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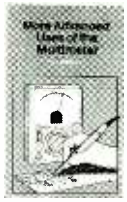

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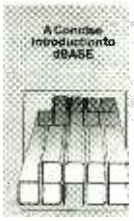

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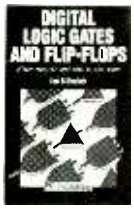

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Editorial

AN "INDISPENSABLE" TOOL

Let's see a show of hands. How many of you out there own or regularly use a fax machine?

Quite a few, I see. Okay, let's try another one. How many of you had heard of a fax machine three years ago?

I didn't think so. Yet in a few short years the fax has become a nearly "indispensable" part of our business and personal lives.

I put the word indispensable in quotes for a reason. While it is true that fax machines make it possible to exchange important business documents accurately and nearly instantly, a lot of the stuff that goes out over the fax hardly qualifies as important.

For instance, even here in the suburbs the majority of deli's and sandwich shops prominently sport a sign that reads "Fax us your orders." And it didn't take long for entrepreneurs of every persuasion to discover that the fax provided another entry point to sell their services and wares. The situation has reached the point where several states have passed or considered laws banning unsolicited "junk" faxes.

Be that as it may, fax machines are an important tool for all types of businesses. This month, we present a story that can help make that tool easier to use. It's a Remote-Control Fax Switch that achieves two objectives at once: It allows you to use just a single line for both your telephone and the fax. It also unclutters your work area by letting you connect the machine at any convenient jack on the line.

All-in-all, it makes living with a fax machine a little more enjoyable. I just wish it provided a way to filter out the junk!

Carl Laron
Editor

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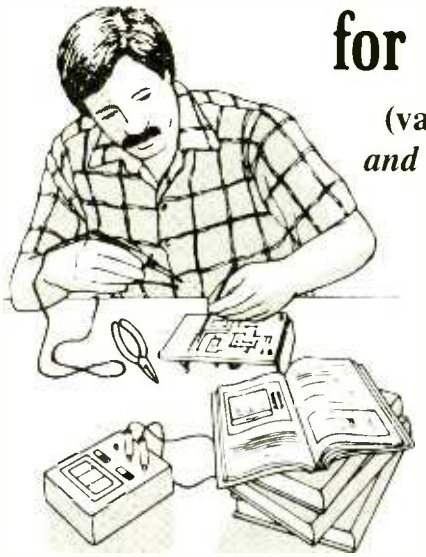

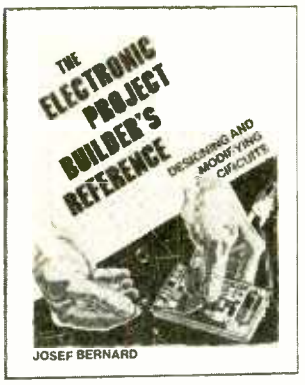

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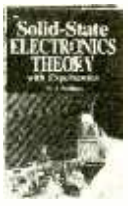

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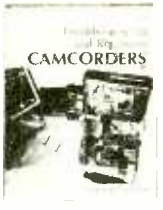

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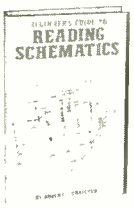

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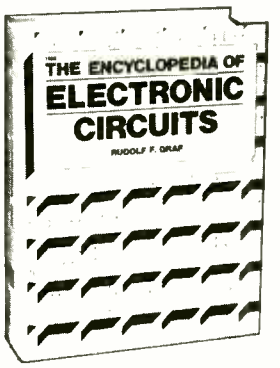

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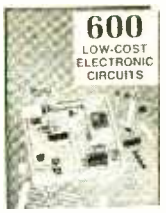

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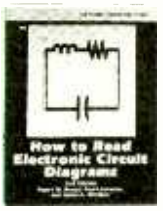

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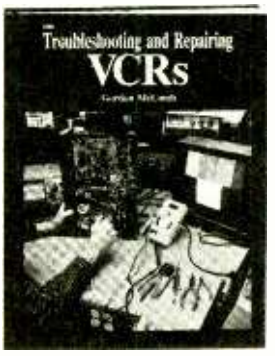

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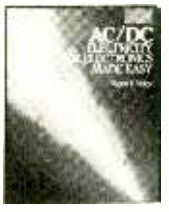

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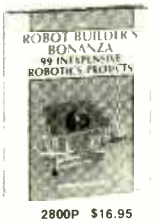

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Letters

PARTS UPDATE

For those who are trying to locate a PXO-1000 chip for the "Budget Frequency/Events Counter" (**Popular Electronics**, May 1990), we have learned that Reptron in Georgia and South Carolina will no longer accept orders for less than ten chips. A parts source list furnished by the author gives telephone numbers for many distributors other than Reptron. One of those distributors, First Frequency in Massachusetts (617-935-3885), has been known to sell single chips. The complete list can be obtained by sending a self-addressed, stamped envelope to the address below; it is also included with each PC-board order.

In addition, the author has made an arrangement with Reptron to have orders for single units funneled through him (at no profit to the author) for the convenience of those who want to build the counter. This limited-time offer is valid for orders received only through September 15, 1990. The address is:

John Wannamaker
Rt. 4, Box 550
Orangeburg, SC 29115

The price for the chip is $9.75 each, including shipping. Please send money orders only. Canadian orders must add $0.25; South Carolina residents must add $0.44 state tax.

Reptron in North Carolina indicates that they will send any requests on hand to the author, but that early requests for information might have been lost. It might be best to start from scratch if you have not heard from Reptron.

Please keep in mind that when Reptron depletes their stock it can take up to ten weeks to receive a new supply from the manufacturer, and the author's supply is subject to those limitations. If a long delay is expected, he will try to notify you.

Anyone who has purchased a PC board and who wants a refund will receive it by returning the board with a request for a refund.

John Wannamaker

SONIC EMULATOR CORRECTION

In my article, "The Sonic Emulator," which appeared in the February 1990 issue of **Popular Electronics**, the value of R10 was mistakenly printed as 4700 ohms. The correct value is 4.7 ohms.

Also, please note that The Sonic Emulator kit is no longer available from Chadco Electronics. For information on a similar device, contact Sound Concepts Inc., P.O. Box 135, Brookline, MA 02146.

Chadwick Pryson

LICENSE RENEWAL

I'd like to bring a piece of information to the attention of **Popular Electronics**' readers. Back in 1986, when the FCC announced that it would no longer require an FCC license to repair or operate certain kinds of transmitting equipment, a number of people claimed that the FCC was discontinuing the General Radiotelephone Operator License and would no longer renew it. *That is not true!* Although that license is no longer required for most users, it is still being issued and renewed. Moreover, the FCC will renew it for up to five years after expiration.

So, if it is less than five years since your license expired (as is most likely the case), you can still renew it. Just request Form 756 from your local FCC office, and return it (along with the original copy of your license or a good explanation of why you no longer have it) to the same office that issued your license.

Even though the license is no longer required, it is still handy to have—it looks good on a resume, and it just might be useful in some future job. So don't let it lapse.

P.S.
Mount Kisco, NY

MEASURING METERS

I don't usually write letters to the editor, but for the second time this year I find myself doing just that. Strangely, it is for the same type of error as appeared in another electronics magazine a few months back.

In the case of **Popular Electronics**, in the June 1990 installment of Circuit Circus, Mr. Charles Rakes talks about "shunt resistance" and in Fig. 3 shows the circuit for measuring meter resistance. Unfortunately, it can not be done accurately using the method shown. Shunting the meter changes the overall load seen by the power source, and hence the current supplied by the power source changes. That is what causes the error. The current from the power source must be kept constant for the measurement to be accurate.

A better way is to use the set-up shown in Fig. 1 here. Meter M2 is the meter under test. Meter M1 is used to monitor current draw. As before, with S1 open, adjust R2 for a full scale reading on M1. Then close S1 and adjust R2 for a half-scale reading on M2 while using R1 to keep the current draw constant. This will yield much better results.

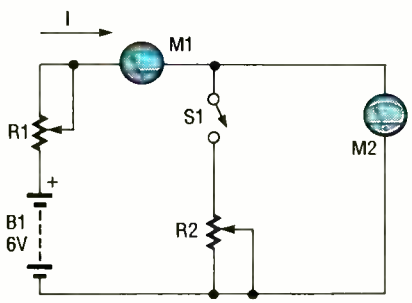

Fig. 1

J.L.
San Jose, CA

HAVES & NEEDS

I'm trying to locate the schematics and/or owner's manual for a Bell & Howell Schools oscilloscope, model *IOD-4540*, and the schematics or the manufacturer's address for an electronic audio crossover made by JSE, *#4150* (the DC-DC converter, which is no longer working, is made by Sagami). Also, I am trying to get my hands on a μPC1298V IC. And, finally, does anyone out there have schematics for a Mattel Intellivision videogame system?

If anyone out there has any kind of information that might be helpful on any of these, please contact me; I will gladly reimburse you for any costs you incur. Thank you!

David McAfee
3332 Barnes Ave.
Baldwin Park, CA 91706
818-814-1330

I have a Spectrum Dynamics model *550* 256×4 PROM programmer that is missing the owner's manual. I have written to the company, but my letter came back stamped "Return To Sender, Unable To Forward." I have a large number of chips for it, and I would very much like to purchase a photocopy of the owner's manual. Any information would be greatly appreciated, and all letters will be answered.

Chad Pauli
811 Northbrook Drive
Davenport, IA 52806

AMAZING AMIGA

As an Amiga computer owner, I read your article "Games and The Amazing Amiga" with great interest. While I and most other Amiga enthusiasts appreciate any attention our computers receive, I was sorry that the Amiga's capabilities in areas other than gaming weren't discussed more.

Anyone who uses an Amiga for any length of time will find that the same features that make it such an awesome game machine also make it a very impressive tool for productivity and business. Personally, I use my Amiga for word processing, desktop publishing, animation, home finance, and graphics. The machine's abilities never cease to amaze me.

And I don't even own a game...

J.F
Youngstown, OH

You are absolutely right, the Amiga is far more than just a glorified game machine. However, we did cover the computer's other capabilities a while back. For those that want the full story about the Amiga, see "The Amazing Amiga" in the August 1989 issue of **Popular Electronics**—*Editor* ■

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Electronics Library

To obtain additional information on the books and publications covered in this section from the publisher, please circle the item's code number on the Free Information Card

THE COMPARATOR BOOK: With Forty-Nine Projects

by Delton T. Horn

The comparator—usually a modified op-amp—compares two input signals and generates an output signal that indicates which of the input signals is larger. Although it is used commercially in a wide variety of applications, the device is often overlooked by the electronics hobbyist—despite its availability and simplicity. This book demonstrates just how well-suited for home-built projects comparators are, and provides dozens of practical ways to include these versatile devices in your projects.

The author paves the way with just enough theory for a thorough understanding of what comparators are and how they work—including coverage of discrete-component and op-amp comparators, and dedicated comparators (such as the popular LM339 quad comparator chip). Then he shows you, with step-by-step directions, how to put those comparators to work in a variety of analog and digital circuits. Some of the projects included in the book are a basic zero-crossing detector, a window comparator, peak detectors, temperature gauges, light meters, intrusion detectors, digital-to-analog converters, a tone decoder, square-wave oscillators, a capacitance meter, and an analog AND gate. Diagrams and parts lists for each project are included, and the clearly-written text will be readily understood by even novice project-builders.

The Comparator Book: With Forty-Nine Projects is available for $15.95 from TAB Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

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COMMUNICATIONS CATALOG

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Consolidating Universal's earlier shortwave, scanner, and amateur catalogs, this 88-page brochure features those three product categories along with an impressive selection of antennas, headphones, books, and accessories. Several new items are also featured, including Icom's R-1 and R-100 wideband receivers, RR-72 communications receiver, and AC-970 VHF-UHF transceiver; Magnavox's AE3205 and AE3808 receivers; Grundig's Cosmopolit shortwave/cassette and Travel Kit series; Universal's M-900 with video fax; and Kenwood's TS-950S HF transceiver.

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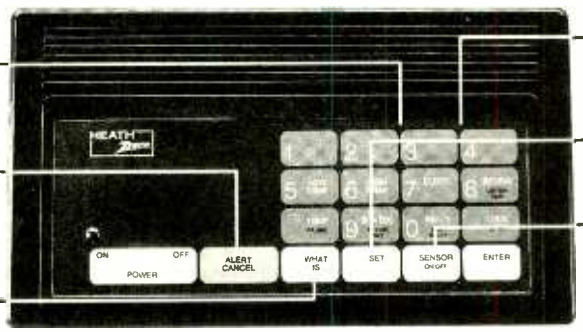

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The Universal Communications Catalog is available for $1.00 or four IRC's (international reply coupons), or is free on request with any purchase from Universal Radio, 1280 Aida Drive, Reynoldsburg, OH 43068; Tel. 614-866-4267.

CIRCLE 76 ON FREE INFORMATION CARD

BEGINNING TECHNICAL MATHEMATICS MADE EASY

by David Brianza

If you're one of the many people whose favorite subject was *not* math, and you now lack some mathematical skills required in your job or hobby, this self-teaching guide offers you a relatively painless way to reach an understanding of technical, applied mathematics. Using no jargon and taking no prior understanding for granted, the book starts with the absolute basics of arithmetic—addition, subtraction, multiplication, and division—before progressing gradually into more advanced topics. The book aims to demystify algebraic equations and theorems, scientific and fractional notation, logarithms, graphing, quadratic equations, polynomials, and more. Each chapter builds logically upon the previous ones, and all contain simple exercises that demonstrate not only how math works, but why. If you're just brushing up on your skills, the exercises can serve as a quick refresher course.

Beginning Technical Math Made Easy is available for $11.50 from TAB Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

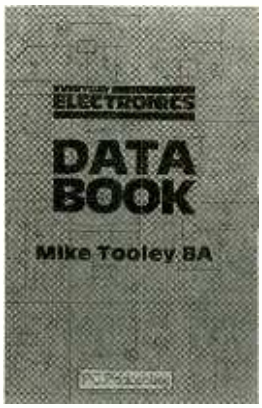
CIRCLE 98 ON FREE INFORMATION CARD

EVERYDAY ELECTRONICS DATA BOOK

by Mike Tooley

In a succinct, easy-to-understand format, this book explains the concepts, principles, and techniques that are relevant to the real world of electronics. Instead of focusing on theory, the book deals with putting principles into practical application.

Written for aspiring, as well as practicing, electronic technicians and engineers who are involved in the design, manufacture, testing,and maintenance of electronic



equipment, the book represents a wealth of knowledge accumulated over more than 30 years. Assuming very little previous knowledge, the book should also meet the needs of students and hobbyists.

The information is presented in the form of a basic electronic cookbook, with numerous examples that show how theory can be put to work using a range of commonly available "industry-standard" components and devices. Examples, tips, and hints are generously interspersed throughout the text.

Everyday Electronics Data Book (Order No. PCP109) is available for $12.00 (including shipping & handling) from Electronic Technology Today, Inc., P.O. Box 240, Massapequa Park, NY 11752-0240.

CIRCLE 77 ON FREE INFORMATION CARD

TEST INSTRUMENTS '90

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This 68-page catalog covers B&K's entire line of electronic test instruments, including digital-storage and analog oscilloscopes, IC testers, digital multimeters, signal and function generators, power supplies, component testers, video-testing instruments, and probes. Complete performance and mechanical specifications are provided, both in detailed individual listings and in easy-to-use comparison charts. The catalog also describes a complete line of ac-

cessories to enhance the convenience and performance of many instruments. An expanded resource in this year's edition is a glossary of key terms for each major product category. The glossaries are intended to help readers determine the right instrument for a given task, as well as to provide an educational training aid.

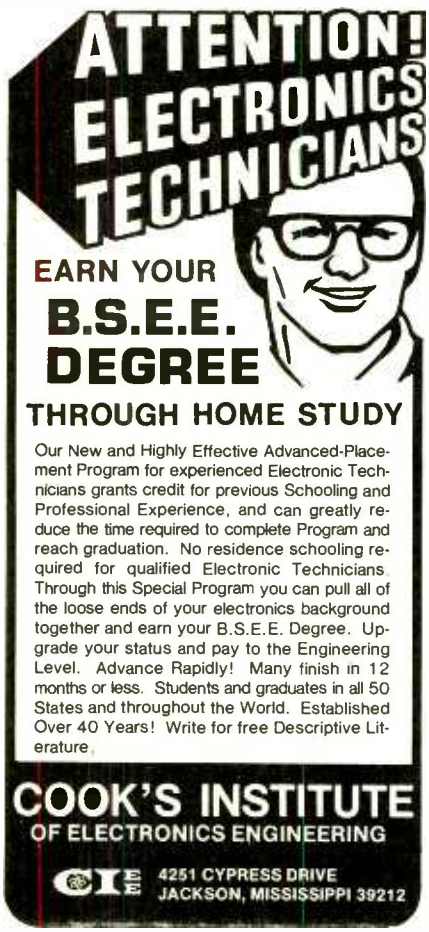
Test Instrument Catalog BK-90 is free upon request from B&K-Precision, Maxtec International Corp., 6470 West Cortland Street, Chicago, IL 60635; Tel. 312-889-9078.

CIRCLE 78 ON FREE INFORMATION CARD

RADAR HANDBOOK: Second Edition

edited by Merrill I. Skolnik

Filled with useful information, this authoritative reference is designed to answer the day-to-day questions of radar engineers, designers, and technicians, as well as those who work in related fields. The second edition, which has been extensively revised and updated to reflect recent advances in radar technology, contains almost 75% new material. It not only explores the prodigious growth in radar capabilities and applications, but also provides detailed explanations of the fundamentals involved. More than 30 specialists in the field have contributed material on their areas of expertise. In-depth discussions are included on subjects ranging from automatic detection and tracking to space-based radar for global coverage, from radar guidance for



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missiles to Doppler weather radar for improved forecasting.

The book features new material on such subjects as data processing, height finding, 3-D radar, electronic countermeasures, reflector antennas, bistatic radar, and the analog SAW dispersive delay line. Also examined are target and clutter cross-section characteristics, prediction, and measurement; the technology for solid-state transmitters; and the latest methods for detecting aircraft in the midst of large clutter echoes. Hundreds of photographs, drawings, charts, and graphs supplement the various discussions.

Radar Handbook: Second Edition is available in hardcover for $87.50 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

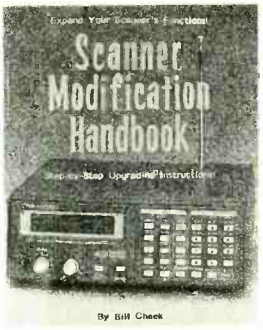
CIRCLE 96 ON FREE INFORMATION CARD

SCANNER MODIFICATION HANDBOOK

by Bill Cheek

Today's scanner technology has allowed technicians to devise ingenious methods for getting receivers to do a lot more than their original designers intended. In this book, communications engineer Bill Cheek provides step-by-step directions for expanding the capabilities of VHF/UHF scanners, using tools that are found on the average workbench (soldering gun, wire cutters, etc.). Some of the modifications are as simple as snipping a wire or adding a 25-cent diode to bring about major enhancements.

Most of the techniques presented are for the Realistic PRO-2004 and PRO-2005, but



some modifications have also been developed for the PRO-34 and for Bearcat's BC-200/205XLT, BC-750XLT, and BC-950XLT. With some ingenuity, however, other scanners might also be modified using adaptations and variations of the methods presented in this book. (Bear in mind that manufacturers do not endorse or recommend making such modifications to their products.)

The book provides tested modifications to restore blocked-out frequency bands, speed up search and scanning rates, improve squelch operation, enhance headset and tape-recorder audio quality, interface your scanner with your shortwave receiver, protect against voltage surges, add an automatic tape-recorder VOX feature, and increase the number of memory channels. In addition, the book provides valuable insider tips and hints on antennas, feedlines, connectors, preamplifiers, converters, and emergency power supplies. Information on scanning and the law, and on how cellular phones work (including frequency charts) is also provided. Photos, tables, and figures accompany the text.

Scanner Modification Handbook is available for $17.95 (plus $2.00 Book Rate shipping or $3.00 First Class Mail, and $1.35 sales tax for New York residents only) from CRB Research Books, Inc., P.O. Box 56, Commack, NY 11725.

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(Continued on page 8)

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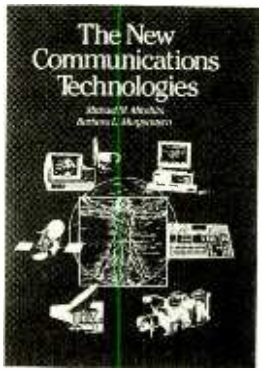
(Continued from page 7)

THE NEW COMMUNICATIONS TECHNOLOGIES

by Michael M. Mirabito and Barbara L. Morgenstern

This guide to the frontiers of today's information society thoroughly explains, in plain English, the new technologies and equipment that are changing the way we communicate. Aimed primarily at those who are developing careers in communications, the book explores the fundamental technology behind each area of communications. It introduces the technologies that have already had an impact, as well as those that promise to influence the communications field in the near future. It also offers a look at the economic and social implications—both domestic and international—of advanced communications technology.



The book provides practical, comprehensive discussions of topics ranging from desktop publishing to digital technology and the role of computer systems in broadcasting. In-depth coverage of teleconferencing, teletext, interactive two-way systems, satellites, fiber optics, optical discs, and HDTV are also provided, as well as an examination of the demands, risks, and advantages of living in an "information society."

The New Communications Technologies is available for $24.95 from Focal Press, 80 Montvale Avenue, Stoneham, MA 02180.

CIRCLE 80 ON FREE INFORMATION CARD

OFFICIAL AERONAUTICAL FREQUENCY GUIDE

edited by Robert A. Coburn, W1JJ0 and Robin Lindley

For those who think the sky's the limit when it comes to scanning, this book shows how to get the most out of monitoring sky-high communications. The comprehensive guide to aeronautical frequencies in the United States includes complete statewide and local coverage of the HF (0–30-MHz), VHF (30–170-MHz), and UHF (450–470-MHz) bands, as well as the 800–900-MHz frequency spectrum. The frequencies are alphabetically listed under the general headings of Community, Service, License, Call Sign, and Comments, to make it easier for readers to find the ones they need. Air-carrier company designators are also listed to aid in the identification of transmissions monitored.

The book includes general system information and FCC Frequency Allocation charts pinpointing where to find air-to-air refueling, air-route traffic control, air-ground radiophone, ground control, Air Force global command control, approach and departure control, airline ground support, and much more. The book also provides information about, and frequencies of, the new trunked 800-MHz systems used for portable and mobile communications at major airports.

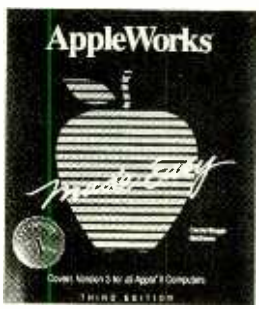
Official Aeronautical Frequency Directory is available for $21.95, plus $2.05 shipping and handling, from Official Scanner Guide, P.O. Box 712, Londonderry, NH 03053.

CIRCLE 81 ON FREE INFORMATION CARD

APPLEWORKS MADE EASY: THIRD EDITION

Written for small-business operators who have already purchased AppleWorks, or who are considering buying it, this book defines the types of business problems that AppleWorks can address, and shows how to effectively use the program to solve those problems. The third edition of this popular tutorial for beginners has been revised and expanded to cover version 3.0. Those who are new to AppleWorks, or are simply unfamiliar with version 3.0, as well as somewhat experienced users who want to hone their skills, will find valuable information in the book.

