even contemporary television must use more close-ups than movies do. (Watch a theatrical film on television. You'll notice dramatic detail deterioration in long shots.) That problem (and profits) are the motivation behind today's fledgling, high-definition television industry. You could say the cycle is repeating; It is dusk and the moon rises on a new Television Night. ■

ANTIQUE RADIO

(Continued from page 79)



The drawings show standard ballast-tube schematics along with corresponding code letters (see text).

stitute for the "G" types more readily than the metal versions do. But again, studying a tube manual and the tube's socket wiring is recommended.

Understanding Ballast Designations. Kevin's list of the tubes in his RCA model 96T5 included one designated BK49B. That is not a tube at all, but a plug-in power resistor mounted in a tube-like shell and utilizing a tube base. Such ballasts were used in sets that have the tube filaments connected in series and connected directly across the 117-volt power line. Their purpose was to drop the voltage by an amount equal to the difference between that required by the filaments and that supplied by the power line.

Thanks to reader H. Palm (Northbrook, IL), who sent along a page copied from an old P.R. Mallory technical manual, we have a very good reference for the interpretation of ballast codes. It tells us that the letter "B" at the beginning of the designation for Kevin's BK49B ballast indicates that the unit contains a connection for a pilot light. The "K" indicates that the lamp is a 0.15-ampere type; other possibilities for that position in the designation would be "L" (0.25 ampere) or "M" (0.20 ampere). The 49 shows that this ballast has a voltage drop of 49 volts during normal operation. The final letter ("B") is a code for the ballast's wiring diagram, and—for your reference—I'm including a drawing of the standard diagrams and their associated code numbers.

That wraps it for this month, but we'll see you in August. Between now and then write me c/o *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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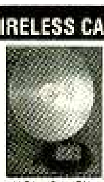

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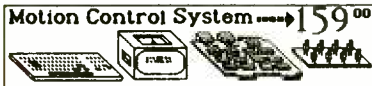

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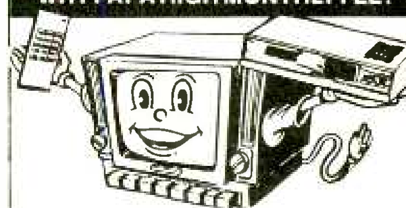

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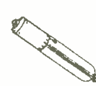

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