The format provides step-by-step instructions, and calls for the reader to learn by performing exercises. Those exercises and the examples presented throughout the book are designed to address real-life business problems that many readers will find useful in and of themselves. In the thorough introduction, readers are shown how to use



(Continued on page 12)

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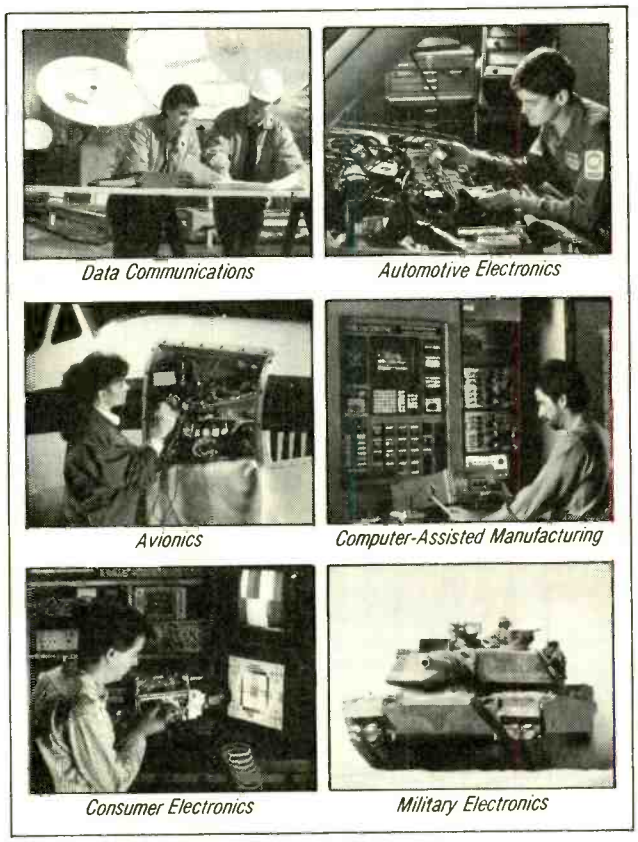

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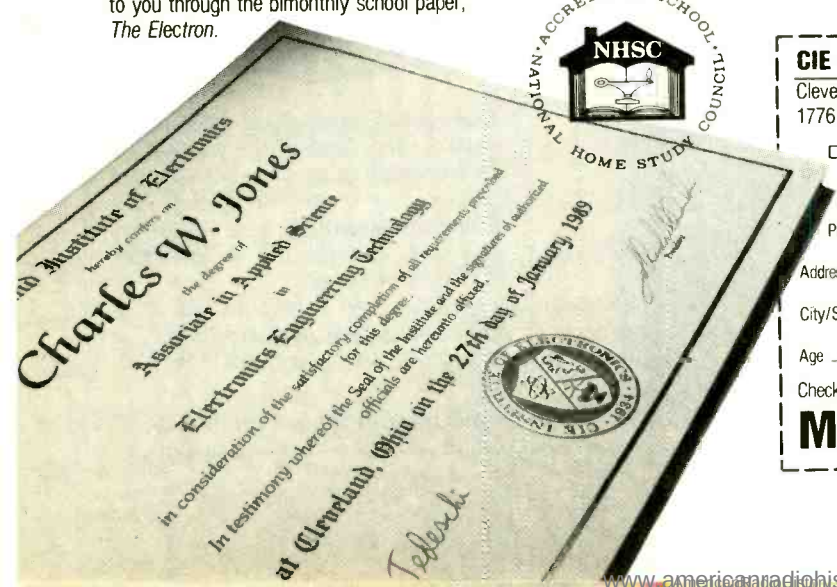

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Electronics Library

(Continued from page 8)

AppleWorks' database, spreadsheet, and word-processing features. The rest of the book is organized so that readers can choose to concentrate on one of those areas at a time, or get a grasp on the basics of all three before studying each in-depth. For those who only need to upgrade their skills with version 3.0, many applications and illustrations move beyond the fundamentals and explore the more sophisticated uses of the program.

AppleWorks Made Easy: Third Edition is available for $19.95 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

CIRCLE 96 ON FREE INFORMATION CARD

ELECTRONICS GOES GLOBAL IN THE '90s

from Global Specialties

The 1990 catalog from Global Specialties includes high-performance, affordably priced electronic testing and prototyping equipment. Featured in its 36 pages are the company's full line of breadboarding products, logic-test equipment, power supplies, frequency counters, function generators, and a logic-analyzer system. Products for troubleshooting personal computers, including slot extenders and expansion boards, are also offered. New products include a portable protocol analyzer, a data-acquisition board for PC's, and a hand-held logic analyzer. All products are American-made, and a lifetime guarantee is offered on all breadboarding equipment.

The "Electronics Goes Global" 1990 catalog is free upon request from your local Global distributor, or by contacting Global Specialties, 70 Fulton Terrace, New Haven, CT 06512; Tel. 800-572-1028.

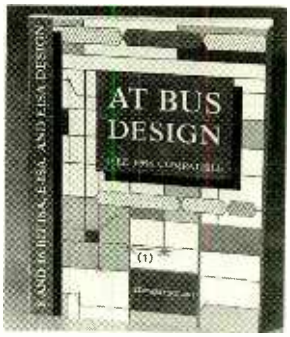
CIRCLE 82 ON FREE INFORMATION CARD

AT BUS DESIGN: IEEE P996 COMPATIBLE

by Edward Solari

Intended to end the confusion and uncertainty caused by reverse engineering the AT family of computers, this authoritative book describes the timing for the XT and AT in detail, providing the designer with valuable information about compatibility with the IEEE's ISA (AT) bus and the 8- and 16-bit portions of the EISA bus. The information presented allows the designer to understand and use the same standards—consistent with the IEEE, EISA, and other designers.

The book thoroughly explains the PC/XT- and AT-bus standards—what the signals mean, what they do, and when they do it. It details how to design CPU platforms, add-in cards, and add-in bus masters. Highlighted "notes" call attention to certain rules, and show how cards can be designed to take advantage of some of the advanced features of the EISA bus and still be compatible with the ISA bus. In those few areas where the ISA and EISA numbers are inconsistent



with each other, the book explains why and tells how the numbers were derived. That allows the designer to make informed decisions based on the particulars of his design. More than 100 tables and diagrams illustrate the text.

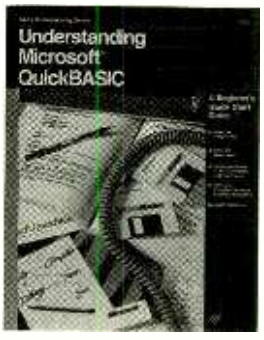
AT Bus Design: IEEE P996 Compatible is available for $69.95 from Annabooks, 12145 Alta Carmel Court, Suite 250-262, San Diego, CA 92128; Tel. 800-4662-1042 (in CA, 6169-271-9526).

CIRCLE 83 ON FREE INFORMATION CARD

UNDERSTANDING MICROSOFT QuickBASIC

by Judd Robbins

QuickBASIC is the leading BASIC programming environment for microcomputers and a popular choice for many business applications. This "quick-start guide" introduces newcomers to QuickBASIC programming and shows how to build useful applications. The clear text is accompanied by hands-on examples and margin notes, and reviews and quizzes appear at the end of each chapter. Advanced users will appreciate the book's language references, which



are more detailed than those in the manual.

The book demonstrates how to design and write programs, and then test and debug them using QuickBASIC's powerful "Instant Watch" debugging tool. It describes how to access, edit, and control files, and how to process character strings. It explores the use of graphics for "dressing up" the output, including actual programs for generating bar graphs and pie charts. Use of QuickBASIC's state-of-the-art hypertext help screen and other windows is also explained. The book includes a reference guide to all commands and functions, and offers several complete working business programs.

Understanding Microsoft QuickBASIC is available for $18.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

DELAY LINE CATALOG

from Automatic Coil Corp.

Featuring more than 650 standardized active and passive delay lines, including TTL digital-delay modules and TTL function modules, this 32-page catalog provides detailed technical information on their operating characteristics, history, and usage. A technical data section presents formulas and graphs to explain characteristics such as delay time, impedance, rise time, figure of merit, bandwidth, attenuation, and phase

compensation. Photographs, dimensional drawings, and specifications for 14-, 16-, and 24-pin DIP (dual-inline-package) configurations are shown. Highlighted in the catalog is a unique 8-pin, 5-tap SIP (single-inline-package) series that occupies 50% less PC-board space.

The Delay Line Catalog (No. AC-37) is free upon request from Automatic Coil Corp., 3545 N.W. 71st Street, Miami, FL 33147.

CIRCLE 85 ON FREE INFORMATION CARD

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WHY TAKE CHANCES?...When Battery-Operated-Equipment Repairs and Replacements Are As Close As Your Phone

from Power Pak, Inc.

This series of brochures provides an education in battery replacement for both industrial and consumer applications. Each brochure is packed with specifications, complete cross-reference material, and other information needed to make an intelligent decision on what type of battery is the ideal replacement for your equipment. The currently available brochures include ones on sealed lead-acid, lithium, nickel-cadmium, cordless-telephone, and computer batteries.

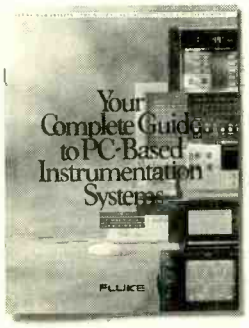
The battery-replacement brochures are available from Power Pak, Inc., 6216 Oakton Street, Morton Grove, IL 60053; Tel. 1-800-637-2212.

CIRCLE 86 ON FREE INFORMATION CARD

YOUR COMPLETE GUIDE TO PC-BASED INSTRUMENTATION SYSTEMS

from John Fluke Mfg. Co.

Highlighted in this 20-page catalog are more than 125 PC-based instruments in categories such as digital multimeters, digital-storage oscilloscopes, signal sources, counters and timer/counters, and data-acquisition systems. Also featured is Fluke's line of test-and-measurement and data-acquisition software for PC-based systems, as well as a section of Fluke's service and support programs, including their nationwide



half-day PC-instrumentation workshops. The booklet includes full product descriptions, screen examples, and selection charts to provide a complete survey of the available products.

Your Complete Guide to PC-Based Instrumentation Systems is free upon request from John Fluke Mfg. Co., Inc., P.O. Box 9090, Everett, WA 98206; Tel. 800-443-5853, ext. 77.

CIRCLE 87 ON FREE INFORMATION CARD

1990 FORDHAM CATALOG

from Fordham Radio

Electronics technicians, engineers, and hobbyists as well as amateur-radio enthusiasts are sure to find something they need (or want) in this 132-page catalog. The four-color, fully illustrated booklet contains wide selections of test instruments; CCTV cameras, monitors, equipment, and systems; educational kits; audio and video products; telephones and answering machines; car stereos and accessories; scanners; radar detectors; antennas; soldering equipment; connectors; tools and tool cases; and more. Each item is illustrated by a photo or drawing, and complete descriptions are included.

The 1990 Fordham catalog is available for $2.00 from Fordham Radio, 260 Motor Parkway, Hauppauge, NY 11788-5134; Tel. 800-645-9518 (in NY: 800-832-1446). ■

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Super duty, 40 oz. magnet. 100 watts RMS, 145 watts max. 4 and 8 ohm compatible (6 ohm). 2" voice coil. fs = 25 Hz. QTS = .166, VAS = 10.8 cu ft. Response: 25-1500 Hz. Net weight: 9 lbs. Pioneer #A30GU40-51D

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Original Sanyo woofer. Paper cone with vented dust cap and treated cloth surround. 12 oz. magnet. 60 watts RMS, 85 watts max. 8 ohm. Resonance: 26 Hz. Response: 25-2,500 Hz.

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Mylar dome. 2.93 oz. barium ferrite magnet. 8 ohm. Response: 1800-20000 Hz. 35W RMS, 50W max. fs = 2000 Hz, SPL = 106 dB. Pioneer #AHE60-51F

#270-050 $6.50 (1-9) $5.90 (10-up)

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Dual voice coil sub woofer. 30 oz. magnet, 2" voice coils. 100 watts RMS, 145 watts max. fs = 25 Hz. 6 ohm (4 and 8 ohm compatible). SPL = 89 dB 1W/1M. Response: 25-700 Hz. QTS = .31, VAS = 10.3 cu. ft.. Pioneer #A30GU30-55D. Net weight: 6 lbs.

#290-145 $39.80 (1-3) $36.80 (4-up)

15" THRUSTER WOOFER

Thruster by Eminence. Made in USA. Poly foam surround, 56 oz. magnet. 2-1/2", 2 layer voice coil. 150 watts RMS, 210 watts max. 4 ohm. fs = 23.5 Hz, QTS = .33, VAS = 17.9 cu ft. SPL = 94.8 dB 1W/1M. Net weight: 15 lbs.

#290-180 $43.50 (1-3) $39.80 (4-up)

GRILL FRAME KIT

With this kit you can make speaker grill frames up to 30" x 40". Kit includes 4 corner pieces, 2 "T" brackets, and 7 frame bars. Grill mounting kit included.

#260-333 $8.50 (1-9) $7.80 (10-up)

18" EMINENCE WOOFER

MADE IN USA

100 oz. magnet, 3" voice coil. 250 watts RMS, 350 watts max. 8 ohm. 30 Hz resonant frequency. 22-2700 Hz response. Efficiency: 95 dB 1W/1M. Paper cone, treated accordian surround. Net weight: 29 lbs.

#290-200 $98.90 (1-3) $89.50 (4-up)

TITANIUM COMPOSITE TWEETER

Titanium is deposited on a polymer dome to combine the advantages of both hard and soft dome technologies. 8 ohm. Ferro fluid cooled voice coil. fs = 1200 Hz. SPL = 90 dB 1W/1M. 50 watts RMS, 70 watts max. 4" round. Polydax part #DTW100T125.

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CIRCLE 5 ON FREE INFORMATION CARD

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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

RADIO FREQUENCY FINDER

Despite its palm-of-the-hand size, *Optoelectronics'* model *2210-A* radio-frequency finder has an exceptional 10-Hz to 2.4-GHz operating range and is useful to 2.8 GHz. It detects and displays two overlapping frequency ranges, from 10 Hz to 12 MHz and from 10 MHz to 2.4 GHz, with resolutions of 1 Hz and 100 Hz, respectively. Accuracy is ±1 PPM. Yet the instrument weighs in at just 9 ounces, and measures an easily transportable 4 × 3½ × 1 inches.

The 2210-A's wide range is accomplished by using a binary-based input-prescaling technique, similar to the design of television receivers, at the high-frequency range. At the low-frequency range, the instrument

uses a 10-MHz crystal and a divide-by-decade technique to get down to sub-audio 10 Hz.

The instrument's front panel features an eight-place LED readout; range-select, power-select (external 1-12 VDC or four rechargeable NiCad batteries), and gate-control switches; and an indicator for short or long sampling times. The single-input BNC connector feeds through a microwave relay according to the range selected, and automatically sets input impedance at either 1 megohm for the low range or 10 ohms for the high range.

The model 2210-A frequency finder/counter costs $219.00. For additional information, contact Optoelectronics Inc., 5821 NE 14th Avenue, Fort Lauderdale, FL 33334; Tel. 800-327-5912 or 305-771-2050.

CIRCLE 100 ON FREE INFORMATION CARD

SPECTRUM PROBE

Smith Design's 107 Spectrum Probe converts any scope into a 100-MHz spectrum analyzer. This low-cost alternative to a spectrum analyzer opens new areas of application. For example, the instrument can be used for automotive, switching regulator, and computer-clock emission containment to obtain compliance acceptance and proper system operation. Hams can use it to control spurious emissions. Electronics schools can use the probe to teach frequency-domain analysis.

The probe allows users to see the logarithmic bandshape of a receiver, usually with only the front-end-generated noise as

a source. It is effective, with a short antenna, over its entire frequency range due to its low capacity, rather than 50-ohm input. (A coaxial cable is provided, however.) A 10-pF 3000-VDC capacitor isolates the input stage, allowing transparent exploration of circuit operation, or even direct viewing of the 120V power-line RF components.

The 107 Spectrum Probe has a list price of $249.00, but direct orders are presently being discounted to $199.00. For further information, contact Smith Design, 1324 Harris Road, Dresher, PA 19025; Tel. 215-643-6340.

CIRCLE 101 ON FREE INFORMATION CARD

CELLULAR TELEPHONE

Designed with the driver's needs in mind, *Audiovox's CTX-4100* features advanced cellular technology—it offers voice-activated dialing, plus one-touch dialing for the two most frequently called numbers. The phone's memory has room for 99 digits, and the memory name tag prints out up to five characters to identify a phone number. Its alpha-search feature lets the user search by either letter or name. The CTX-4100 also offers automatic answering, which gives a 15-second, personalized outgoing message or honks the horn to alert the driver that a call has been received. Additional features include multi-city registration, an optionally activated security code, an RJ-11 jack, and a reprogramming code. The cel-

lular phone is equally at home in a car, an RV, or a boat. It can be converted into a completely transportable unit with the optional *TCT-200* carrying pack.

The CTX-4100 cellular phone has a suggested retail price of $1,195.00. For additional information, contact Audiovox, 150 Marcus Boulevard, Hauppauge, NY 11788; Tel. 516-231-7750.

CIRCLE 102 ON FREE INFORMATION CARD

DC/DC CONVERTERS

Six dual-output DC/DC converters from *CALEX*, known as the *XW Dual Series*, have wide 2:1 input ranges and are designed for use in 12-, 24-, or 48-VDC powered systems. They accept any input voltage from 9–18, 18–36, or 36–72 VDC. There are two output choices for each of the input-voltage ranges: ±12 volts at 1.25 amps, or ±15 volts at 1 amp. Thanks to an 80-kHz MOSFET switching design, efficiencies of over 85% at only 20% of full load are possible.

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Pulse-by-pulse current monitoring provides eight hours of short-circuit protection, and a unique internal heat-limit circuit shuts everything down if it overheats. The converter automatically restarts when the case temperature returns to normal. Filter circuits minimize conducted noise, and low-radiation pot cores, toroidal transformers and inductors, and a six-sided shielded case minimize radiated RFI noise. Internal transient over-voltage protection is also provided.

Key specifications for the converters include 20-mV p-p output noise; 0.02% line regulation; 0.8% load regulation; 0.3%/KHrs long-term output stability; 500-VDC isolation voltage; and an operating temperature range of −25°C to +80°C. Built-in input-to-output isolation allows designers to have isolation and ignore ground.

All XW Dual Converters cost $165.00 in single quantity; quantity discounts are available. For more information, contact CALEX Mfg. Co., Inc., 3355 Vincent Road, Pleasant Hill,CA 94523; Tel. 800-542-3355.

CIRCLE 103 ON FREE INFORMATION CARD

CONTINUITY TESTER

A low-priced continuity tester for non-energized circuits, the model *CF-100A*, has been introduced by *A.W. Sperry*. The instrument combines a circuit continuity indicator with a pocket-sized flashlight. The small pocket clip can be positioned to make a pointed probe for tight spots. The CF-100A

comes with a long test lead with an alligator clip, and uses two standard "AA" batteries (not included).

The model CF-100A continuity tester has a suggested list price of $3.99. For further information, contact A.W. Sperry Instruments, Inc., 245 Marcus Boulevard, Hauppauge, NY 11788; Tel. 516-231-7050.

CIRCLE 104 ON FREE INFORMATION CARD

DIGITAL MULTIMETER

A professional-grade, 4-digit DMM from *Beckman Industrial*, model *RMS225*, features an array of capabilities, including 10,000-counts resolution, true RMS, a 41-segment analog bar graph, a relative mode, "Auto Max Min," and "Probe Hold." The Auto Max Min feature allows the user to record minimum and maximum readings while remaining in the auto-ranging mode.

That affords the highest possible resolution on both minimum and maximum and eliminates the possibility of missing maximum readings due to range overload. Probe Hold lets the user remove the probes from a circuit without losing the displayed measurement.

The RMS225 features DC voltage ranges of 1V, 10V, 100V, and 1000V, with resolution of 100μV and basic accuracy of 0.25%. AC voltage ranges are 10V. 100V, and 750V, with resolution of 1mV and 1% accuracy in the 45-Hz–2-kHz band. Current ranges (AC and DC) are 10mA, 40mA, and 10A, with 1-μA resolution. The DMM also features a self-resetting fuse on ranges to 40mA. The protective holster that comes with the instrument includes a tilt base with two steady positions and a "Flex-Strap" that allows true vertical hanging from virtually anywhere.

The RMS225 digital multimeter—complete with a three-year warranty, installed 9-volt battery, test leads, and an operator's manual—has a suggested list price of $149.00. For further information, contact Beckman Industrial Corporation, 3883 Ruffin Road, San Diego, CA 92123-1898; Tel. 619-495-3200.

CIRCLE 105 ON FREE INFORMATION CARD

COMPACT AUDIO SYSTEM

Sized for the den, dorm, or home office, *Casio's MS-202* offers a full complement of components—dual cassette deck, AM/FM stereo tuner, three-band graphic equalizer, turntable, speaker system, and remote control—in one streamlined, compact unit. The tape deck features high-speed dubbing, continuous play from tape A to tape B, and autostop in the playback and record modes. Users can record from the tuner, the turntable, or from another tape. The digital-synthesized tuner has 18 station presets, up/down scan tuning, automatic or manual tuning, and an LCD readout. The integrated amplifier incorporates 10 (5 × 2) LED power-level indicators for left and right channels, a three-band graphic equalizer, a headphone jack, and a CD/AUX input. A

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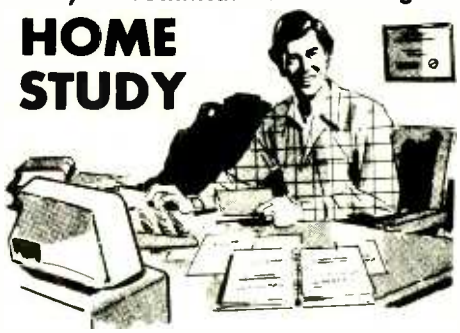

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New Products

full-size, semi-automatic, belt-drive turntable; a pair of 13-inch full-range speakers with matrix surround sound; and a wireless remote control for power, volume, mute, and tuner scan round off the system.

The MS-202 compact audio system has a suggested retail price of $249.95. For more information, contact Casio, Inc., 570 Mt. Pleasant Avenue, P.O. Box 7000, Dover NJ 07801; Tel. 201-361-5400.

CIRCLE 106 ON FREE INFORMATION CARD

40-CHANNEL CB RADIO

Especially suitable for RV's and off-road vehicles that are exposed to harsh weather conditions and high ambient-noise levels, *Midland International's* model *77-118* CB has a large, waterproof-mylar front-panel speaker that is protected from the elements and that provides maximum audio under high-noise conditions. In addition, three NOAA VHF weather channels provide 24-hour reports, and Midland's "Mic-ro-tune II" permits remote channel changing for operator safety.

The 40-channel radio's advanced features include full ETR electronic frequency control, which uses a microprocessor PLL system that locks the receiver and transmitter on the frequency; a noise-limiter switch to reduce background noise; a high-intensity LED readout; a memory-hold circuit that retains the last channel used; instant access to Emergency Channel 9; and a four-stage S/RF meter system that displays incoming signal strength and output power. The 77-118 is equipped with a double-layered heat sink to reduce the chance of power-transistor failure. Easy installation and in/out flexibility are provided by a quick-disconnect bracket and a DC cord.

The 77-118 40-channel CB radio has a suggested retail price of $164.90. For additional information, contact Midland International Corporation, Consumer Communications Division, 1690 North Topping, Kansas City, MO 64120; Tel. 816-241-8500.

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The TPI probes' list prices starts at $74.00. For further information, contact Test Probes Inc., 9178 Brown Deer Road, San Diego, CA 92121; Tel. 619-535-9292.

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LIGHTNING PROTECTOR

Addressing the growing concern over the damaging effects of atmospheric disturbances on components of multi-user computer systems, *Telebyte* has introduced the model *22NX Lightning Sponge*. The device accommodates lightning strikes and diverts them to a low-impedance path to "earth" ground before they can damage display terminals, computers, or any other devices using RS-422 communication circuits. Its

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design incorporates two separate stages for limiting high-voltage transients. The first stage is comprised of gas tubes that can accommodate 1000 amps; that is followed by semiconductor avalanche diodes. The output voltage is limited to ±7 volts. The DC-series resistance of each protection circuit is maintained at approximately 5 ohms,

and the response time is measured in nanoseconds. The Lightning Sponge includes four circuits, so it can be used on any full-duplex RS-422 circuit that uses two transmit and two receive lines. It works for data rates up to 2 MHz.

The 22NX Lightning Sponge costs $79.00 in single quantity, and $63.20 each in quantities of 100. For further information, contact Telebyte Technology Inc., 270 East Pulaski Road, Greenlawn,NY 11740; Tel. 516-423-3232 or 800-835-3298.

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AT DESKTOP COMPUTER

Specifically designed for use in smaller, independent businesses, *Sanyo's MBC-17LX5* is a small-footprint, AT-compatible desktop computer that offers power, reliability, and ease of use. It incorporates an 80286 processor with a 12-MHz clock speed to ensure faster performance. The standard configuration includes 1MB of RAM, a 1.2-MB 5¼-inch floppy-disk drive, and serial and parallel interfaces. For greater expandability, the MBC-17LX5 has five available slots, two 8-bit and three 16-bit, to accommodate a wide variety of interface boards, including video boards, network cards, or a hard-disk controller. For hard-

disk drive or tape back-up, two drive bays are also available.

The system's 101-key keyboard features "silent click" operation, and has separate numeric keypad, four-key cursor control pad, and 12 function keys. The space-saving main unit can be positioned horizontally or vertically. Equipped with MS-DOS 3.3 and GW-Basic, the computer can handle a wide range of popular IBM-PC software.

The MBC-17LX5 desktop AT computer has a suggested retail price of $1,449.00. For additional information, contact Sanyo Business Systems Corp., 51 Joseph Street, Moonachie, NJ 07074; Tel. 201-440-9300.

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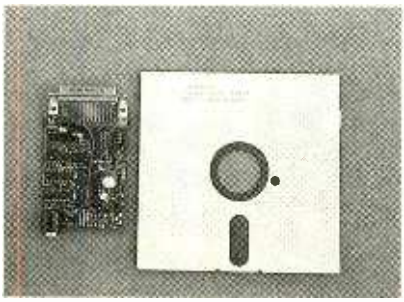
desk-top publishing, computer animation, inspection, and pattern recognition. The high-resolution SV1000 has two modes, providing either a 640×480 or 320×200 resolution, both with 256 gray-level pixels. Pictures can be displayed and saved on disk, or exported to other programs by using the "grab" and "freeze" utility featured in most desk-top publishing and paint programs.

The small board plugs into the printer port on any PC from an 8088 to an 80386 with a CGA, EGA, or VGA monitor. Setup is easy with the included software and simple



menus. The software has built-in diagnostics to check both the video-digitizer and the input video source.

The SV1000 video digitizer board and software costs less than $90.00; a demo disk is available for $3.00. For additional information, contact Colorburst, P.O. Box 3091, Nashua, NH 03061.

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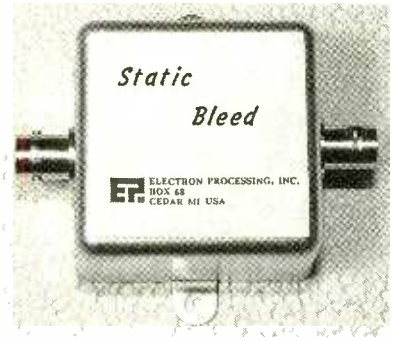
STATIC PREVENTER

Designed to shunt to ground the high voltages that can develop on wire antennas and cause arcing, poor reception, and equipment damage, *Electron Processing's Static Bleed* provides a cure for the static build up on long-wire SWL antennas that is often caused by wind or nearby storms. The Static Bleed is not a lightning arrestor, but is a means of preventing harmful voltages from developing on an antenna. Those voltages, which often start as an elevated noise level,



can easily reach levels that might damage the receiver, yet are not removed by lightning arrestors. The unit is easy to install in an antenna line, via a selection of UHF, BNC, N, F, or PHONO type connectors. No power source is necessary for operation; simply connect the antenna cable and the ground wire. The unit works on antenna systems from 0.1 to 30 MHz.

The Static Bleed has a suggested list price of $29.95 with quantity discounts available. For additional information, contact Electron Processing Inc., P.O. Box 68, Cedar, MI 49621; Tel. 616-228-7020.

CIRCLE 112 ON FREE INFORMATION CARD

DTMF MICROPHONES

Designed to be reliable, easy to use, and affordable, *Shure's 885TT* DTMF microphone can be used with all two-way vehicular radios with telephone-interconnect installations. Its illuminated keypad with positive tactile-feel keys ensures accurate number entry, and Shure's "Top-Talk Sound Channels" optimize audio clarity. The ruggedly built microphone also has externally adjustable audio and DTMF levels for easier setup, and tailored frequency response for optimum intelligibility. The 885TT takes

advantage of Shure's "ModuLink System 1," a system that features modular cordsets that plug into over 40 of the most popular radio transceivers without any hardwiring. The system speeds installation and eliminates the need to buy a new microphone when only a new cord is called for.

The 885TT DTMF microphone has a suggested user price of $165.00. For more information, contact Shure, Consumer Services Department, 222 Hartrey Avenue, Evanston, IL 60202-3696; Tel. 800-257-4873.

CIRCLE 113 ON FREE INFORMATION CARD

SOLDERING SYSTEM

Part of *Ungar's* "Concept 2100" line of high-capacity soldering stations, the model *2110* can handle everything from delicate precision work to the most demanding soldering applications. The 2110 meets industry and military soldering specifications, and its static-dissipative case and handle ensure full compliance with ESD control programs.

The soldering station has temperature stability of less than ±10°F at idle, provided by an electronic circuit that also minimizes transient spikes and eliminates the temperature fluctuations associated with magnetic

or mechanical control systems. The model 2110 station permits variable temperature control from 550°F to 850°F.

The station uses Ungar's line of "9000 Series" soldering tips, including a selection of "thermal thrust," high-capacity tips for tough soldering jobs. The tips will perform at all temperatures. Maintenance is simplified with external calibration and fuse access. The ceramic heater can be replaced at the work station with no tools needed.

The model 2110 soldering system has a suggested list price of $132.50. For further information, contact Ungar, 5620 Knott Avenue, Buena Park, CA 90621; Tel. 714-994-2510. ■

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"I think there's too much bass."

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RICK BRUSH,
NRI PROGRAMMER/ANALYST

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Think Tank

By Byron G. Wels, K2AVB

THE "BEAR" FACTS...

You've got to admit that last month's problem was a doozy! I know it tripped up a lot of you, as the mail was very sparse. We've also got one reader who, when he solves the problem, writes to tell me how stupidly easy it was. When he *can't* solve it, you don't hear from him. And this month, not word one. So here's the solution. Take a look at Fig. A, and you'll get it—five rows of lamps, four in each row, and a total of only ten lamps!

Now you know I'm not going to leave you in limbo. Here's a head-scratcher for this month: A hunter (okay, he's carrying a walkie-talkie; that makes it "electronic") leaves his cabin, travels five miles south, five miles west, shoots a bear, then travels five miles north and arrives back at his cabin where he started. The question is, what color was the

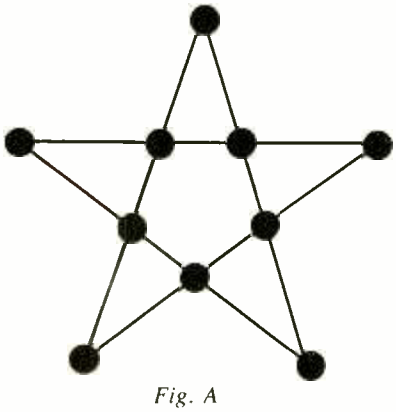

Fig. A

bear? Now don't look at me like that! You really have all the information you need. Get busy and when you get it, write and explain. And be sure to watch this column next month for the solution.

You should also be advised that I'm working furiously to get ahead on this column. It's now March, and in May, I'm finally rewarding myself with the vacation of a lifetime. Having been a working stiff all of my life, I've never taken a *real* vacation, but this is my year. My friend Murray (you remember Murray) and I are flying to Florida, where we'll be boarding a cruise ship and heading to sea for seven glorious days in the Caribbean. I *know* they'll be "glorious days" because that's what the brochure said. Eight gourmet meals a day, snacks all day and all night, free entertainment, and all I want to do is immerse myself in total, complete rest.

In order to do that however, I've got to complete my columns before I go. And I can't do that without your help. So send in those circuits, people! Byron needs a vacation! And have you heard about the Indian Chief? He had three wives, all of whom got pregnant at about the same time. He decided to try an experiment, and had one sleep on a deer skin, another on a bear skin, and the third on a hippopotamus hide.

In due course, they all gave birth. The one on the deer skin had a son, the one on the bear skin had a son, and the one on the hippo had *two* sons! The conclusion he drew as a result of this, was that the sons of the squaw on the hippopotamus was equal to the sons of the squaws on the two adjacent hides!

And on that sour note, let's hit the mail bags.

Universal Power Controller. Originally, this circuit was drawn from a discarded furnace controller. I've adapted it to many control projects that require a local sensor input.

The operation of the circuit is simple. (See Fig. 1.) The main relay (K2) has a low-impedance coil and the lockout relay (K1) has a high-impedance coil. The normally closed contacts of K1 and the closed sensor loop shunt the current needed to activate K2. When one of the sensors opens, current is routed through K1's coil. It, in turn, opens its contact set ensuring an open is in the sensor loop. This does two things: First, it ensures the lockout relay remains activated even if the open sensor should close, and second, it provides a latch that can be reset by opening the controlling device or switch.

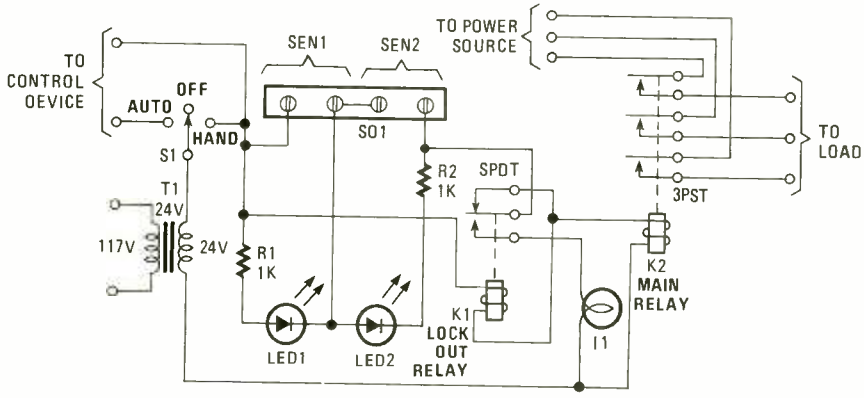

Fig. 1. The Universal Power Controller, which is really a discarded furnace controller, can be adapted to many control projects that require a local sensor input.

Once K1's contacts open, current is limited to the main relay. Select a lockout relay that will draw less than the holding current of the main relay. I have made both AC and DC versions of this circuit. Just use AC relays for AC applications and DC relays for DC applications. The voltage ratings are identical for both relays. The intent is for the main relay to control an application of power to a motor or other device needing power not normally switched with low-rated switches.

The LED's indicate which sensor has opened up. Inductor L1 shows that the circuit had at one time been tripped, and now the offending sensor has again been closed. References in the circuit are for an air conditioning system and are indicated only to help understand the circuit.

—*Paul Dalenberg, MSgt, USAF Okinawa*

Nice going Paul! Your book is on the way, and I hope you do enjoy it. Readers, even if you have no immediate use for this circuit, do go through it anyway. There's a lot to be learned here.

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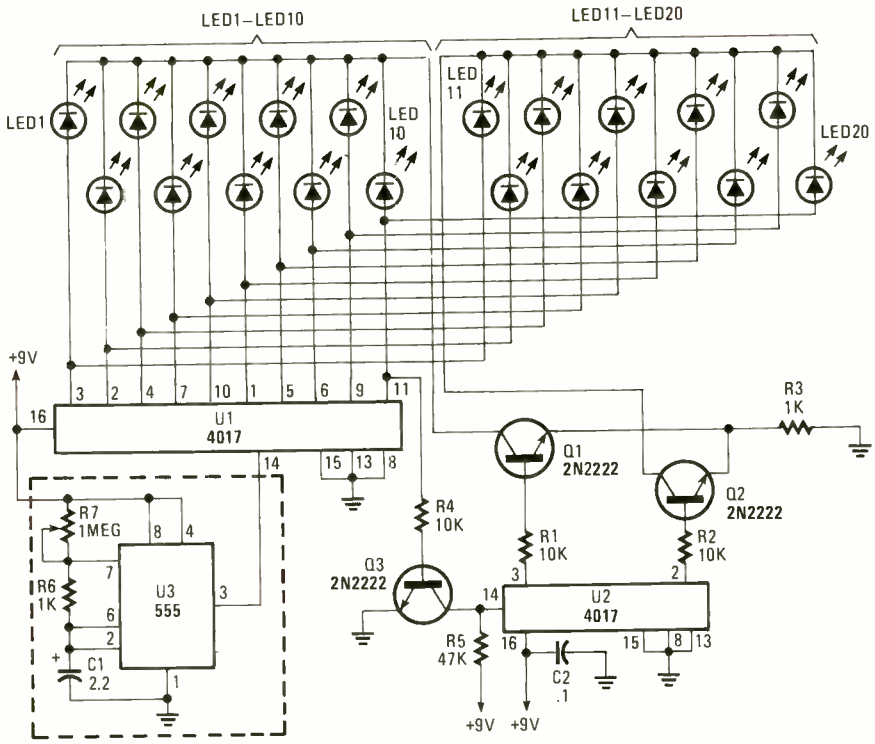

Fig. 2. The Super Light Chaser, unlike many circuits of its type (in which two or more 4017 decade counters provide only eight outputs per IC), can sequence up to 100 LED's.

Super Light Chaser. I've always felt slighted by the fact that every light chaser seems to use two or more 4017 decade counters to provide only eight outputs per IC to be used for pulsing the LED's (nine for the first IC). Pins 3 and 11 are generally used for clock enabling and resetting when tied to pins 13, 14, and 15 of a succeeding 4017. This all seemed very roundabout to me.

After building a couple of toys around the 4017 for my daughter, I designed a circuit (see Fig. 2) that uses all ten of the outputs for the sole purpose of pulsing LED's in sequence. I was going to use flip-flops to switch from one 4017 to another. I discovered that one 4017 could be used for cascading and a second for switching the ground potential of ten LED's at a time.

With this set-up, you can cascade 100 LED's with only two 4017's. Three 4017's will cascade 1000 and four will cascade 10,000. In fact, 15 4017's will cascade one quadrillion LED's!

The signal from pin 11 of U1 serves as the clock for U2, after a little conditioning with Q3 and R4–R5. The outputs of U2 go high in sequence so that consecutive LED ground potentials are enabled ten at a time which makes them ready for sequencing by U1.

I discovered some interesting variations from the original circuit, which can easily be implemented while breadboarding. Although it is possible to cascade up to 100 LED's, using only 20 or 30

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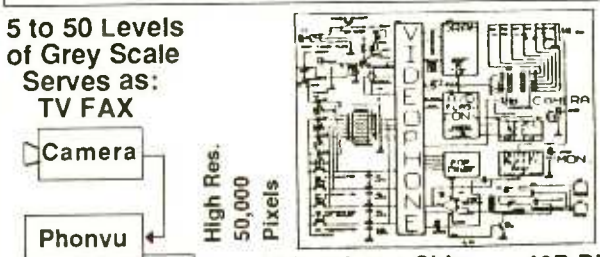

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LED's allows for more possibilities when experimenting.

—John Bandalos, Frederick, MD

John, I'm not sure of how practical any of this is, but I would suggest that any readers make sure that you've got an uncle in the battery business!

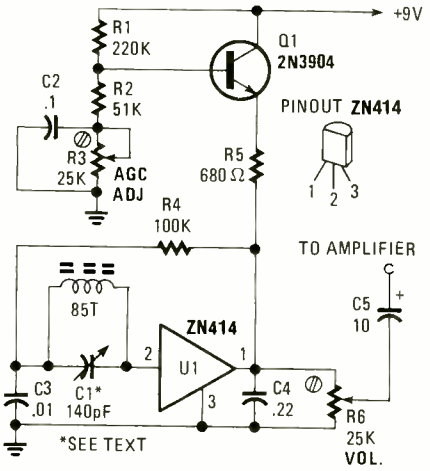

Fig. 3. The heart of the TRF Radio is Ferranti's ZN414 single-chip radio, which contains three stages of RF amplification and a detector in a TO-92 package.

TRF Radio. This circuit uses the Ferranti ZN414 single-chip radio, which contains three stages of RF amplification and a detector in a TO-92 package. Only a few additional components are required. (See Fig. 3.) The only precautions in building the circuit are to keep lead lengths as short as possible, especially at the input of the ZN414 and place the output-coupling capacitor (.22 μF) close to pin 1 of the device.

There are many L/C combinations that will work. I used what I happened to have on hand: A small 140-pF variable capacitor, and a ferrite rod about 4-inches long and 5/16 inches in diameter Around the ferrite rod, I close wound 85 turns of #28 enameled wire. Resistor R3 is adjusted so that strong AM stations won't swamp the weaker ones.

Reception in this area included all AM stations from 680 kHz to 1370 kHz with excellent fidelity. The circuit can be built on a small perfboard.

The circuit is fun to experiment with and can provide excellent fidelity if used with a good amplifier/speaker system. You can get the ZN414 from Circuit Specialists, PO Box 3047, Scottsdale, AZ 85271. The price is $1.75 each, and a data sheet is available for an additional 75 cents. The company has a postage and handling charge of $3.00.

—Robert O. Barg, Rochester, NY

Good circuit, Bob!

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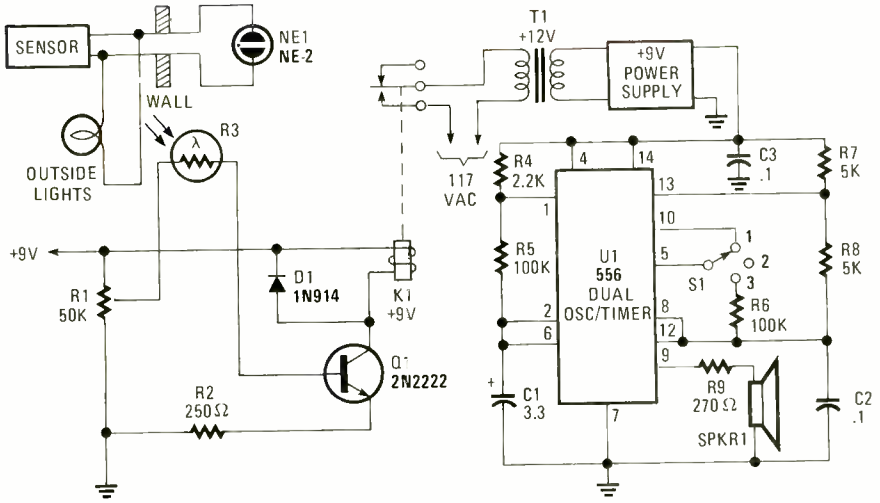

Fig. 4. In the Lights-On Sensor, when light from a neon lamp is sensed by R3 (a light-dependent resistor), Q1 is activated, thereby energizing relay K1, which in turn fires up the oscillator/sounder circuit.

Lights-On Sensor. I recently installed some heat/motion sensors outside the house as an "early warning" system. However, not all of the sensors can directly switch loads other than lights. I used this arrangement to alert me to whenever the sensors are activated. (See Fig. 4.) The neon lamps are in a box inside the house, mounted in such a way that any one sets off the relay, turning on the alarm. I even have a diagram of the house to tell me which sensor is doing its job.

The alarm is easily heard throughout the house (it isn't a mansion) and it certainly gets me out of a deep sleep as the alarm is located in the bedroom.

I can also cut the audio and by just seeing the neon light on, I know when something is moving around out there. Very often, it reminds me that I have left the 300-watt halogen light on. I hope this will qualify me for one of your books Byron.

—Steve Skeete, St. Peter, Barbados, West Indies

Cute and different idea Steve. As most of our regular readers know, we're out of the Fips Books. I'm sending you a Think Tank book however, which I know you'll enjoy!

Three-Way Touch Lamp. If any of this looks familiar, understand that I came up with this circuit by "adapting" from other articles in the Think Tank. The concept however, is my own.

Here's how it all works (see Fig. 5) The touch plate is connected to a 0.27-μF capacitor, which connects to pin 2 of the 555 IC. The diode, which is also connected to pin 2, keeps airborne ambient AC from triggering the 555 on and off. The RC timing network I came up with will trigger the 555 for approximately one second. The output (pin 3) went to pin 14 of a MC1407 decade counter/divider. The three outputs went to three diodes and their associated

(Continued on page 27)

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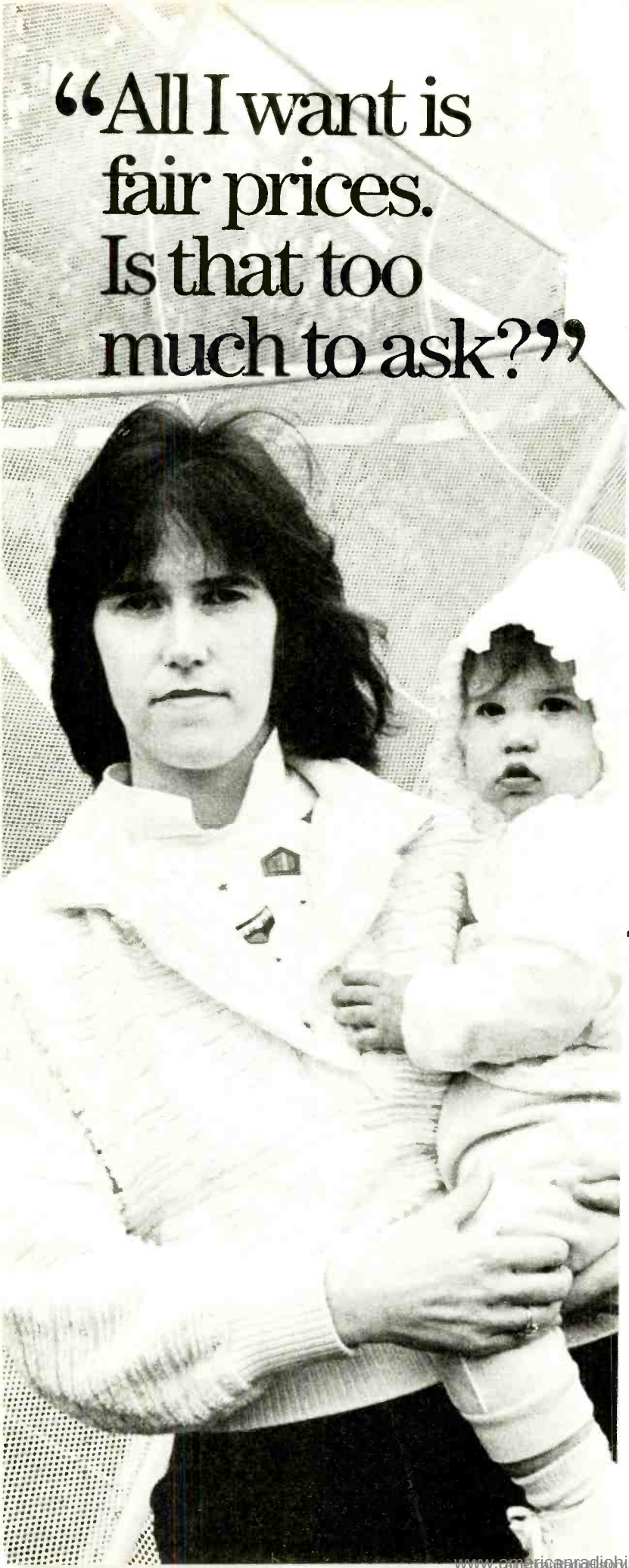

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(Continued from page 25)

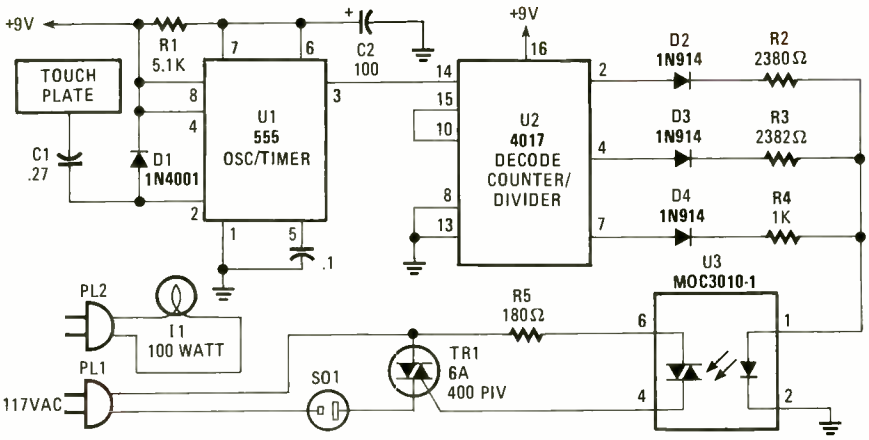

Fig. 5. The Three-Way Touch Lamp switch is built around a 555 oscillator/timer, a 4017 decade counter, and an MOC3010 optoisolator/coupler.

resistors to come up with the required effect of the three-way light. The three outputs feed an optocoupler with a Triac-driver (bilateral trigger) output. The output of the optocoupler triggers the Triac connected to the light. The voltages I measured were 40-, 80-, and 117-volts AC. I sure hope this gets me a Think Tank Book!

—Bradley J. Anderson, Tonopah, NV

Sure does Brad! The advantage here readers, is that you can now use a standard one-way bulb and derive the benefit of three-way lighting. Frankly Brad, I don't recognize any of the circuit features, so I'm treating it like an all-new device.

Expanded-Scale Voltmeter. I developed this expanded-scale voltmeter while living in the Bahamas on our yacht, and running a marine electronics business at one of the popular cruising destinations. In the ten years I was there, I saw many battery (and charging) problems. Many sailors now have this circuit to thank for keeping an eye on their "juice."

Expanded-scale voltmeters aren't new, but they're also not cheap. This one can be made from junkbox parts, but if everything is purchased new, it will only cost about $16.71 to build. It can easily read down to 0.1 volt or better and permits precise calibration at both ends of the scale.

The circuit (see Fig. 6) is little more than an eight-volt regulator (which provides a reference) and resistive-divider network, coupled with a 50-μA meter, which swings from 0 at 10 volts to full scale at 15 volts. That permits easy reading as you just add a "1" digit in your mind as you read the meter.

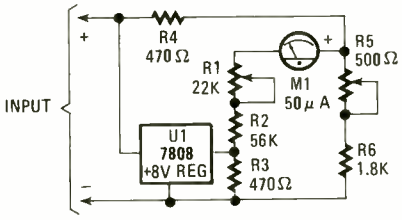

Fig. 6. The Expanded-Scale Voltmeter is little more than an eight-volt regulator (which provides a reference) and resistive-divider network, coupled with a 50-μA meter, which swings from 0 at 10 volts to full scale at 15 volts.

To calibrate, adjust R5 so that the meter reads zero with 10 volts at the input (8 volts at both terminals of the meter). Raise the input to 15 volts and set R1 for full scale (the + terminal will now be 4 volts above the regulator output). Common practice would have you repeat the adjustments, but you'll find that task unnecessary. Use a good-quality digital voltmeter for obvious reasons. The circuit draws 27 mA (0.65 ampere hours per day), which obviates the requirement for an on/off switch.

—Jack Swanton, Wiscasset, ME

Interesting circuit Jack. A device of that sort can help save a lot of time and a lot more money. And since (I assume) that a lot of our readers must be boaters too, it will surely come in handy.

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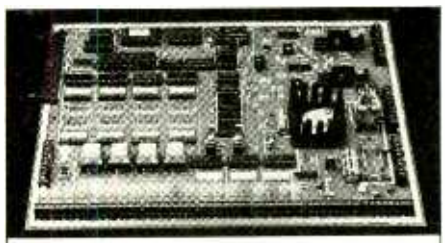

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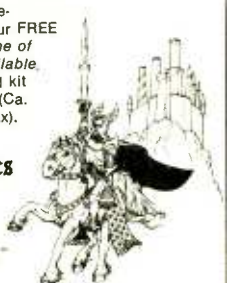

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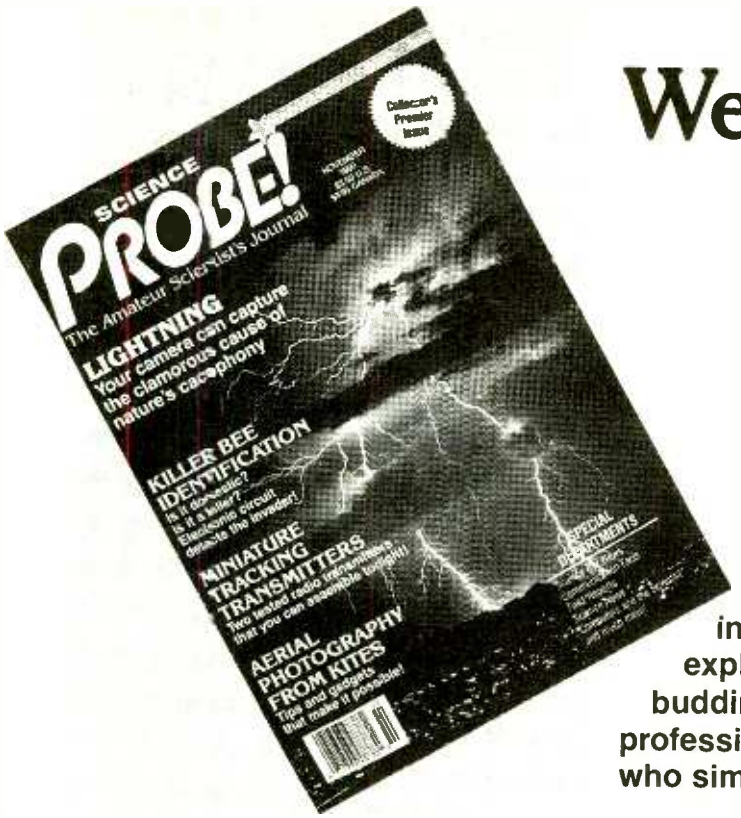

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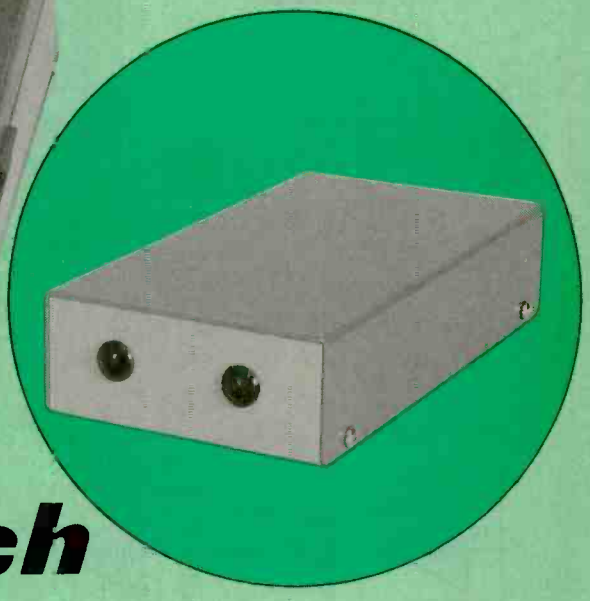

Operate your fax on the same line as your telephone with this easy to build switch. You can also use it to activate a remotely located fax machine or telephone.

The *fax* (facsimile) machine is a wonderful device. With it, you can send printed or graphic information across the country or around the world in minutes. Connected to a separate telephone line, it will faithfully answer each call and receive information 24 hours a day.

As marvelous as the technology is, a fax machine can not operate on a regular speech line without manually switching it over at the machine. If left in the automatic-receive mode, a fax machine imposes wild tones on the line, which are hard to talk over. If it is left in the manual position, the fax won't receive information unless it's manually turned on at the machine. One simple solution to that problem is to locate the fax machine within reach of your regular telephone. But a fax machine is not a small instrument, and as such can present a considerable space problem on a typical desk.

But with the *Remote-Controlled Fax Switch* described in this article, you can place the fax at some convenient remote location. Then when you answer the phone and hear the fax tone, you can activate the fax machine (at the remote location) by pressing a switch on the remote (transmitter) control and hanging up the phone. And when the transmission is completed and the connection terminated, the fax is automatically disconnected from the telephone line.

Likewise, the circuit can also be used to control the use of another telephone on the same line; that second telephone is automatically disconnected from the line when the call is completed and the phone is hung up. One application that this capability is useful for is to control telephone use by visitors and others.

A block diagram of the Remote-Control Fax Switch system is shown in Fig. 1. The transmitter and receiver are inserted into the telephone line at the main and remote locations via line splitters; such splitters are available at most hardware and electronics stores. The receiver, with the fax machine connected to it, is located at the remote location. The transmitter, located at the main telephone station—is a tone generator that produces an inaudible tone of around 100 kHz.

When S1 is pushed, a tone is sent by way of the telephone line to the receiver, which then connects the fax machine to the telephone line. At the end of the transmission when the fax machine shuts down, the receiver disconnects the fax from the telephone line and clears the line for the next communication.

The Transmitter. Figure 2 shows a schematic diagram of the transmitter circuit. The circuit, which is powered from a 9-volt transistor-radio battery, is built around a single 4584 hex inverting buffer Gates U1-e and U1-f form a pulse generator, the frequency of which is determined by C4, C5, and R1. Gates U1-a and U1-b are used to buffer the output signal and U1-c inverts the output of U1-b to produce a push-pull (complementary) signal.

The complementary outputs of U1-a and U1-c are coupled into the telephone line through C1 and C2, respectively. The circuit is activated by a push-button switch on the positive side of the 9-volt battery.

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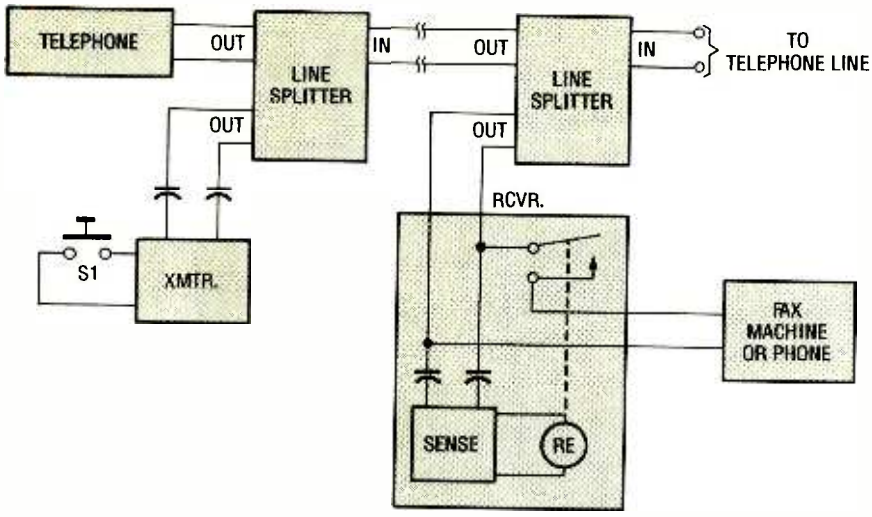

Fig. 1. A block diagram of the Remote-Control Fax Switch system. The transmitter and receiver are inserted into the telephone line at the main and remote locations via line splitters. The receiver, with the fax machine connected to it, is located at the remote location. The transmitter—located at the main telephone station—is a tone generator that produces an inaudible tone around 100 kHz.

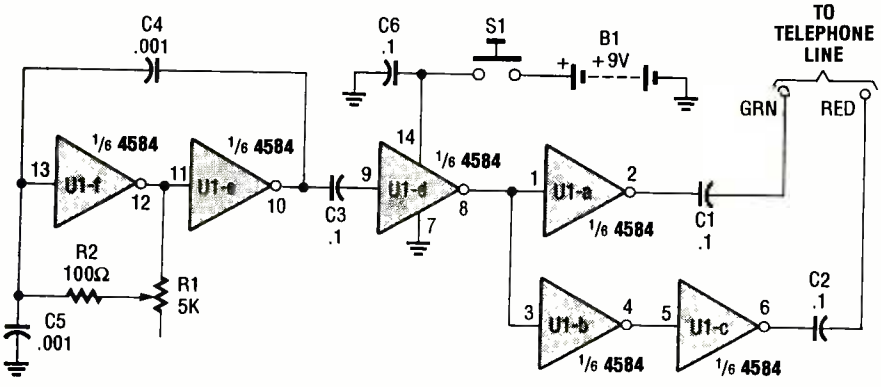

Fig. 2. The transmitter circuit, which is powered from a 9-volt transistor-radio battery, is built around a single 4584 hex inverting buffer. Gates U1-e and U1-f form a pulse generator, while U1-a and U1-b are used to buffer the output signal and U1-c inverts the output of U1-b to produce a push-pull (complementary) signal.

The Receiver. The schematic diagram for the receiver portion of the system—which is somewhat more complex than the transmitter—is shown in Fig. 3. When the phone is "on-hook" (the handset in its cradle), there is about 49 volts across the line. When the phone is taken "off-hook," the telephone line voltage drops to around 10 volts.

When the telephone is on-hook, 49 volts is applied to the input of the receiver circuit. That voltage is rectified by D1–D4 and then fed through D5 and R10 to U1 (a PS2501-1NEC optocoupler), turning on its internal LED. Light radiation striking the photosensitive area of that device's internal transistor-output element causes it to turn on. Under that condition, the base of Q1 (a 2N3905 PNP transistor) is pulled to ground, turning it on. That, in turn, causes +V to be applied to pins 5 and 6, thereby disabling U2.

When the phone is lifted off-hook, reducing the line voltage input to the circuit, U1 turns off, removing the bias from the base of Q1, causing it to turn off. With Q1 turned off, pins 5 and 6 of U2 are pulled low, enabling the 555.

When the transmitter outputs a tone signal, the signal travels through the telephone line and is applied to the input of the receiver circuit. From there it travels through T1 to pin 3 of U4 (a 567 tone decoder). The tone decoder responds to a small band of frequencies, which is set by the values of R9 and C8. When the correct frequency is applied to pin 3 of U4, the tone decoder produces a negative going output at pin 8 (pin 8 is normally pulled high via R7). Capacitors C6 and C7 are filter elements for U4.

PARTS LIST FOR THE REMOTE-CONTROL FAX SWITCH TRANSMITTER

U1—CD4584 hex inverting buffer, integrated circuit
R1—5000-ohm, miniature potentiometer (Digi-Key part K4A53)
R2—100-ohm, ¼-watt, 5% resistor
C1–C3, C6—0.1-μF, 50-WVDC, polyester capacitor
C4, C5—0.001-μF, 50-WVDC, ceramic-disc capacitor
B1—9-volt transistor-radio battery
S1—SPST normally-open pushbutton switch
Printed-circuit board materials, enclosure, battery holder and connector, wire, solder, hardware, etc.

The pin 8 output of U4 divides along two paths. In the first path, the output of U4 is fed to the base of Q2 (a 2N3905 PNP transistor) through R4, turning on the transistor, which in turn connects the +V bus to the anode of LED1, turning it on. The LED is used to tune the transmitter to the correct frequency to operate the receiver.

In the second path, the negative-going output of U4 is fed to the trigger input of U2 (which is configured for latching operation), causing it to output a signal at pin 3. The output of U2 feeds the base of Q3 through R8, turning it on. Turning on Q3 energizes relay K1, feeding the incoming fax transmission to the fax machine connected to the circuit's output terminals. The fax should be left on in the automatic mode.

A dual monostable multivibrator (U3) is included in the circuit to prevent U2 from being inadvertently triggered by transients on the telephone line. The monostable receives a negative going pulse from pins 6 and 7 when the phone is lifted off-hook, and then applies a reset pulse to U2 at pin 4 after a delay determined by the values of R6 and C5. (The delay is about two seconds and is usually timed out before the receiver is put to the ear.)

The delay allows the transients to subside before U2 is reset. When U2 is reset, it waits for a negative pulse on pin 2 to turn on. When U2 is turned on, its pin 3 output goes high, turning on Q3 and closing relay K1. It also turns on LED2 to indicate relay activation.

The power for the circuit is supplied by a 6-volt plug-in power supply. Additional filtering is provided by C9 and C10. An on-off switch can be added if desired.

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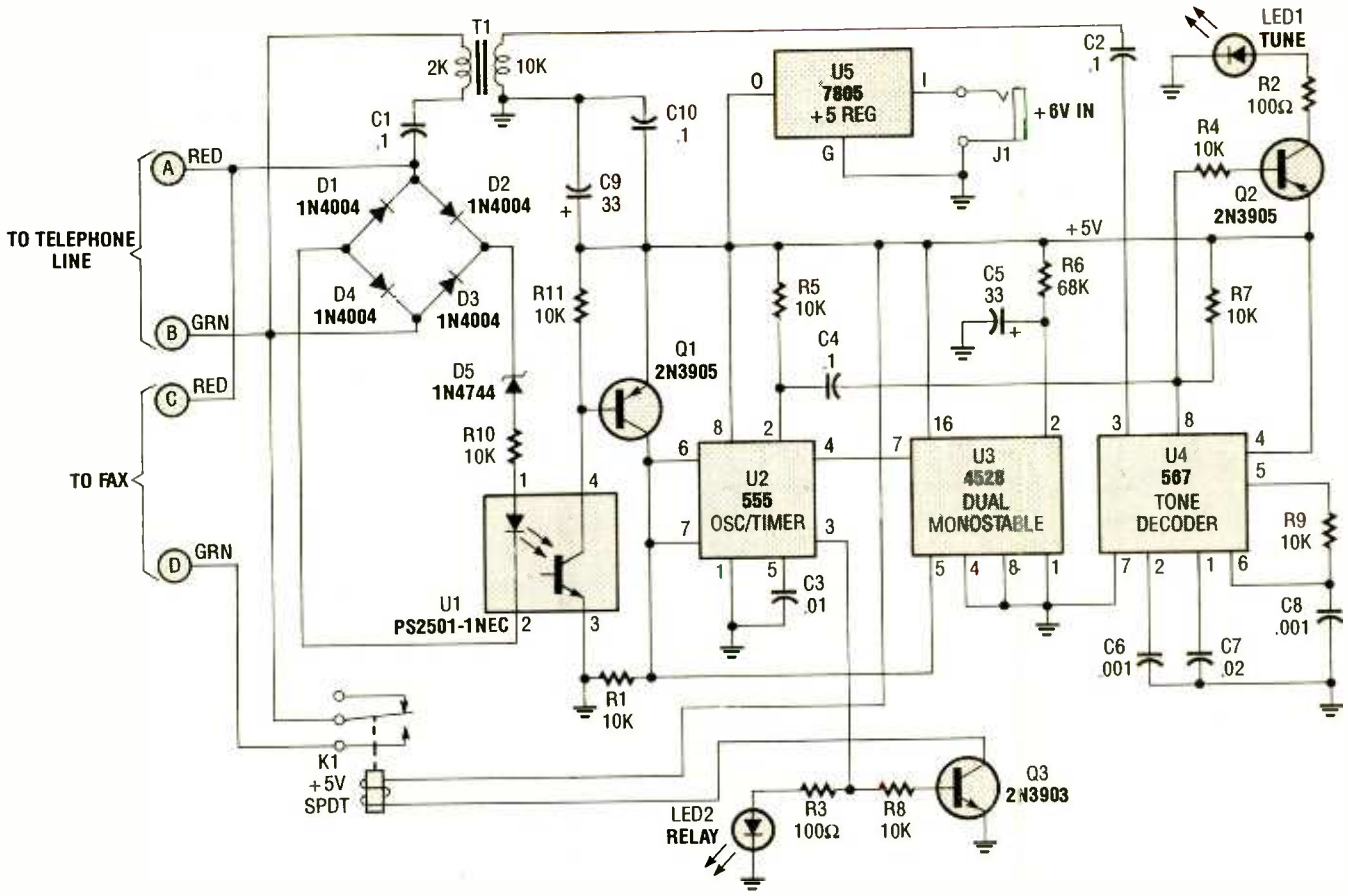

Fig. 3. The receiver portion of the system—which is somewhat more complex than the transmitter—is built around 5 IC's, three transistors, and a handful of support components.

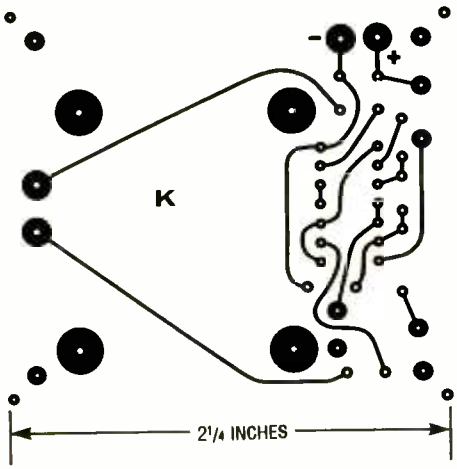

Fig. 4. The foil pattern for the author's prototype of the transmitter is shown here.

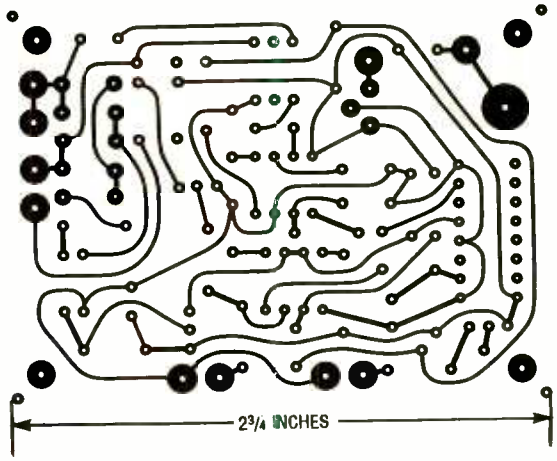

Fig. 5. Here is the foil pattern used by the author in the production of the receiver portion of the project.

Construction. There is nothing critical about the construction of the Remote-Control Fax Switch. In fact, the system's two subassemblies can be hard wired on perfboard. However it is much easier to assemble the project on a pair of printed-circuit boards; that technique also helps to eliminate wiring errors (which are so familiar to hobby electronics buffs). The foil pattern for the author's prototype of the transmitter is shown in Fig. 4; the foil pattern for the receiver is shown in Fig. 5.

Parts-placement diagrams for the transmitter and receiver are shown in Figs. 6 and 7, respectively. Note: If you use the printed-circuit layout, you must use the relay and transformer specified in the Parts List when assembling the receiver to ensure that those components fit the board pattern. The transmitter can be housed in any small enclosure that can be mounted or placed near your regular telephone.

When assembling the circuits, start by installing sockets at the points where IC's are indicated. Next install the jumper connections (there are three on the receiver board). Afterward, install the passive components (resistors, capacitor, etc.), followed by the semiconductors. Once all of the on-board components have been installed, take

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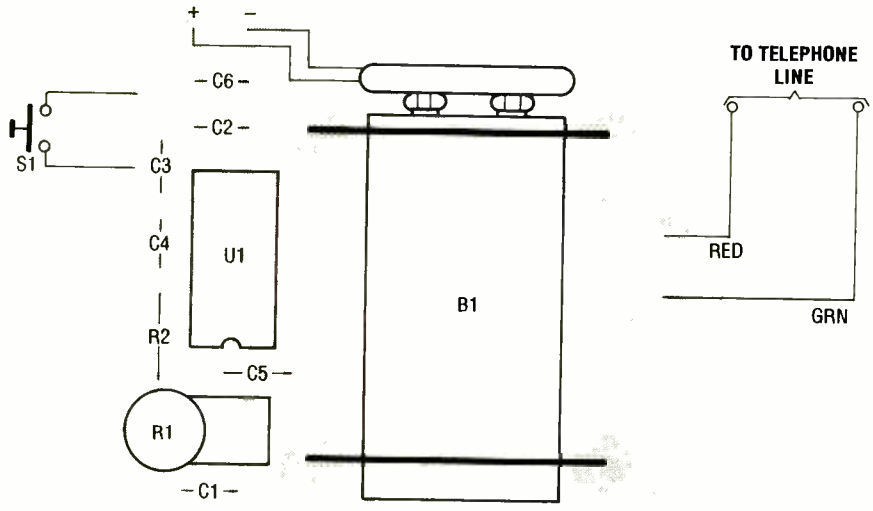

Fig. 6. Guided by this parts-placement diagram, assemble the transmitter. Note: There is a single quad-conductor cable with a modular plug on one end coming from the transmitter board that is used to connect the circuit to the telephone line.

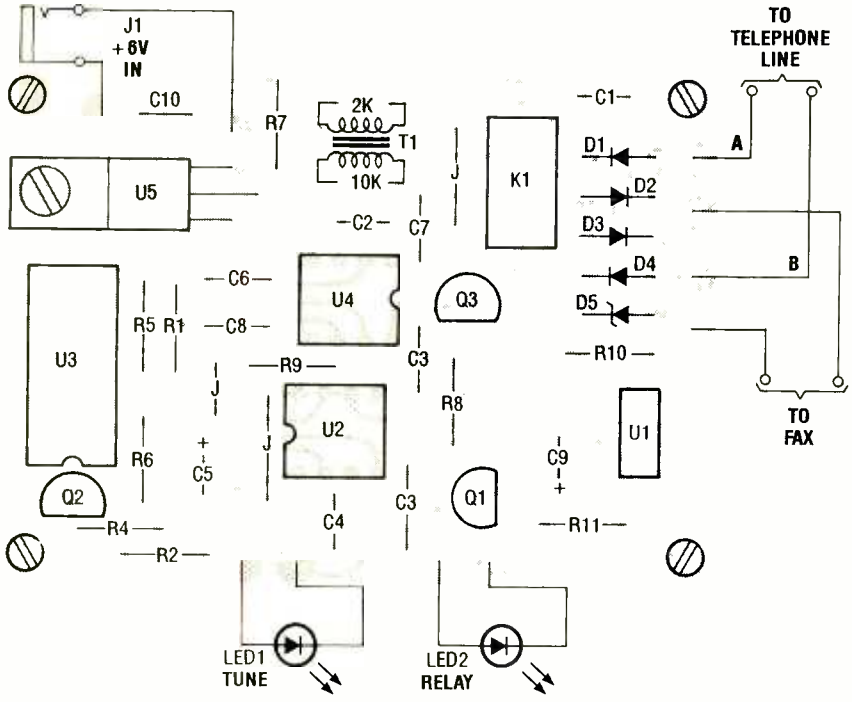

Fig. 7. When assembling the receiver portion of the board using the pattern shown in Fig. 5, you must use the relay and transformer specified to ensure that those components fit into the space and pin holes provided.

a few minutes to carefully check your work for the common construction errors: poor solder joints, solder bridges, misoriented or misplaced components, and the like.

After that, solder lengths of hook-up wire to the appropriate points on the board for connection to the off-board components. You will also need three lengths of quad-conductor telephone cable with modular connectors attached to one end of each. One length of quad-conductor cable (with a plug at one end) is used for the transmitter, the two remaining lengths are needed for the receiver.

One length of the receiver's quad-conductor cable is terminated with a modular plug and the other with a modular jack. The jack is used to connect your fax machine to the system, and the plug is used to connect the system to the telephone line.

When connecting the receiver to the telephone line, be sure to observe the color coding of the wires; a direct short can be put across the phone lines by connecting the two sides of the line to terminals A and C or B and D when the relay closes.

PARTS LIST FOR THE REMOTE-CONTROL FAX SWITCH RECEIVER

SEMICONDUCTORS

U1—PS2501-1NEC optoisolator/coupler, integrated circuit (Digi-Key)
U2—LM555 oscillator/timer, integrated circuit
U3—CD4528 dual monostable multivibrator, integrated circuit
U4—LM567 tone decoder, integrated circuit
U5—7805 5-volt, voltage-regulator, integrated circuit
Q1, Q2—2N3905 general-purpose PNP silicon transistor
Q3—2N3903 general-purpose NPN silicon transistor
D1–D4—1N4004 1-amp, 400-PIV, rectifier diode
D5—1N4744 15-volt, 1-watt, Zener diode
LED1, LED2—Jumbo light-emitting diode

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1, R4, R5, R7–R11—10,000-ohm
R2, R3—100-ohm
R6—68,000-ohm

CAPACITORS

C1, C2, C4, C10—0.1-µF, 50-WVDC, polyester
C3—0.01-µF, 50-WVDC, ceramic disc
C5, C9—33-µF, 16-WVDC, radial-lead electrolytic
C6, C8—0.001-µF, 50-WVDC, ceramic-disc
C7—0.02-µF, 50-WVDC, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

K1—Aromat HD1E-M-DC5V 5-volt relay (Newark Electronics part 346F5743)
T1—1000- to 2000-ohm driver transformer (Mouser part 42TC002)
J1—Miniature phone jack
Perfboard materials, enclosure, quad-conductor telephone cable, hook-up wire, solder, hardware, etc.

Alignment Procedure. Aligning the transmitter to the receiver is simplified by using LED1 as a state indicator, since it is normally off unless a signal from the transmitter is received. Connect both the transmitter and the receiver to the telephone line. With the telephone receiver on-hook, press switch S1 on the transmitter. Then tune R1 in the transmit-

(Continued on page 96)

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TELEPHONE TOLL TOTALIZER

See the cost of your long distance telephone calls while you are making them and avoid those unpleasant surprises on your bill.

BY WALTER W. SCHOPP

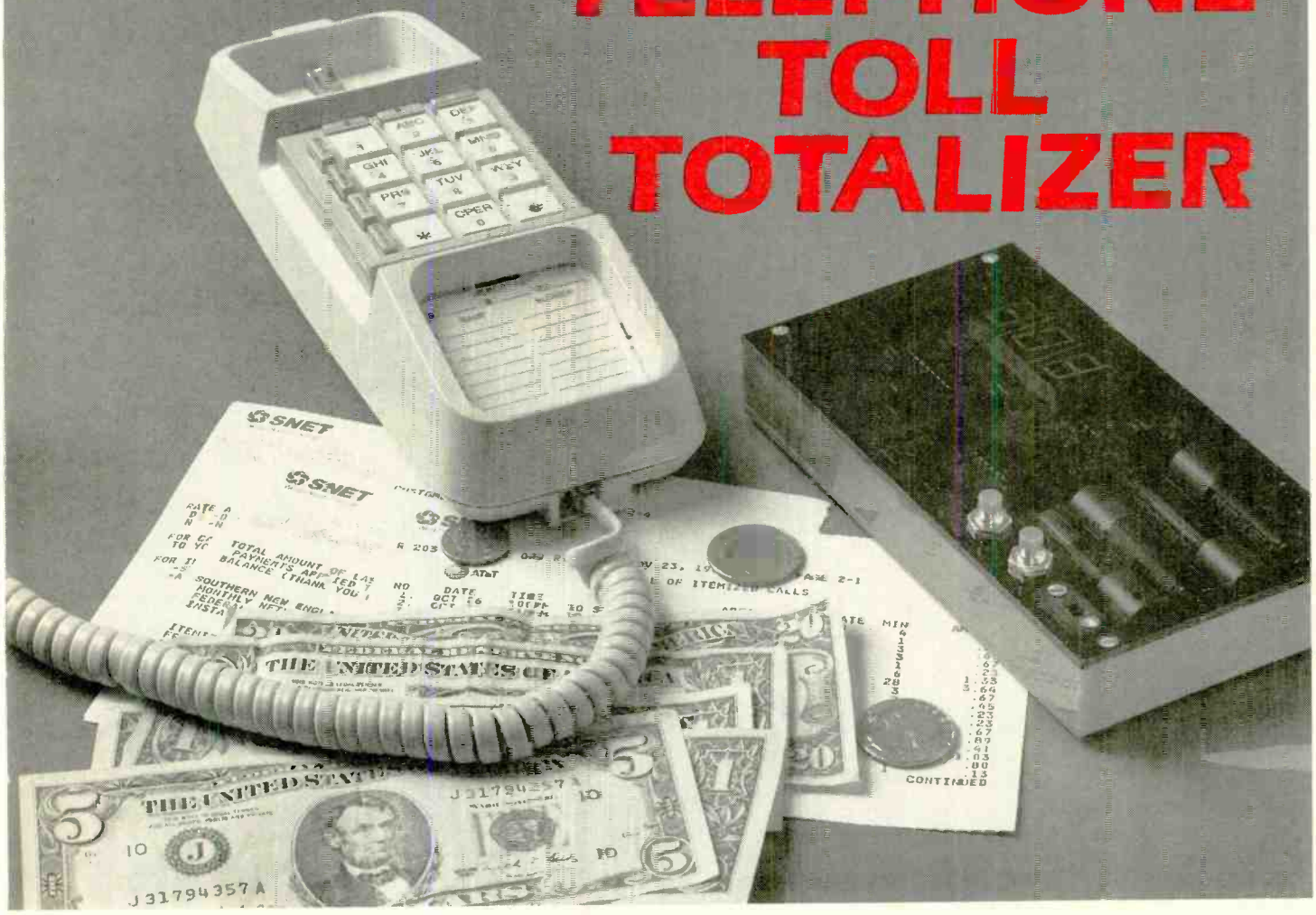
It is said that time flies when you're having fun. It also seems to fly by very fast while you are talking on the telephone. How many times have you talked too long without thinking about it and had an unpleasant surprise on your telephone bill at the end of the month? Well the *Telephone Toll Totalizer* described in this article will prevent those unwanted surprises by showing you the approximate cost of each phone call in dollars and cents while you are making it.

The Telephone Toll Totalizer can be located close to your telephone and reset before dialing your call. When the party you are calling answers the phone, the start button is pressed. As soon as you hang up, the stop button is pushed and the approximate cost of the call is left displayed on the readout.

Calculating Cost. Long distance rates vary from telephone company to telephone company, however the bill you receive at the end of each month tells you the cost of each long distance call and the total minutes of that call. With that information, you can determine the average cost of your long distance telephone calls and set the counter to indicate that rate.

Phone companies use a rate based on so much for the first minute and about 30% less for each minute thereafter. There are also evening rates that run 30% less than daytime calls, and night rates that run up to 60% less than the day rate. As a rule, many short calls cost more than the same number of long calls because of the higher first minute rate; there are many other variables to consider.

As you can see, it would take a computer to actually come up with the exact price of each call. To simplify the project, and hence make it buildable for the majority of hobbyists, some



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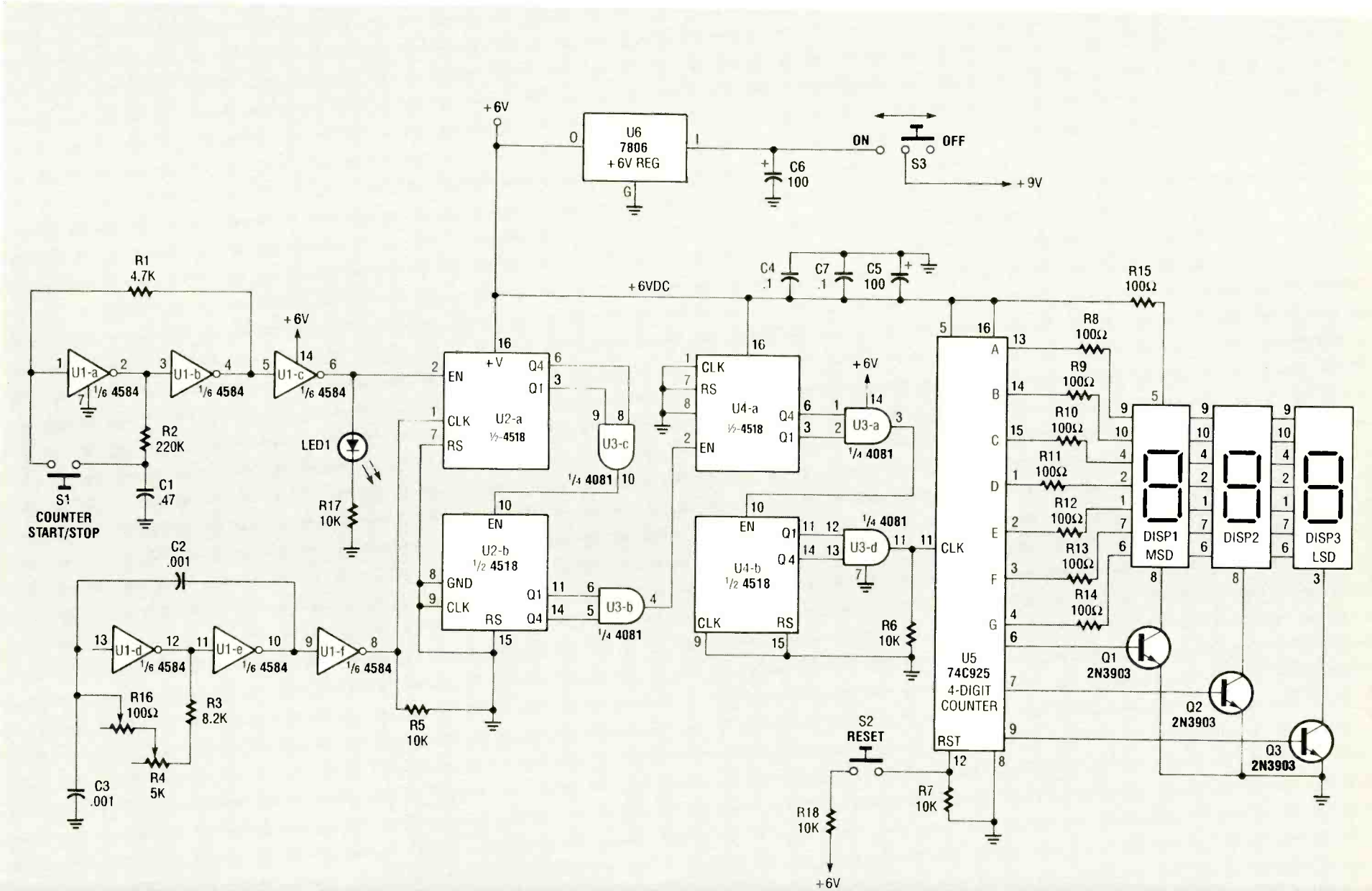

Fig. 1. The Telephone Toll Totalizer—built around two 4518 dual synchronous up counters, a 74C925 4-digit counter, a 4584 hex inverting buffer, and a 4081 quad 2-input AND gate—is fairly simple.

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compromises had to be made. The Telephone Toll Totalizer calculates the cost of a call based on the fact that if a call for a certain amount of time cost so much last month, it will cost the same the next time you make it.

If you review your phone calls over a period of months, you will find that your phone habits are fairly constant and can be averaged for a profile of your usage. They will come out fairly close as to time spent on calls and the cost of the calls. By totaling a month of long distance calls and adding up the minutes of each call listed on your bill, you can use that information to come up with a fairly accurate cost-per-minute figure.

Do your math in cents instead of dollars. That makes the answer come out in total cents with fractional cents shown behind the decimal. Now that you have an average of how much each minute of time on the phone is worth, you can determine how much each second of time on the phone is worth by dividing the per minute value by 60 seconds. This number will be less than one, so we will have only a fraction of one cent behind the decimal point.

Now all that is needed is a decade counter that counts at that rate to display dollars and cents. But since the cost per minute will be somewhere between 15 and 25 cents, that task is not quite as simple as it seems. The resulting cost-per-second means that you need a very slow counter frequency. The counter's clock circuit is required to produce a pulse every three to five seconds, which is a very slow rate and one that is very difficult to calibrate accurately.

There is, of course, an easy way around that dilemma: Use a fast clock frequency and feed the output of the clock to a divider. For instance, if we multiply the cost-per-second rate by 100,000, we can come up with a fairly stable generator operating in the kilohertz (kHz) range. By accurately dividing that frequency by 100,000, the result is a super slow counter that corresponds to the cost-per-second rate.

About the Circuit. Figure 1 is a schematic diagram of the Telephone Toll Totalizer. The circuit, built around two 4518 dual synchronous up counters, a 74C925 4-digit counter, a 4584 hex inverting buffer, and a 4081 quad 2-input AND gate, is fairly simple. A pulse generator comprised of U1-d and U1-e—whose output frequency is determined by C2, C3, R3, R4, and R16—produces pulses at the rate of your "cost per second" times 100,000; the rate is variable via R4 and R16.

Potentiometer R4 is used for the coarse adjustment of the frequency, while R16 is the fine adjustment. The output of the pulse generator (at pin 10 of U1-e) is buffered by U1-f, and fed to the clock input of U2-a, which is gated by an alternate-action switch composed of U1-a and U1-b. The output of the alternate-action switch is buffered by U1-c. Each time S1 is pressed, the output of the switch at pin 6 of U1-c alternates between positive and negative, alternately enabling and disabling U2-a.

LED1 is used to indicate that the counter is enabled and counting. (Do not reduce the value of R17 to increase LED1's luminance; doing so would lower the voltage presented to the enable input of U2 enough to keep U2 permanently disabled.)

The two dual synchronous counters (U2 and U4) are configured as divide-by-10 counters. That's done by ANDing pins 3 and 6 together and then feeding that signal to pin 10 (the input to the second counter in those dual counter packages). Two outputs of U2-b (at pins 11 and 14) are then ANDed together and fed to pin 2 of U4-a. Then as with U2-a, the pins 3 and 6 outputs of U4-a are ANDed together, and fed to U4-b. Together U2 and U4 divide the input-clock frequency by 10,000.

The pins 11 and 14 outputs of U4-b are fed through AND gate U3-d to the clock input of U5 (a 74C925 4-digit counter with multiplexed outputs), which is designed to drive four 7-segment displays. Multiplexing is a process by which all like segments are tied to the same driver output, and the individual digits enabled at the proper moment by a control output. The control outputs of U5 (pins 6, 7, and 9) are fed to base junctions of Q1–Q3, through which the displays are multiplexed at a rate of 3 MHz.

Note: Although the 74C925 is a 4-digit unit only 3 digits are used in this application—the least-significant-digit driver (pin 10) is not used. By omitting the least significant digit, the input to the counter is divided by ten, making a total division of 100,000.

The Telephone Toll Totalizer can be powered from a 6-volt plug-in DC power supply or four "AA" batteries. If batteries are used, regulator U6 can be omitted. Also omit C5 and C6; those capacitors are not required for battery operation.

Construction. There is nothing critical about the construction of the Telephone Toll Totalizer; if you choose, the circuit can be hard wired on perfboard. However, it is recommended that the circuit be assembled on printed circuit board. Figure 2 shows an appropriate foil pattern. Using a printed-circuit board helps to avoid errors, which are so common to hobby electronics projects.

A parts-placement diagram corre-

PARTS LIST FOR THE TELEPHONE TOLL TOTALIZER

SEMICONDUCTORS

U1—CD4584 hex inverting buffer, integrated circuit
U2, U4—CD4518 dual synchronous up counter, integrated circuit
U3—CD4081 quad AND gate, integrated circuit
U5—74C925 4-digit counter, integrated circuit
U6—7806 6-volt 1-amp, voltage regulator, integrated circuit
Q1, Q2, Q3—2N3903 general-purpose NPN silicon transistor
DISP1, DISP2, DISP3—Seven-segment common-cathode display, Radio Shack 276-077, Mouser 579-LR6780, or equivalent
LED1—Jumbo light-emitting diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—4700-ohm
R2—220,000-ohm
R3—8200-ohm
R4—5000-ohm miniature potentiometer (Digi-Key 0FA53 or similar)
R5–R7, R17, R18—10,000-ohm
R8–15—100-ohm
R16—100-ohm miniature potentiometer (Digi-Key 0FA12 or similar)

CAPACITORS

C1—0.47-µF, ceramic-disc
C2, C3—0.001-µF, ceramic-disc
C4, C7—0.1-µF, ceramic-disc
C5, C6—100-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1, S2—Normally-open pushbutton switch
Printed-circuit board materials, enclosure, AC molded power plug with line cord, 6–9 volt power source, wire, solder, hardware, etc.

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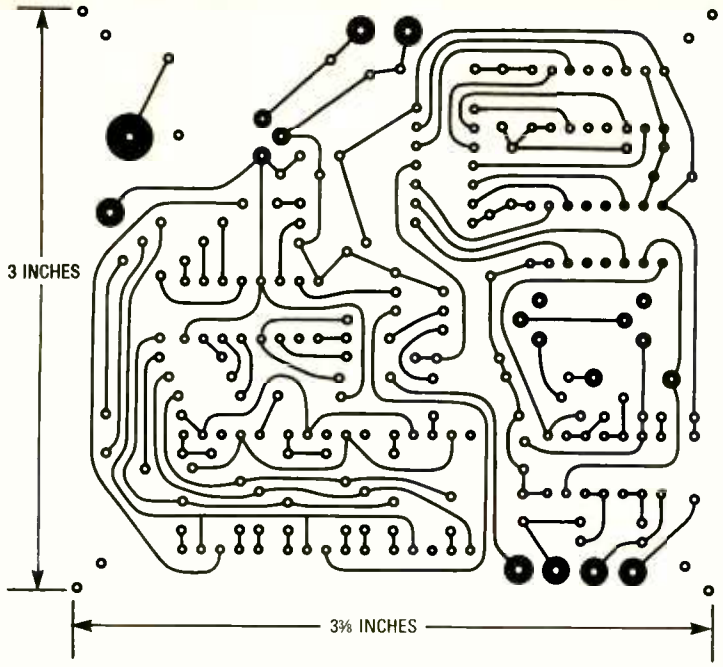

Fig. 2. There is nothing critical about the construction of the Telephone Toll Totalizer. If you choose, the circuit can be hard-wired on perfboard, but it's recommended that the circuit be assembled on printed-circuit board.

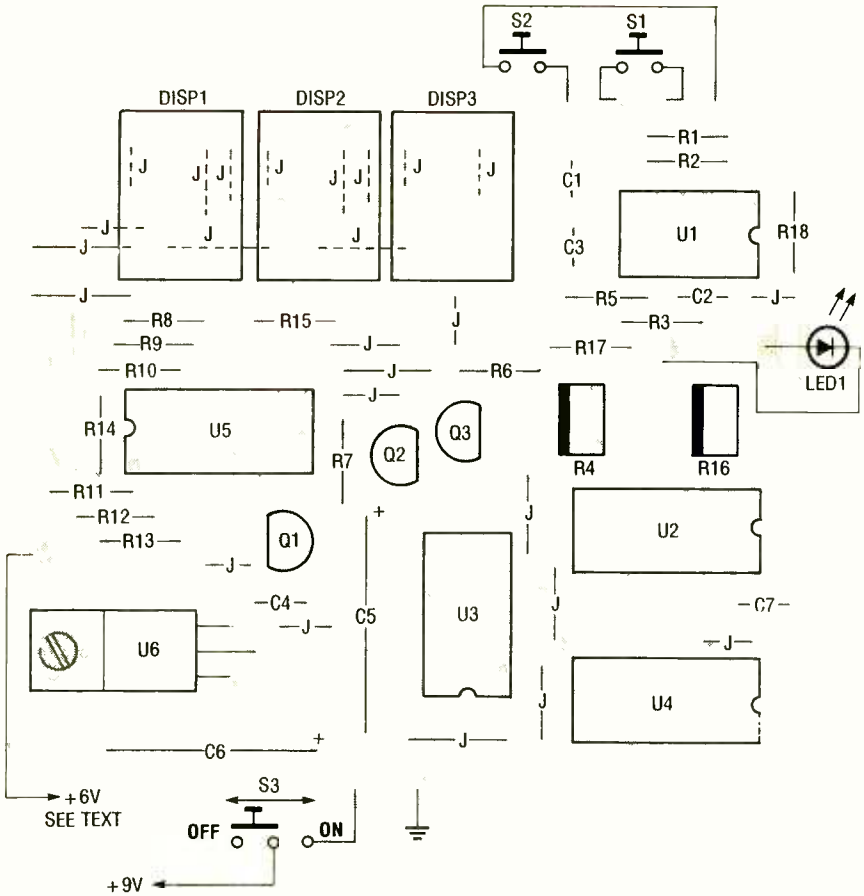

Fig. 3. This parts-placement diagram corresponds to the foil pattern in Fig. 2. Once you gather all the parts listed in the Parts List, construction can begin.

sponding to the foil pattern in Fig. 2 is shown in Fig. 3. Once you gather all the parts listed in the Parts List, construction can begin. It is recommended that sockets be used for the IC's. Using sockets eliminates the chance of damaging the IC's due to excessive heat during soldering, and the sockets also serve as reference points from which the other component positions can easily be found.

Start by installing the jumper connections at the points indicated in Fig. 3, and then install sockets at the IC locations. After that, install the passive components (resistors, capacitors, etc.) followed by the diodes and transistors Next connect lengths of hook-up wire where indicted for connection to the off-board components. Finally install the IC's in their sockets.

Afterward, inspect your work for errors; solder bridges, cold solder joints, misoriented or misplaced components, etc. Once you are satisfied that there are no errors, put the circuit board to the side and prepare the enclosure that will house your project.

The board can be mounted in any suitable enclosure, and a piece of dark red plastic (bezel) can be used to cover the display. The display can also be located off-board (again with a red plastic bezel) and connected to the circuit through hook-up wires.

Calibration. Using a frequency meter, calibrating the Totalizer is very simple. To calibrate the unit to your phone rate, divide your long distance cost in cents by the minutes spent in calling. Since we are working with cents and minutes, drop the decimal that separates dollars from cents on your cost. The answer is your cost-per-minute in cents and fractions of a cent. Divide the cost-per-minute rate by 60 to get the cost-per-second rate in fractions of a cent.

Multiply the cost-per-second rate by 100,000 and this is the frequency at which the pulse generator (clock) should operate. For example, let's say the cost of your monthly long distance bill comes to $22.86, or 2286 cents, which represents a total of 145 minutes of long distance phone time. Your cost-per-minute (CPM) would be:

CPM = 2286/145 = 15.765

Next use the calculated CPM value to find your cost-per-second (CPS):

CPS = CPM/60

CPS = 15.765/60 = 0.26275

Then multiply the CPS value by 100,000, which, with the calculated CPS value, works out to 26275 or 26.275 kHz. Thus the frequency of your pulse generator should be set at 26.275 kHz.

The output of the pulse generator can be monitored using a frequency

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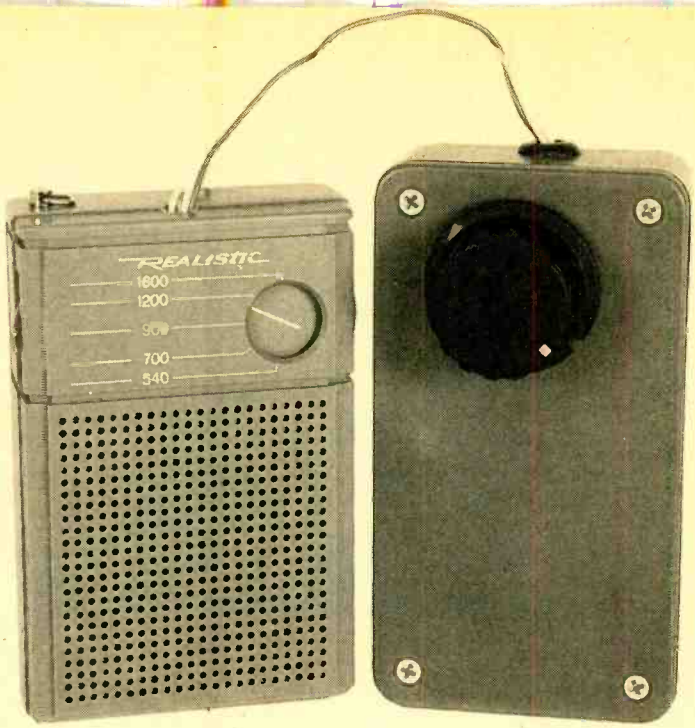

Build An ECONOMY PORTABLE SHORTWAVE RECEIVER

Keep in touch with events around the world with the least expensive, easiest to build, shortwave radio around.

BY JOSEPH F. MITSCH

From the time early man first walked the earth until the 1950's, the earth's population grew to 2.5 billion people. However, from 1950 to 1990, a span of only 40 years, the earth's population has more than doubled to an estimated 5.24 billion.

Driven by the engine of population, the world is rapidly changing. Nowhere are the changes in politics and economics more obvious than on the shortwave-broadcast bands where the nations of the world dispatch up-to-the-minute reports on the state of the global village.

Shortwave-broadcast monitoring is informative and exciting, and will enable you to hear the latest news from Europe, Africa, Asia, and elsewhere. The radio signals are all around you as you read this article, and all you need to decode them is a shortwave-broadcast receiver.

Unfortunately, even inexpensive commercial shortwave receivers nowadays cost anywhere from $100.00 to $300.00, and top-of-the line units can easily run into the thousands of dollars. But shortwave listening does not have to be expensive. Instead you can build the *Portable Economy Shortwave Receiver*, made from Radio Shack's *AM Flavoradio*, for under $20. The AM Flavoradio seems ideally suited for conversion to an inexpensive shortwave-broadcast receiver thanks to its surprisingly strong audio-amplifier and RF-detector stages.

All that is required to convert this ordinary AM radio into a reasonably stable shortwave-broadcast receiver capable of receiving 1–6 MHz, is a tuned coil with plenty of taps on it and at least twenty-four inches of antenna; naturally, the longer the antenna the better the performance. The conversion described in this article is so easy that it is a perfect project for even the beginning builder.

Using the converted Flavoradio I was able to listen to a half-hour history program from Radio Japan; not bad for under $20.00! I have also been able to lock onto Radio Netherlands, WWV, the BBC from London, Radio Havana, Radio Austria, Radio Swiss International, amateur transmissions, and much more for hours of shortwave-listening fun with only occasional fine-tuning needed. In each case, the audio quality was extremely good, and I would often have to turn the volume down to a rational level.

The Flavoradio also has the extra advantage of using only a nine-volt battery for its power supply, so it is extremely portable. Current drain is, on average, only 27 mA so the battery will last a long time. Even after the conversion is made,

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everything is still small enough to stick in a coat pocket, sit on a desk, or just take to bed for an evening of international intelligence gathering. The only drawback is that normal AM operations will be lost in the exchange from local AM to shortwave, a small price to pay for a lot of DX radio fun.

Making the conversion. The schematic diagram for the Economy Shortwave Receiver is shown in Fig. 1. In addition to the Radio Shack AM Flavoradio, the only components required are a hand-wound coil (L1), a 10-position switch (S1), a long-wire antenna, an enclosure, and a few lengths of hookup wire. Note that a 10-position switch may be difficult to obtain. In its place, the author substituted an easily found 12-position switch and simply did not use two of the positions.

The theory behind the conversion is very simple. By replacing the Flavoradio's tuning coil with L1 we change the resonant frequency of that unit's LC tuning circuit. The new resonant frequency can be found from:

$$f = 1/(2\pi\sqrt{LC})$$

where L is the inductance in henrys, C is the capacitance in farads, and *f* is the resonant frequency in hertz.

The units given in the above formula are, of course, not the most convenient for use in this application. To make the calculations easier, use this formula instead:

$$f = 10^6/(2\pi\sqrt{LC})$$

where *f* is the resonant frequency in kHz, L is the inductance in microhenrys, C is the capacitance in picofarads, and 2π is equal to 6.28.

As shown in the schematic, the Flavoradio uses a 365-pF tuning capacitor. The L1 described in this article is a 40-μH coil with 10 taps. It is wound on a ⅞-inch O.D. form (a piece of PVC pipe) using #30 enameled magnet wire. For those of an experimental bent, Table 1 lists some other specifications for coils wound using the same materials.

Getting to Work. First, obtain a small tray to put assorted parts in; I used an old plastic margarine bowl. Then, lay the radio down on a table so that the back of the unit is facing up toward you. Remove the one-inch long, small Phillips screw in the middle portion of the back panel.

Once this screw has been removed, gently pry the two halves of the radio

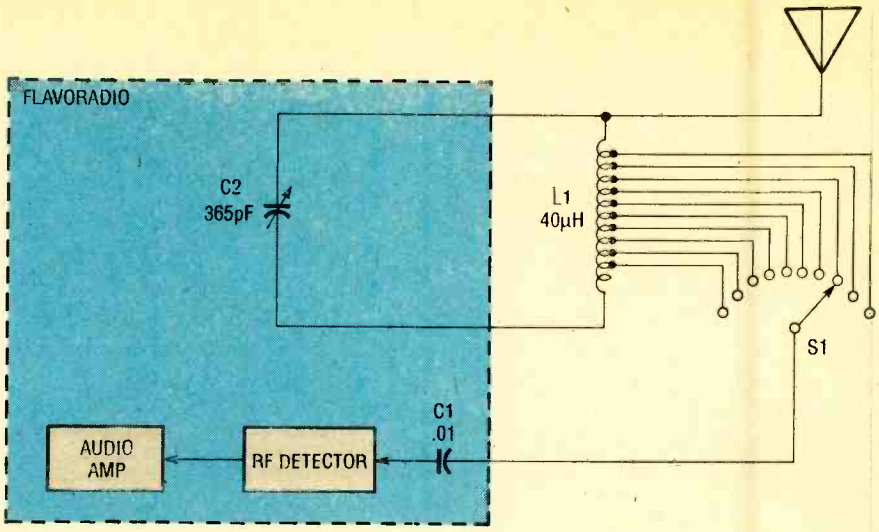

Fig. 1. Adding a rotary switch and a 40-μH homemade coil to an inexpensive AM radio yields a portable shortwave receiver with surprising performance.

TABLE 1—COIL SPECIFICATIONS

Inductance	Turns
.5 μH	3
1 μH	4.3
2 μH	6.6
4.5 μH	10.45
6.5 μh	12.7
14 μH	20.3
40 μH	40

case apart. A thin flat-blade screwdriver can be useful in this, but be sure to work gently to prevent dislodging or damaging the speaker wires, or anything else.

Now you have two halves of the radio, spread out on a table before you, with the radio's PC board showing solder-side up. Notice that the tuning control is a two-piece unit with the frequency indicator (a white line) located on a dime-sized insert at the center of the control. At this point, note the orientation or setting of the radio's tuning control and then gently lift the insert from it's seated position by prying it free with a small-bladed knife. Just lift the cap up around the edges; it is held in place with just a narrow strip of double-sided tape and will be replaced later. After that inner cap is removed you will see another small Phillips-head screw, which may now be removed.

Carefully lift up the remaining portion of the knob with a gentle rocking motion. You are now looking at the top portion of a 10–365 pF variable capacitor. Later, we will attach the leads from our new coil to the two tabs on this capacitor; those tabs are located just above the knob that you have just removed.

Note that there is no need to remove the radio's PC board. Therefore, do not remove the two remaining Phillips screws in the bottom corners of the circuit board or the volume-control knob.

Next, heat up your soldering iron and hot glue gun; you will need them both for this next step. Observe the three, thread-like, filament wires at the top of the printed-circuit board—these are the old AM coil wires. From left to right there should be a black wire, a red wire, and a pale-pink wire going to the three top solder pads found in the upper right-hand corner of the radio's circuit board. Put a drop of hot glue on those filament wires, about ¼-inch from the solder pads, to hold them in place. Then take your soldering iron to each pad and lift the filament wires from their respective pads and fold them out of the way as they are no longer needed.

Winding the New Coil. It is now time to wind the 40-μH coil. Don't cringe! That coil has only one layer and will tolerate a large degree of imperfections and still function faithfully. The coil form should be about 1¾-inch long and have an outside diameter of about ⅞ inch, but, within reason, those dimensions are by no means critical. For instance, a small pill bottle with a one inch diameter will work; my prototype used a piece of ¾-inch PVC plumbing pipe from the local hardware store.

You will need about 24 feet of #30 enameled magnet wire to wind the coil. Place one end of the magnet wire on the coil form and press it with your left thumb while grasping that same end in a pulling motion with your right

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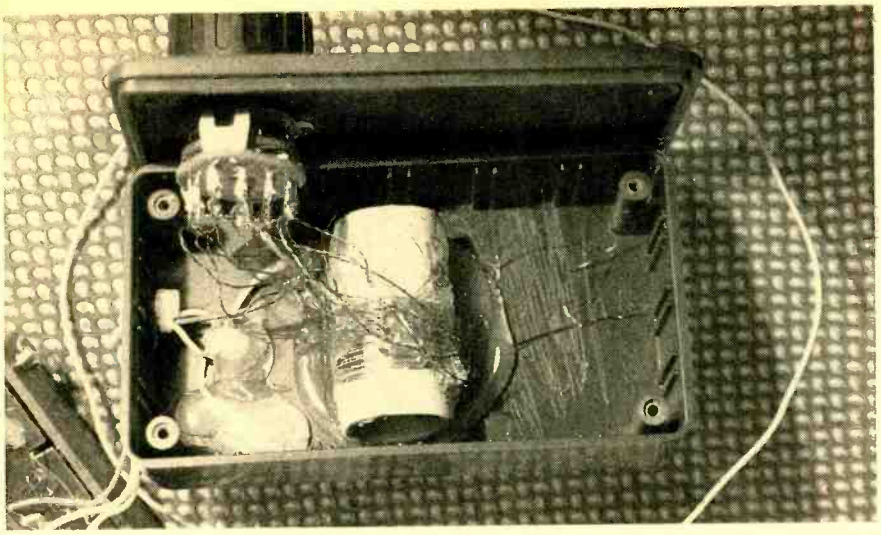

The coil assembly mounts on the bottom of the enclosure using hot glue; the scratches in the case provide better adhesion for the glue. The rotary switch is mounted on the lid.

hand, until you have pulled out a six-inch tail of wire. Secure the wire at the spot where your left thumb is located with a few drops of hot glue or strong adhesive tape. Fold the wire tail out of the way and you are ready to begin winding the coil.

Wrap the remaining wire around the coil form using your left thumb or a pencil mark as a turn counter. Wrap the wire around the coil form four times, keeping tension on the wire and placing the windings as close together as you can without overlapping.

Once you have four turns, hold the wire in place on the coil form with your left thumb. Using your right hand, pull out another six-inch strand toward you and fold it back toward the coil form, making an elongated loop.

Next, place your right index finger in the looped end of the wire and begin spinning it around so that the wires become a twisted pair. When the wire feels snug on your right index finger, stop twisting the braid, and fold the wire to the left out of the way so that it won't interfere with your winding the rest of the coil.

You have just made your first coil tap. Continue winding another four turns of wire then stop and pull out another six-inch measure of wire, fold it back to make a loop, and twist it in a similar fashion. Repeat that process every four turns until you have 10 taps and 40 turns of wire. Leave another six-inch length of wire on the far coil end, but don't twist it into a tap.

You should now have two end wires and ten twisted-pair tap wires on your coil. Secure the assembly with a few beads of hot-melt glue across a convenient spot on the coil, firmly securing both ends of the coil. Coat as much of the coil as is possible with glue to make the coil itself rigid. If your coil is not perfect, don't worry; chances are it will still work fine.

PARTS LIST FOR THE SHORTWAVE RECEIVER

L1—40-μH tapped coil, see text
S1—rotary switch, 10- or 12-position, Radio Shack 275-1385 or equivalent
AM Radio (Radio Shack 12-203 or equivalent), 30-gauge magnet wire (Radio Shack 278-1345 or equivalent), enclosure (Radio Shack 270-222 or equivalent), coil form (see text), stranded insulated hook-up wire, hook and loop fasteners, solder, hot-melt glue, wire, etc.

Cut the small loops off the twisted-tap wires with a pair of scissors and proceed to sand about one inch of the enamel insulation off of the ends of all the tap wires, keeping the wire twisted. Also sand the two coil end wires. Tin the ends of all the wires to make sure they will take solder. If they do not take solder, continue sanding until all of the ends can be tinned.

Prepare three 10-inch pieces and one 24-inch piece of stranded insulated hook-up wire by stripping off one quarter inch of insulation off all ends and then tinning them. Once that is done, it's time to prepare a plastic project box to house the coil and the rotary switch.

With the lid off, drill a hole in the top of the box, ¼-inch from the back panel and about 1¼-inch over from the side; placement is not at all critical here. Next, drill a ¼-inch hole in the enclosure's lid. Locate that hole so that it is about 1⅛-inch from the top and about the same distance from one side.

Using a hack saw, cut the the rotary-switch shaft down to about 1 inch. Tin the switch contacts and set the switch aside for a moment.

Abrade (scratch) the middle of the enclosure's back panel and then use hot-melt glue to cement the coil in place. Be sure to place the coil so that access to the end leads and taps is unimpaired.

Take one of the 10-inch lengths of hook-up wire you cut earlier and solder it to the common contact of the switch. That contact is the one that is off by itself, toward the center of the switch. Then solder the coil taps to the switch's remaining contacts. Bend the stabilizing tab on the switch back out of the way and secure the switch to the lid of the project box.

Take the other two 10-inch pieces of hook-up wire and solder one to each of the coil's leads. Secure those wires to the bottom of the box, near the sides, with hot glue.

Shove the other end of those two wires, along with the lead from the switch's common contact, through the hole in the top of the project box. You may want to use a nylon tie wrap or a knot in the wires as a strain relief so the wires can not be pulled out of the box.

Hooking it Up. Locate the word "MODEL" etched into the upper right-hand corner of the radio's PC board. Directly under that is a solder pad. Solder either one of the coil leads to that pad.

Locate the solder pad that is ½-inch directly to the left. Solder the lead from S1's common contact to that pad.

Next, locate the solder pad that is directly to the right of the first two. As a check, the model number of the radio is etched in the board just above that pad. Solder both the remaining coil lead and the 24-inch piece of hook-up wire you cut earlier to that pad. Solder an alligator clip to the free end of the hook-up wire. That clip will serve as the antenna terminal.

File a notch into the radio's case that is big enough to let the new wires enter the case without pinching when it is closed. Gently guide those wires through the slot, and then press down

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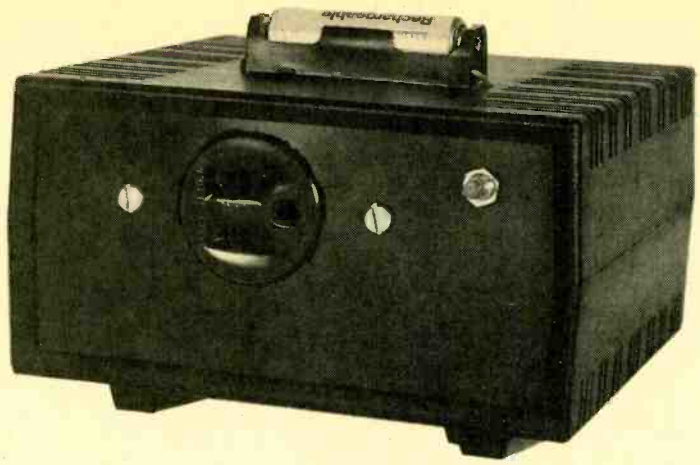

Build a NiCd-Battery Tester

NiCd batteries work best in matched sets. This circuit helps to identify weak cells so that they don't adversely affect the stronger cells.

BY JAMES R. BAILEY

Nickel-cadmium batteries are useful and cost-effective—particularly for those who own and use portable instruments—boom boxes, take-along TV sets, power tools, etc. Unfortunately, after being used or abused over a period of time, individual cells can lose an appreciable percentage of their charge-holding capacity. One low-yield cell in a set of four can drastically reduce the time between chargings of the entire set. Moreover, if the set is deep charged, the weaker cell can be further damaged; that is because it can be reverse charged by the stronger cells in the set.

The best way to get the greatest life and performance out of your nickel-cadmium (NiCd) batteries is to use them in sets that are matched in storage capacity. Using them in such a manner allows your best cells to perform to their maximum capability, while avoiding reverse charging of weaker cells.

The only reliable way to test individual NiCd cells is to run them down at a predetermined current rate while measuring the time each takes to discharge to a specified voltage. NiCd cells, for all intents and purposes, are discharged when their terminal voltage drops to one volt. Their capacity is simply the product of the current multiplied by the discharge time, which is expressed in ampere-hours (Ah) or milliampere-hours (mAh).

The popular "AA" NiCd cells are available in storage capacities of from 500 to 900 mAh. If a freshly charged 500 mAh NiCd cell is connected to a 500-mA load, it would take about one hour to discharge to one volt. The *NiCd Battery Tester* described in this article can do just that. It discharges AA or larger cells at 500 mA and measures the time it takes to reach a terminal voltage of one volt.

How It Works. Figure 1 is a schematic diagram of the NiCd Battery Tester. The circuit is comprised of two 3-terminal voltage regulators (U1 and U3), ¼ of a quad comparator (U2), a 2N3904 general-purpose transistor (Q1), a 4-amp, 50-PIV bridge rectifier (BR1), and a handful of support components.

In Fig. 1, the output of an adjustable voltage regulator (U3) is set by R8 and applied across a 5-ohm load consisting of two parallel-connected 10-ohm, 10-watt power resistors (R10 and R11). Power for U3 and the rest of the tester comes from a twelve-volt regulator U1 in series with the NiCd cell being tested.

When a battery is placed across test terminals J1 and J2, the battery's +V terminal feeds the non-inverting input of U2. A 1-volt reference voltage derived from a resistive voltage-divider network (consisting of R1–R3) and regulated by D1 (a 5.1-volt Zener diode) is fed to the inverting input of U2.

If the reference voltage applied to pin 4 of U2 is greater than that applied to pin 5, the output of the comparator goes low, and Q2 is cut off. If, on the other hand, the reference voltage applied to pin 4 of U2 is below the battery voltage, the output of the comparator goes high, turning on Q1. When Q1 is turned on, power from the +V bus is applied to relay K1 (a 12-volt double-pole double-throw unit), activating it.

With K1 activated, one set of K1's contacts completes the SO1 leg of the circuit, thereby providing power to any device plugged into SO1. Power is supplied to SO1 as long as the battery under test has an output that's greater than 1 volt. By plugging an electric timing device (*i.e.*, a clock) into SO1, you'll get an accurate measure of the cell's running time. When battery voltage drops to 1 volt the output of U2 goes low, deactivating K1 and, hence, disconnecting the battery under test from the load.

The other set of relay contacts feeds power to the comparator/relay-driver circuit. Momentarily pressing S1 bypasses the DC contacts of K1 and starts the test.

Construction. Assembly of the NiCd Battery Tester is straightforward. In fact, the author's prototype was assembled

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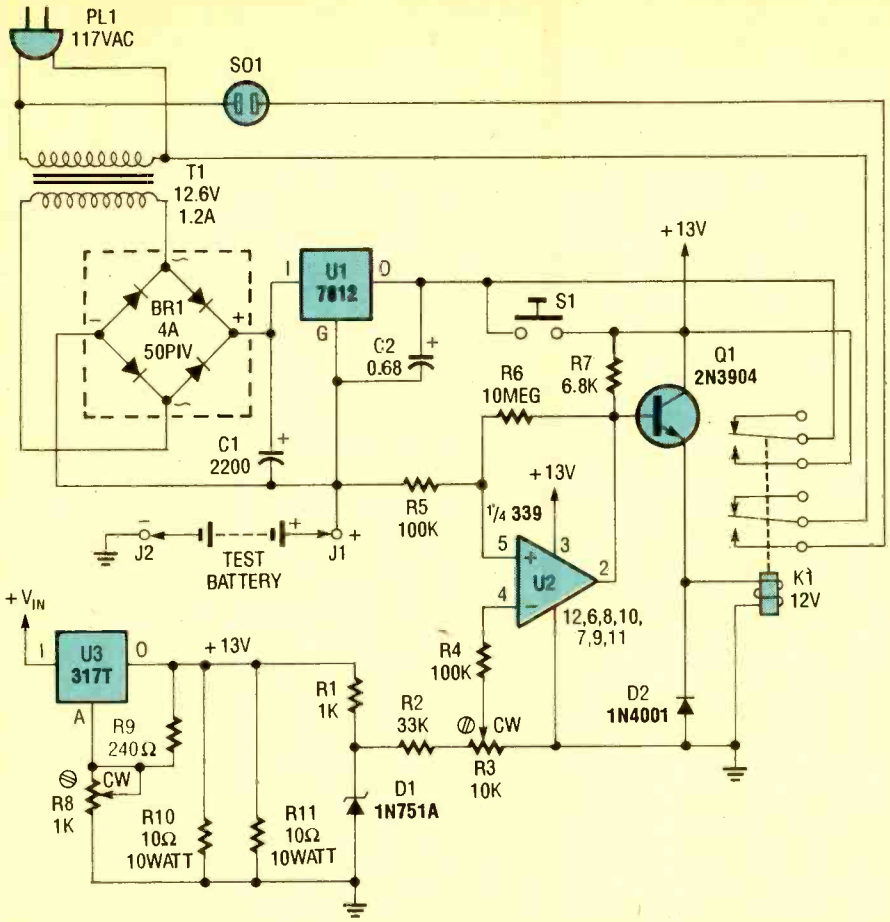
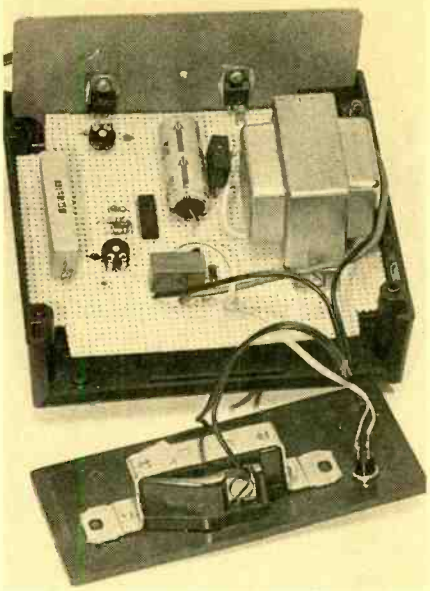


Fig. 1. The NiCd Battery Tester is comprised of two 3-terminal voltage regulators (U1 and U3), ¼ of a quad comparator (U2), a 2N3904 general-purpose transistor (Q1), a 4-amp 50-PIV bridge rectifier (BR1), and a handful of support components.



Here is an inside view of the author's prototype unit. Note that the two 10-ohm, 10-watt power resistors (R10 and R11) are piggybacked, and that U1 and U3 are attached to the back panel, which serves as a heat sink.

on perfboard. However, in order to reduce (if not eliminate) some of the errors that tend to creep into electronics projects, it is recommended that the circuit be assembled on a printed-circuit board. A foil pattern for the NiCd Battery Tester is shown in Fig. 2.

While there is nothing especially critical about parts selection or layout, the circuit board has been laid out to accept the specified Radio Shack transformer and relay. If electrically equivalent components having different

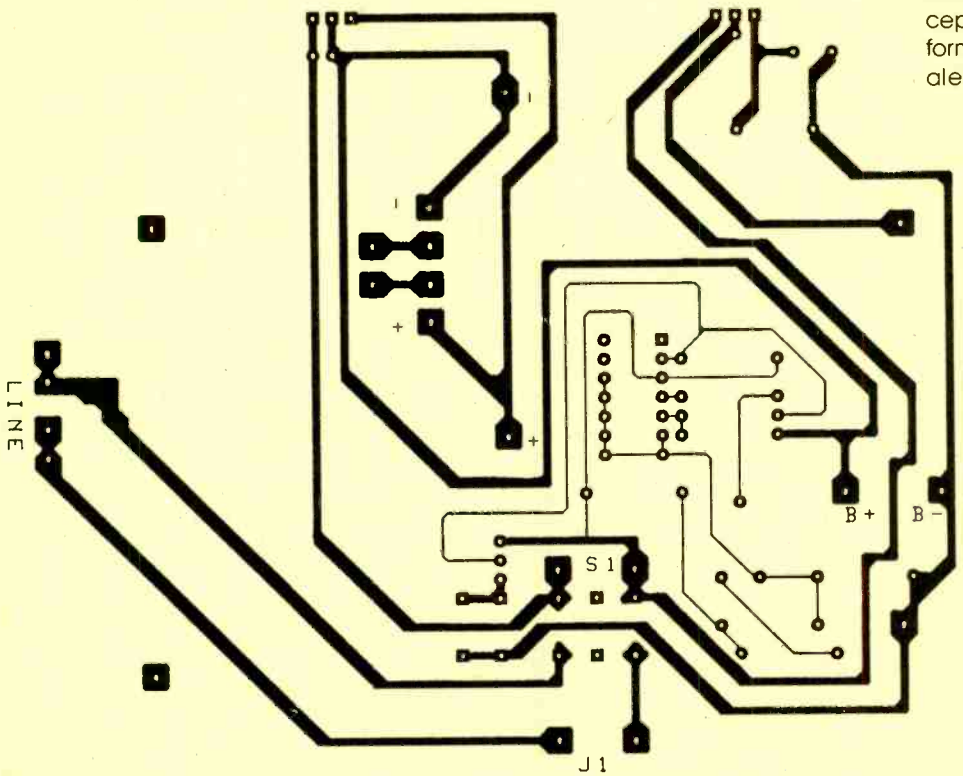


Fig. 2. Although the author's prototype was assembled on perfboard, it is recommended that the circuit be assembled on a printed-circuit board. You can use the foil pattern shown here.

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PARTS LIST FOR THE NICD BATTERY TESTER

SEMICONDUCTORS

U1—7812 12-volt voltage-regulator, integrated circuit
U2—LM339 quad comparator, integrated circuit
U3—LM317T adjustable voltage regulator, integrated circuit
Q1—2N3904 general-purpose, NPN silicon transistor
D1—1N751A 5.1-volt, ½-watt Zener diode
D2—1N4001 1-amp, 50-PIV rectifier diode
BR1—4-amp, 50-PIV full-wave bridge rectifier

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—1000-ohm
R2—33,000-ohm
R3—10,000-ohm trimmer potentiometer
R4, R5—100,000-ohm
R6—10-megohm
R7—6800-ohm
R8—1000-ohm trimmer potentiometer
R9—240-ohm
R10, R11—10-ohm, 10-watt, power resistor

ADDITIONAL PARTS AND MATERIALS

C1—2200-µF, 25-WVDC, aluminum electrolytic
C2—0.68-µF, 25-WVDC, Tantalum
S1—Normally-open pushbutton switch
K1—12-volt, 1-amp DPDT relay
T1—12.6-volt, 1.2-amp transformer
SO1—117-volt AC socket
P1—Molded AC power plug with line cord
Perfboard materials, enclosure, TO-220 heat sink, battery holder, strain relief, wire, solder, hardware, etc.

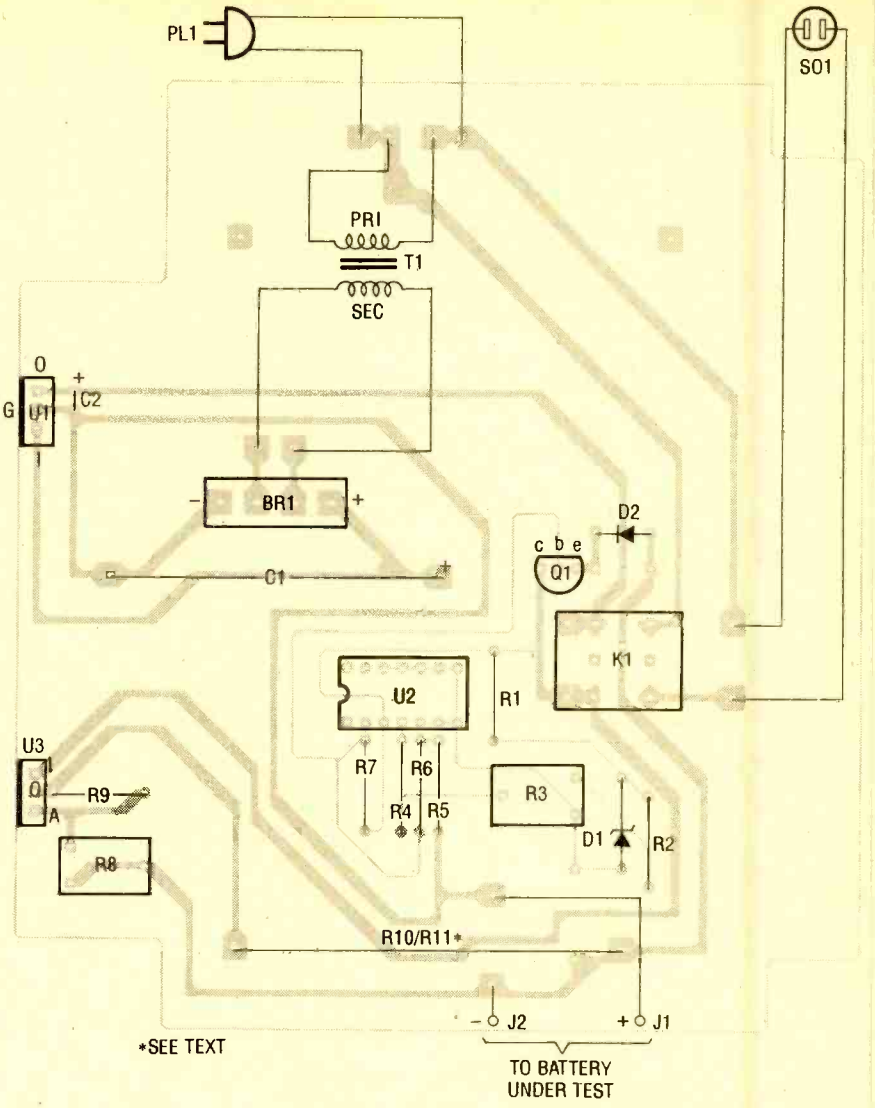

Fig. 3. Assemble the NiCd Battery Tester guided by this parts-placement diagram. Note: If you use a relay or transformer other than the specified components, it may be necessary to locate those components elsewhere and connect them to the circuit board through hook-up wire.

dimensions are used, it will be necessary to either modify the board or to mount those components elsewhere and connect them to the board through hook-up wire.

When assembling the circuit, keep all the solder joints on K1 small, and trim all stray wire strands to eliminate the danger of short circuits. Once you obtain all of the parts listed in the Parts List, begin assembling the circuit guided by the parts-placement diagram shown in Fig. 3. Note that the points labeled J1 (+) and J2 (−) are not in fact jacks, but are connected to a battery holder. Also note that R10 and R11 are mounted to the board piggyback style and are connected to the position designated R10/R11.

Regulators U1 and U3 should be mounted to heat sinks. If the project is housed in a metal enclosure, a wall of the enclosure can serve as a heat sink for the regulators. If, on the other hand, you choose to use a plastic enclosure, it will be necessary to use some other form of heat sinking. Don't forget the jumper wire.

Once all the board-mounted components have been installed, connect lengths of hook-up wire to the points indicated in Fig. 3 for connection to the off-board components. Afterward, prepare the enclosure that will house the project. Make a hole in the rear of the enclosure for the line cord. It's a good idea to use a strain relief on the line cord to prevent it from accidentally being disconnected.

After that, drill a hole in the front panel of the enclosure for S1, and make a cutout in that panel for SO1. Mount the front-panel components, and connect the appropriate wires from the circuit board to them.

Temporarily solder the +V lead of the battery holder to the board. Solder a length of hook up wire to the J2 position. That wire along with the black wire of the battery holder will be used in the calibration procedure.

Calibration. The first step in calibrating the project is to set R3 and R8 fully counter-clockwise. Put a freshly charged NiCd battery in the holder (be sure to insert it correctly). Connect a milliammeter capable of measuring 500 mA between the negative lead of the battery holder and the wire connected to the board's J2 position. The negative

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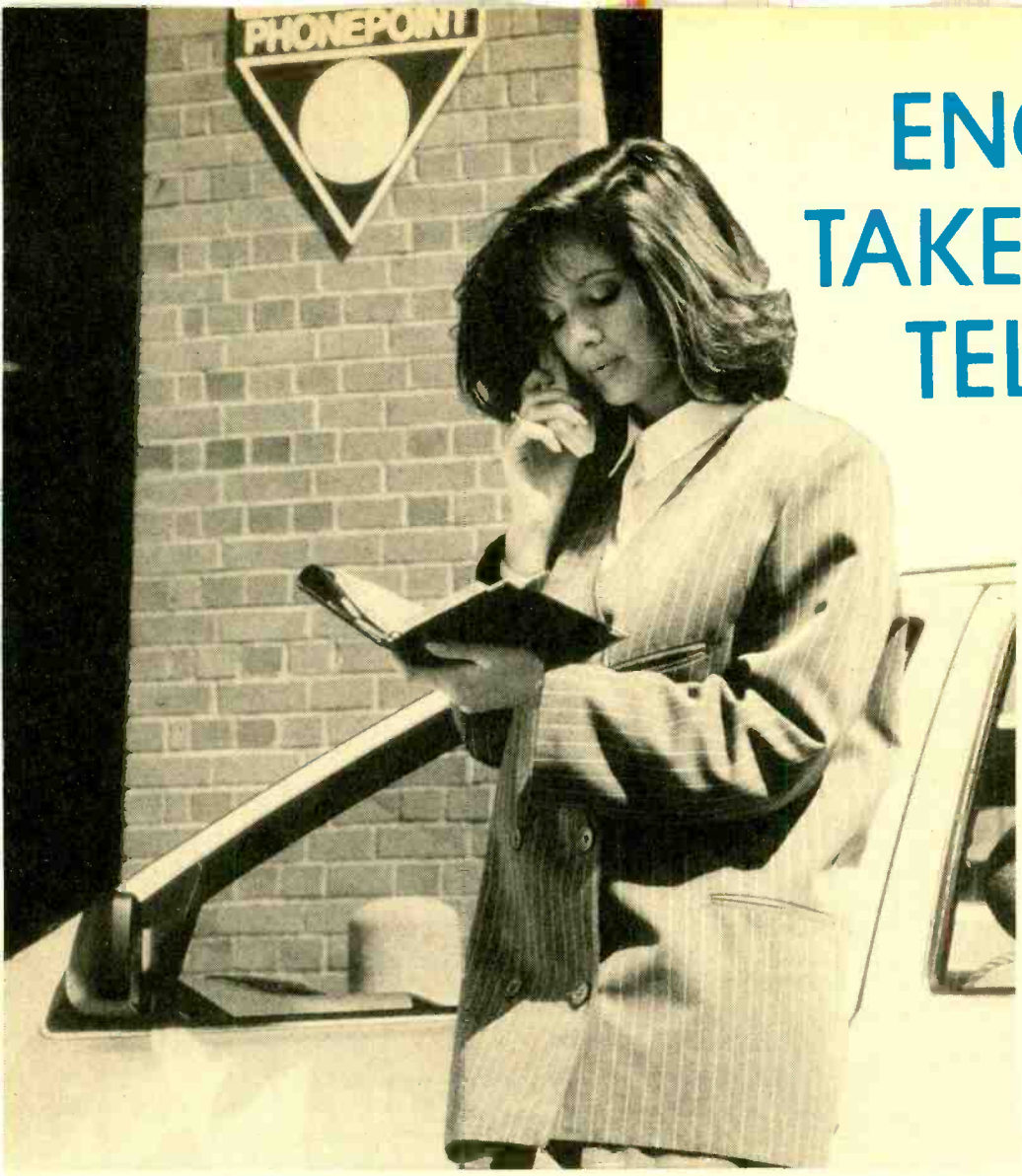

ENGLAND'S TAKE-ALONG TELEPHONE

BY MEL MANDELL

Using special cordless phones, Britons can access one of many scattered base stations for low-cost phoning on the go. Doing so could become a substitute for cellular phones.

A new communications system called Telepoint is the British solution to an everyday frustration: the inability to use a pay phone because it's tied-up, malfunctioning, or you don't have the change. A blending of pay and cordless telephones, this new form of personal communications could replace expensive, bulkier cellular phones for many people who are on the go.

Instead of pay phones, Telepoint offers prominently marked, but well-secured, high-frequency base stations wired into the public phone network. They can be accessed by compact cordless phones nearly as small as the one TV's Maxwell Smart had concealed in the heel of his shoe. They have a range of about 300 feet.

Charges—added monthly to the phone bills of the owners of the cordless phones—would be from 5 to 10 percent higher than placing the same call on a pay phone. Two versions of those "second-generation" cordless digital devices are offered: one that weighs nine ounces and another that weighs only six ounces. The former was developed by Ferranti Electric and comes with an optional battery recharger for $56 (which is sold together with the cordless phone in a $320 package). The latter is the creation of Shaye Communications, Ltd., and to date its 3.6-volt, "AA" size lithium batteries are not designed for recharging.

Because the phones broadcast at only 10 milliwatts, the $8 non-rechargeable batteries used in the Shaye phone are expected to last users an average of about three months. In contrast, the batteries in portable cellular phones, which broadcast at 600 milliwatts, need to be recharged after as little as 45 minutes of talk time, which means that most users have to *schlep* a spare battery pack along if on an extended trip.

One source of the cordless phones expects them to be offered initially in a $520 package deal with pagers for those who don't have pagers already. With pagers, the cordless Telepoint phones come even closer to matching cellular portables. Some experts predict the cordless phone will eventually include pagers as an option (see the sidebar entitled "The Phone of the Future.") The paging option would only add slightly to the weight and $15 to $30 to the base price. If Telepoint takes off as expected, the cost of the cordless phones without pagers could drop to only $120.

By purchasing a $375 base station for one's home or office, the same cordless phone could be used there. A base station installed in the home or office and tied into the public phone network permits Telepoint subscribers within range to receive calls. When they are on the move, Telepoint subscribers can't receive any messages on their handsets.

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Advantages. Telepoint has other important advantages over pay phones: because no coin boxes are required, it would never be unusable because the boxes are full (and thieves would never attack them to empty their non-existent coin boxes); and vandals would not find the inaccessible or well-secured base stations easy targets (they can be mounted out of reach). An epidemic of vandalism of public pay phones is one reason the British are pushing Telepoint. Another is that they depend more on pay phones: 18 percent of households in the United Kingdom (UK) don't have phones, compared to less than 10 percent in the United States.

The first Telepoint base station was installed in Great Britain in the summer of 1989 by Zonephone, whose operating partner is Ferranti Electric. Operating licenses have been granted to three other consortia. Two of the four include American partners. One is Nynex International, an affiliate of Nynex, which owns New York Telephone Company, New England Telephone Company, and a half-dozen cellular phone systems. Its partners are Standard Telephone & Cables Ltd., France Telecom, and the $20-billion-a-year British Telecom (BT), which owns all or part of no less than ten U.S. companies involved in one aspect or other of telecommunications. "Phonepoint" is the designation this consortium has given to its version of Telepoint.

The other American participant is Motorola, whose "Callpoint" partners are Shaye Communications Ltd. and Mercury Communications Ltd., both headquartered in London. The participation of two giant American companies suggests that Telepoint, if successful, could be introduced into the United States in a few years, if the Federal Communications Commission can find a narrow frequency band to assign to it.

Taking on Cellular. Some observers see Telepoint as a competitor to cellular phones, but Barry Moxley, managing director of Phonepoint, told me that it would really serve a different market: users that either can't afford cellular or who would find Telepoint adequate enough for their personal communications needs.

On the other hand, Philip Plail, spokesman for Zonephone, sees Telepoint as potent competition for cellular. He told me that Zonephone expects 40 percent of cellular users to switch to Telepoint once the systems cover major towns, cities, and highways in the UK in about two years. Significantly, Ferranti Electric, which operates Zonephone for one of the licensed consortia, has no cellular interests. The fourth consortium, headed by Barclays Bank, lags the other three and has not yet named its version of Telepoint.

Initially, there will be no interconnection between the four versions of Telepoint. However, in time subscribers to one system will be able to gain access to the Telepoint stations of the other services. And Phonepoint and Callpoint subscribers could access the other service's base stations by becoming subscribers, since these two services support the same cordless phone.

Cellular, of course, has the advantage over Telepoint of providing two-way communications on the move, either in one's car, boat, golf cart, or simply walking down the street. Cellular base stations, which broadcast at up to 20 watts, also offer far greater ranges—miles for some rural "cells"—than the one-watt Telepoint stations.

However, cellular base stations cost a minimum of $400,000 in contrast to only $1,600 to $3,000 for a Telepoint base station. The high cost and complexity of a cellular common-carrier system make for hefty usage charges—as high as 90 cents a minute for "air time" in the United States. That's on top of whatever the phone company charges for the call. (And in the US, when a call is placed to a cellular phone, the air-time charge is added to the phone bill of the party called not the caller; in the UK, the caller pays for air time.) In addition, most cellular carriers assess users hefty monthly base fees of up to $50 on top of usage charges.

The monthly base usage fee associated with Telepoint would be only $13 to $16. In addition, registration or sign-on fees are only about $32, in contrast to cellular sign-on fees upwards of $80 in the U.K., but only $45 in the U.S. And, of course, cellular phones, despite the heavy discounting and steadily declining prices, still cost several times as much as the projected cost of the much smaller, lighter cordless phones used for Telepoint. For instance, in the United States the cost of cellular phones installed in cars has dropped to as low as $400. Portable cellular phones start as low as $500, but can cost up to $3,000 (such as for the marvelous new Motorola MicroTAC, which weighs less than 11 ounces). In general, despite the fact that cellular phones are even more popular in the UK than here, they cost about twice as much there.

Using Telepoint. If Telepoint is a success in Great Britain, a highly likely outcome, base stations would be erected wherever pay phones are now installed; the pay phones would remain in service for those who don't buy cordless phones and subscribe to Telepoint. Users in cars would either stop at base stations or place their calls while their cars are being fueled. Similarly, Telepoint users inside trains or subways would access the system whenever their trains stopped at a station.

In the UK, Telepoint has been assigned the frequency band between 864 and 868 megahertz, divided into 40 channels each 100 kilohertz wide. The initial Telepoint base stations will support only one or two channels at a time. However, stations able to support 40 channels simultaneously could be manufactured if demand takes off. Each base station is equipped with a memory that is frequently updated with the identification numbers of Telepoint users who have not paid their bills or have suspended service.

To access a nearby Telepoint base station, a user hits the access button on his or her cordless phone. A computer-generated message dispatched by the base station asks for the user's ID, which he or she keys in. If not on the "blacklist," the user is given access to a

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The Phone of the Future.

Telepoint is a big step towards the phone of the future. The lightweight folding unit would respond to voice commands, accept voice messages and digital data, and even forward commands to home-management systems. The concept for the 21st-Century device is the subject of a major research and development program at the British Telecom's renowned Martlesham Research Laboratories near Ipswich.

An American firm has already patented a device that offers one function of the phone of the future: Activus, Inc., has developed a portable, cordless, pocket-sized answering machine. According to Richard J. Helferich, president of the Chatsworth, California-based company, the solid-state device would weigh five ounces and its battery should last six months. In use, it would be connected to a cellular or house phone or pager. It is about a year from production. ■

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AUGUST 1990

GIZMO®

VOLUME 3, NUMBER 8

A CHRONICLE OF CONSUMER ELECTRONICS

Gizmo Comes out of the Dark Ages

NORTHGATE SLIMLINE 320 80386 COMPUTER SYSTEM. Manufactured by: Northgate Computer Systems, Inc., P.O. Box 41000, Minneapolis, MN 55441. Price: From $2499.

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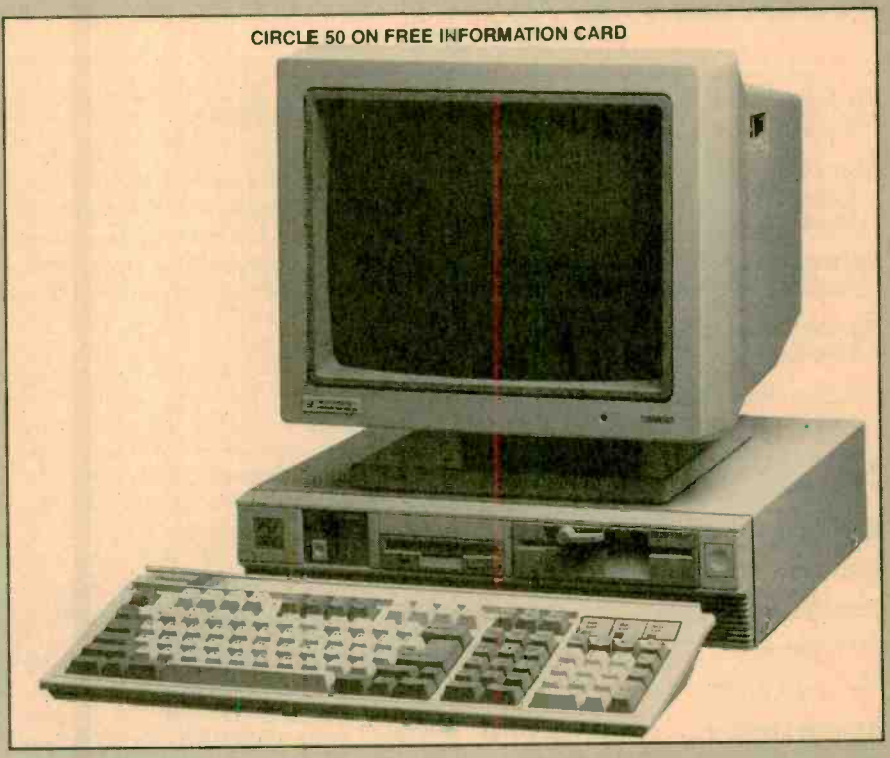

We're ashamed to admit it, but the truth had to come out sometime. All this time we've been expounding on the mysteries of high-tech electronics, we've been preparing GIZMO on a clunky old 8088-based XT-type computer. Certainly, we've upgraded the system from time to time, replacing the 8088 with a more efficient NEC V20 microprocessor and—at some time way back in our prehistory—adding a 20-megabyte hard-disk drive to supplement the two 5¼-inch floppy drives. That system has served us well, and has been responsible for several books, innumerable articles, and *tons* of GIZMO! And for just plain "making words" it's more than adequate. Still, every so often we get the urge to put the pedal to the floor ... and nothing much happens.

For a long time we've poo-poo'd speed, saying that our old system got us where we wanted to go very well (sounds like your great-aunt talking about her 1964 Dodge, doesn't it?) and that we didn't need any more. Still, in the evening we'd leaf through the ads in the back of the computer magazines and calculate how much it would cost us to put together a zippy little 386 system. We figured we could do it for about $2700, buying a bit here and a bit there. Then we saw the ads for *Northgate's* 20-MHz 386 system, designated the *SlimLine 320*. The whole thing—including MS-DOS 4.0, GW BASIC, and a bunch of utilities—was just under $2500, ready to go. Wow!

What do you get for that kind of money? You get a lot. To start with you get a real 80386—not an -SX, that half-hearted little 32-bit/16-bit halfbreed microprocessor. Running at 20 MHz—not breakneck speed, but enough to make operations such as running Microsoft Windows and spell-checking long files a lot less tedious than they were on our old system. You also get a 40-megabyte IDE hard-disk drive that has a 28-millisecond average access time (our old drive's record was 65 milliseconds) and uses a 1:1 interleave and 16-bit data format for fast data transfer.

Northgate also includes two floppy drives in the SlimLine 320—one for 5¼-inch floppy disks, and one for 3½-inch plastic-encased "firmies." Both drives are double-sided high/low density (1.2 Mb/360K for the 5¼ one and 1.44 Mb/720K for the 3½-inch one). Northgate has cleverly added a couple of lines to DOS' CONFIG.SYS file that allow you to do high- and low-density formatting by treating each drive as *two* logical drives—for example, the 5¼ inch drive is "A:" for high-density purposes, and "D:" for low-density formatting.

We were afraid that to achieve the system unit's small size—just 16.5 × 16.5 × 3.85 inches—Northgate would have to make some sacrifices inside. Instead, they applied a little ingenuity and provided five expansion slots (two 8-bit and three 16-bit) that accept ordinary—not PS/2-type—expansion cards *horizontally*. Getting the 8-bit cards in required a bit of ingenuity on *our* part—we finally had to remove the power supply (a minor operation requiring only the removal of six screws) to allow us access to the screws that we needed to get at—but after that there was no problem. We were at first concerned about the relatively few expansion slots—the venerable old pre-IBM Imsai computer of the late 1970's, which you may have seen flashing its front-panel lights in the movie *Wargames* a few years ago, had around 20 slots. But the SlimLine 320 has plenty of expansion capability for most purposes and its 100-watt power supply should easily be capable of meeting the requirements of any boards you can plug into the expansion backplane.

Even many of the things that would have

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CIRCLE 51 ON FREE INFORMATION CARD

Z-o-o-o-m!

SONY ECM-Z157 AND ECM-K57 CAMCORDER ZOOM MICROPHONES. Manufactured by: Sony Corporation of America, One Sony Drive, Park Ridge, NJ 07656. Price: $99.95 (ECM-Z157), $69.95 (ECM-K57).

Some time ago, when we were writing about the extended zoom capabilities of some camcorder or another, we lamented the current unavailability of a companion zoom microphone to go along with it. There used to be one or two, but they seemed to have disappeared. Well, "seek and ye shall find." All of a sudden we found ourselves inundated (in a manner of speaking) with information on current-production zoom mikes.

We were disappointed with what we found out about most of them—the methods they used to realize the zoom effect didn't appear as though they'd be very effective, or as though they were very sophisticated either. We had a particular—and rather elegant—theory of operation in mind, and wanted a mike to match it. *Sony*, we discovered, has two microphones that measure up to our rather stringent criteria. We tried out the *ECM-Z157* continuous-zoom microphone and its lower-priced, two-positions-only cousin, the *ECM-K57*. They work, and they have an additional benefit that is not immediately obvious, but which we shall bring to your attention, of course.

The microphones, which use electret elements and are powered by a single "AA"-size dry cell, come with a short coiled cord terminated in a gold-plated mini plug that goes into your camcorder's mike jack. When that is done, the plugged-in mike takes the place of the one built into the camcorder. Built into the base of each is a T-shaped fitting that slips into a camcorder's "hot-shoe"-type accessory holder and can be snugged down to keep the mike in place.

A switch on the side of the mike controls the zoom effect; on the ECM-Z157 it's a slide switch that can be moved between icons suggesting a supercardioid ("telephoto") pickup pattern and one indicating a broader cardioid pattern for "wide-angle" purposes. At the wide-angle extreme of the switch's travel is a third icon representing a more-or-less omnidirectional pattern. The icons at the two positions of the ECM-K57's switch represent cardioid and omnidirectional pickup patterns. For the sake of simplicity, we'll confine ourselves to a discussion of the operation of the somewhat fancier ECM-Z157.

Some zoom-type mikes use a single element with filters—an inexpensive and not very effective way to achieve a pseudo-zoom effect by restricting the frequencies picked up in the telephoto position to those expected to be of most interest to a viewer, namely those of the human voice (approximately 300-3000 Hz). More professional, and expensive, "shotgun" mikes use two cardioid elements, one behind the other. Sony's ECM-Z157 design incorporates three elements—two cardioid and one omnidirectional—to cover the range from telephoto to wide angle.

The supercardioid "telephoto" pickup pattern results from the spacing of the two in-line cardiod elements. That spacing is such that sounds of mid- (and some low-)range frequencies impinging on the elements reinforce each other. The principle is the same as that used in lasers or in directional radio antennas. By spacing the elements so that the incoming sound waves are in phase at both and reinforce one another, a highly directional, or supercardioid, pickup pattern is achieved. At the other end of the range, the omnidirectional element alone provides a "wide-angle" effect. Between the zoom switch's two extremes, the outputs of the two sections of the mike are summed to various degrees to provide the equivalent of pickup patterns between telephoto and wide angle.

The instructions for the mikes instruct you to use them in the "omni" mode to cut down on wind noise. That feature is not the reason you would normally purchase a zoom mike, but it intrigued us. We tried it

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You Can Take it With You

MARANTZ PMD430 PORTABLE STEREO CASSETTE RECORDER. Manufactured by: Marantz Company, Inc., P.O. Box 2066, Aurora, IL 60507. Price: $599.

From time to time we've looked at personal portable cassette players that can also record. They can come in very handy if you want to do something like tape an interview or record memos to yourself. You can even use these little portables to record music. However, if you're really serious about the quality of your recordings you need more than can be squeezed into a little wear-it-on-your-belt-sized package. There are only a few companies producing portable recording equipment of professional, or near-professional, caliber. One of them is *Marantz*, whose *PMD430* portable stereo cassette recorder we recently had the pleasure of using for a while. It offers near-professional performance in a reasonably priced package.

Of course, *real* professional equipment still uses reel-to-reel technology, but what you can get onto and off a cassette these days is not bad at all if you go about it the right way.

One of the big problems that goes along with cassette recording is tape noise and a not-so-hot signal-to-noise ratio. That's why most cassette recorders incorporate a noise-reduction system of some sort—usually Dolby B or its more advanced offspring, Dolby C. The PMD430 doesn't have Dolby C, but it does have Dolby B noise reduction as well as something even better, for our money, than the "C" system. That's dbx, a very effective noise-reduction system that's been widely used in professional analog-recording systems for years (its use predates that of Dolby systems) and can—increasingly, it appears—be found on a number of home analog cassette decks as well.

Like Dolby, dbx is a companding system. That is, it compresses the audio signal when it puts it on tape by increasing its level in certain critical bands, and then expands it again to restore the normal balance during playback. The Dolby systems restrict their processing to certain bands of frequencies—two of them in Dolby B and three in the "C" process—but dbx is a straight-across-the-board companding system, squeezing down everything within its range by a factor of two-to-one. That's a lot, and it makes listening to a dbx tape without the proper decoding quite unpleasant. However, it does render tape noise virtually undetectable and also has the advantage of providing a cassette recording with a dynamic range of more than 105 db—that's right up there with CD's and other digital recordings! Why don't more people use dbx? We don't know. There are a few dbx-encoded records around, though, and television's MTS stereo system also uses dbx noise reduction.

For those who prefer more conventional noise-reduction techniques, there is, as we've noted, Dolby B. However, while with Dolby you have to keep an eye on the record-level meters—yes, the PMD430 has two VU meters, and no automatic level control—to make sure they don't go more than three dB or so into the red, with dbx you can pin the meters and still not distort the recorded signal. A peak LED flashes to indicate transients too brief to register on the meters. If you are still concerned about the effects of high signal levels, there is a limiter that can be switched in, as well as a two-step attenuator at the mike inputs. The Dolby noise-reduction system used in this recorder is referred to as "Double Dolby," but that should not be taken to mean that two different Dolby systems are included. Rather, the term refers to the fact that a second Dolby B system is provided for off-the-tape monitoring, which we shall discuss below.

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In the same compartment with the noise-reduction selector switch is one that allows you to bring a multiplex (MPX) filter into play when recording directly from an FM tuner while using Dolby B noise reduction. The 19-kHz pilot tone used in FM-stereo broadcasting can confuse the Dolby system (it thinks someone's hitting a really high note) and affect its workings. The filter cuts things off below that point. You don't really lose anything, since there's virtually nothing above 15 kHz—besides that pilot tone—in a stereo broadcast anyway. Also in the compartment is a tape-type (FeO_2, CrO_2, or metal) selector, a fine adjustment for recording bias, and a pitch adjustment for playing back tapes that may have been recorded slightly off-speed.

Further adding to its professionalism is the PMD430's three-head design. A three-head recorder has a couple of significant advantages over the less expensive and more prevalent two-head ones. First, the design eliminates the compromises that have to be made when the record and playback functions are combined in a single head. With a separate head for each function, the windings and gap sizes can be optimized, adding a couple of kilohertz to the range of frequencies that can be recorded. Second, having a separate playback head means that you can monitor, *from the tape*, what you are recording as you are recording it. If there's distortion, or another problem that will show up when the tape is played (but that is not apparent if you monitor just the signal being input to the recording electronics), that will bring it to your attention. A headphone jack with its own volume control is provided for that purpose, as well as for listening to playback. There's also a small monitor speaker built in, should you prefer to use that. Through it, you can listen to either the right or left channel, or to a monophonic mix of both.

Other inputs and outputs include a pair of ¼-inch mike jacks (input impedance is 10K). If you use a dual-element stereo mike with a single cable and plug, connecting it to the left-channel input will get the stereo signals in properly. A pair of RCA-type phono jacks each satisfy line-level input and output requirements. There's also a DIN-style connector.

The tape-transport controls are mechanical, but require little pressure to operate. The counter, too, is mechanical. A memory rewind function allows you to return the tape to a resettable-counter position of 000 to return to a position you have marked.

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As you might suppose, this piece of equipment is a little larger than a personal-portable style unit. It measures 9 × 2 × 8 inches—a bit large to stuff in your pocket—and weighs three pounds. That's still not much, though, considering what's inside. A snap-on webbed shoulder strap makes carrying the unit, or using it on the move, convenient. Power comes from three "D"-size dry cells that reside in a built-in compartment and that last for six hours or so. An AC adapter is also provided with the recorder, and a rechargeable battery pack is available as an optional extra. The pack is recharged by the AC adapter and does not have to be removed from the recorder for that purpose.

We took the PMD430 and an EC33-S one-point stereo mike (which Marantz kindly lent us along with the recorder) to a local restaurant that provides its patrons with live entertainment on weekends. The results, when we played the tape back at home, were excellent. What we got upon playback was what we had monitored through the phones at the restaurant and, except for the music and the usual dining noises, was quiet. There was no hiss discernible at all—a tribute to dbx—and the dynamics of the performance were reproduced faithfully.

We have been told that this recorder is finding widespread use in legal firms for such things as taping depositions. Why the lawyers need such a fine piece of equipment for that purpose is not for us to understand—maybe it's to justify their fees—but they seem to like it. The Marantz PMD430 will be of even more value to you if you need a recorder for field work, be it interviews for broadcast use, making "living history" tapes, capturing wildlife sounds, or capturing the sounds of the "wild life." In its price class, it's a fine machine. ■

NORTHGATE COMPUTER

(Continued from page 1)

required expansion slots in IBM-style computers a few years ago are included on the Northgate computer's system board. There are, for instance, two serial ports and one parallel port, as well as a clock and disk-controller circuitry, built in. There's also a 16-bit VGA adapter on board, which takes care of your color or monochrome video requirements. The $2400 base price includes a 12-inch monochrome VGA monitor, but color displays are also available from Northgate (or other sources, if you prefer). By adding more video RAM (the 320 includes 256K on board) you can get color resolutions up to 1024 × 768 pixels using an appropriate monitor.

Speaking of RAM, the SlimLine 320 ordinarily comes with one megabyte of memory. Depending on whether you use 256K or 1-Mb SIMM's—Single In-line Memory Modules—you can expand the system to two or eight megabytes without adding any extra boards. The top 384K of the megabyte that comes with the computer is set up by Northgate to act as a disk cache to provide faster operation, but removing or disabling a single line in the CONFIG.SYS file eliminates the caching function and allows you to utilize that RAM for any purpose.

Finally, the keyboard that Northgate provides with the SlimLine 320 is its own OmniKey Plus, a worthy successor to the OmniKey 102 we reviewed in **GIZMO** about a year ago. While we would not go so far as to say that this excellent keyboard is by itself reason enough to buy the computer, it certainly adds to its value.

We had no difficulties in running any of our software—including *Flight Simulator*, supposedly the ultimate test of a well-behaved BIOS—on the SlimLine 320. Northgate's BIOS is produced by AMI, the same company that provides Compaq's. The only peculiarity we could find was the system's tendency to turn on the keyboard's Num-Lock function whenever it was booted up. Accountants and engineers may appreciate that; we included a line in our AUTOEXEC.BAT file to turn it off.

Most of Northgate's sales are made by mail (although there are three factory outlet stores in the company's home state, Minnesota). Do not, however, let what may appear to be a lack of support when you need it influence you into turning away from this computer. Northgate maintains 24-hour, 7-day, toll-free customer- and technical-assistance hotlines. When we had a problem getting Windows 386 to run on the 320 we spoke with a very knowledgeable technical-support person at Northgate, who patiently waited and provided advice as we worked our way through several potential solutions.

Well, what about the speed? Certainly, there are faster computers around, some of them even made by Northgate. Still, we subjected the 320 to the usual Norton speed tests, and it came out with a respectable overall Performance Index of 17.1. That test, by the way, factors in the performance of the hard-disk system. The Computing Index, which does not use the disk drive, was calculated to be 21.5. That's not bad at all (the figures are relative to an IBM XT running at 4.77 MHz). A turbo button on the front of the system unit, right alongside the one marked reset, allows you to halve the clock speed to 10 MHz.

To tell the truth, we sometimes missed our old system's "relaxed" operating speed. It used to be that when the computer was off making a list of all the misspelled words in one of our 68K **GIZMO** files, we had time to go into the kitchen and get a cold drink. Not so with this Northgate system! It's kind of like the difference between motoring and turnpike driving. ■

SONY MICROPHONE

(Continued from page 2)

out on a windy spring day and, sure enough, it worked! In the telephoto position, our words, at a distance of about 20 feet from the mike, were almost completely lost behind the noise of the mike element being battered by the air. At the omni setting, though, only an occasional wind rumble made it to the tape.

We would have expected things to work in just the opposite fashion—that the omni setting would have picked up a lot *more* wind noise than the more tightly focused telephoto one—and queried Sony as to why the mike worked the way it did. After following several false leads, we finally got an answer that seems to make sense.

One of the design features that differentiates the mike's two cardioid elements from the omnidirectional one is the inclusion of a small hole at the back of the cardiod-element capsule. The purpose of that hole is to permit sound waves to enter the capsule from the rear and strike the mike element from behind as well as from the front. The design of the capsule is such that sound waves from the sides and rear that enter through that hole cancel sounds from the same sources that affect the front of the element. That contributes largely to the cardioid nature of the element's pickup pattern. The omnidirectional mike has no such hole, so its response through 360° is more even.

Now, according to Sony, wind noise is not as well-phased as the type of sounds that the mike is intended to pick up. That may be because while the latter are generated at some distance from the mike and reach it only as waves in the air, the mike element itself is an active participant in the generation of wind noise.

In the case of the microphone's cardioid elements, moving air can enter through both the front and the rear. Since the front and rear noise signals are generated directly and independently, and there is no phase relationship between the two, there is no signal cancellation—in effect, you get two sources of wind noise for the price of one. In the case of the omni element, though, wind noise is generated only at the front. The difference in wind noise between zoom and omni modes is readily apparent and, in fact, seems to be greater than the factor of two you might suppose.

Neither the ECM-Z157 or its fixed-position relation, the ECM-K57, will take the place of a wireless mike, which is effective over a much greater range. However, neither involves the complications frequently associated with the use of such equipment. If you are a videomaker who finds yourself for one reason or another shooting from farther away than you would like, one of these mikes could be just what you've been looking for to get you closer to the sound. ■

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How Simple Can You Get?

TOSHIBA MODEL 3200 FACSIMILE MACHINE. Manufactured by: Toshiba America Information Systems, Inc., 9740 Irving Boulevard, Irvine, CA 92710. Price: $995.

CIRCLE 53 ON FREE INFORMATION CARD

If you're a regular **GIZMO** reader, you've probably gathered by now that one of the qualities we often look for in a product is affordability. When we heard about *Toshiba's Model 3200* fax machine with a list price of under $1000 (and undoubtedly available for several hundred dollars less at discount outlets) we thought, "What a great unit for a home office, where budgetary considerations may outweigh other factors!" After some time with this machine we think that maybe we should reweigh those other factors.

Let's get something straight from the beginning. If you want a fax that will just send and receive material, that and not much more, this machine may satisfy your needs. Our problems stemmed from what seems to be a difference in opinion over the definitions—as they are applied to a machine like this—of terms such as "simple," "easy-to-use," and "user-friendly." Note that Toshiba does not use those terms in its description of the 3200; however, we'd be willing to bet that that's what was floating around the back of their collective mind when they designed this unit. The end result does not reflect that thinking.

On paper, the 3200 fax machine has a lot to offer. Among the features listed on the box in which it comes (and intended, we suspect, to be an attention-getter on discount-store shelves) are: polling ("lets you collect documents from unattended facsimiles, and allows them to collect documents from you when you are not there"), auto-switching (the unit will act as a fax or a phone, depending on the nature of the incoming call), and transmission of terminal identification (date, time, page number and your ID on every page you send). Neat stuff, huh? Well, every one of those features has a "gotcha!" that you don't discover, of course, until you've unpacked the machine and tried to decipher your way through its inexcusably bad manual. There is a toll-free "help-line" number on the back of the manual, and good thing, too ... you'll probably need it. The number listed on our manual, though, had been changed. Fortunately, Toshiba was considerate enough to arrange with the phone company for a recording with the new number. The gentleman at the other end of the line, when we finally got through, was most helpful and provided us with answers to our questions. A typical answer, though, was usually, "No. It doesn't (*or* you can't) do that." Oh yes, and the page numbers in his manual differed from those in ours.

Let's start with the polling feature, which you might want to use to keep your phone bill down by doing your faxing in the evening or at night when phone rates are lower. It's true the 3200 will, if set up properly with a document (or documents, up to seven of them) to be sent in the hopper, fax it to a machine that calls in, but outgoing faxes are another matter. All the 3200 can do is call another fax system and request it to send a document that is waiting in *its* hopper. Of course, when you stop to think about it, not much more is possible if the other machine is unattended.

Unattended polling from *your* end? Far from it! If you want to take advantage of the low phone rates at 2:30 in the morning, you're going to have to set the alarm on your bedside clock (or camp out in your office), rouse yourself at the appointed hour and dial the phone yourself! The 3200 has no facility for doing that for you. Send faxes automatically to several fax machines in sequence? Forget it! (We hadn't really expected that feature at that price, but the term "polling" got us excited for a while.)

Programming the 3200 is an experience we could have done without. Perhaps to avoid cyberphobia (fear of programming) among the general populace, Toshiba has eliminated pushbutton programming and replaced it with typing-paper-size optical-mark-reader (OMR) sheets. These may remind you of the IQ and aptitude tests you were given when you were in school, where you had to use a black pencil to carefully fill in little boxes representing the numbers of the correct responses to multiple-choice questions. The marked-up answer sheets were later sent off to a big IBM computer somewhere, where they were scanned and your test results calculated. Our guess is that Toshiba expects your resident fax-and-computer *maven* to fill in the sheets for the rest of the cyberphobic office staff, whose only responsibility is to then feed them into the machine.

There are two different types of OMR sheets. One type allows you to program up to 20 characters (and spaces) of user ID to appear on faxes you send. A single sheet is good for ten characters; you have to use two for 20 and remember to mark one as the first sheet and one as the second. The other type of OMR sheet sets up fax functions such as journal (a transaction log of the last 20 calls), ring delay (how long to wait on auto-answer before picking up the phone), TTI (whether or not to transmit user-ID information), contrast, resolution, date, and time. The resolution setting is the only one that can also be set without using an OMR sheet.

Toshiba supplies you with enough OMR sheets to do all that—once. You get one function sheet and two ID sheets (that's in case your ID runs longer than 10 characters). The manual says that if you erase carefully and don't smudge you can reuse the OMR sheets. You cannot, though, duplicate filled-in sheets because Toshiba says the machine won't read photocopied markings. And the little boxes

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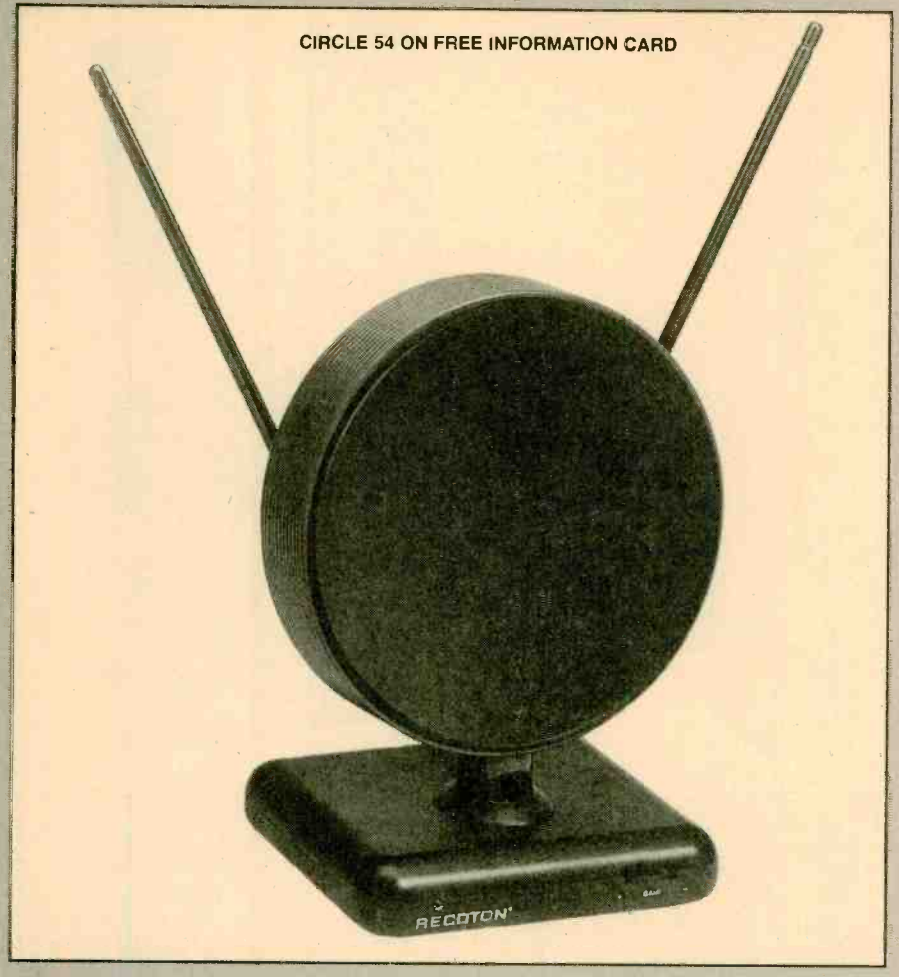

The Long and the Short of It

RECOTON POWER WAVE TV600 INDOOR AMPLIFIED ANTENNA. Manufactured by: Recoton Corporation, 46-23 Crane Street, Long Island City, NY 11101. Price: $89.95.

Not everyone has cable TV service. And not everyone—apartment dwellers, for example—can put up an outdoor antenna. For such people, the only solution to good TV reception is an indoor antenna. The same applies to reception of FM programming, only even more so—it is rare to find FM brought in by cable; unless you're extremely fortunate, you have to provide your own antenna.

There are lots of indoor TV antennas around—unadorned three- or four-dollar rabbit ears, "magic" antennas that plug into the wall and supposedly use house wiring to pick up signals, and even antennas shaped (no one quite knows why) like miniature satellite dishes. *Recoton* has a variation on the rabbit-ears theme that gives you a little more than the plain-vanilla kind.

The *Power Wave TV600* is, basically, a set of rabbit ears with an amplifier. It looks something like a huge vertical hockey puck from which sprout two telescoping whips. (With the whips fully collapsed, the device reminded us of Ray Walston's "Uncle Martin" character in the old TV sitcom *My Favorite Martian*; Uncle Martin sometimes showed up with little antennas sticking up out of his head.) The "hockey puck" can be tilted and swiveled. That feature allows you to "move" the antenna without actually moving it, a worthwhile feature in view of the antenna's bulkiness.

For an indoor antenna, the TV600 is enormous. Part of that is due to the UHF antenna that's enclosed by the "hockey puck," but the telescoping whips themselves are longer than most others we've used. Struck by the antenna's outsize appearance, we took a ruler to it. One of the elements, fully extended, measured 43½ inches. We then checked one of the whips built into an old portable TV we keep around, and found that it was only 31 inches in length. Finally, we dug an old set of rabbit ears out of a closet and discovered that, at full extension, one of its elements was 35 inches in length. We suppose that the optimum length for an element of any antenna depends on the target frequency decided upon by the manufacturer. Well, at least you can make a long element shorter; you can't stretch one that's too short.

The TV600's telescoping elements, we noticed, are anodized black; perhaps that was done to make those elements seem smaller.

The Recoton antenna has built into it a three-stage, variable-gain VHF amplifier and a UHF amplifier, both apparently designed by Larry Schotz. Mr. Schotz is the man who designed and holds the patent on the Schotz tuner found in a number of FM receivers. Under adverse reception conditions, the tuner can emphasize the mono (L + R) portion of a multiplex stereo signal while processing less of the stereo (L − R) portion—which is AM, not FM—and which brings in a lot of hiss when signals are weak. That reduces background noise. Of course it also reduces separation. In our opinion that tuner design is well-suited to autosound applications, but is of rather dubious value in the home installations in which it is largely found.

An amplifier in an *indoor* antenna? Well, why not. Even in town, you sometimes need all the help you can get. Of course, all the added gain makes the antenna better at passing along to your receiver any interference it picks up—the refrigerator motor starting up, for instance—but as long as that's only momentary perhaps you'll be able to live with it. Power for the amplifier, by the way, comes from a plug-in AC adapter. Although the antenna has an on-off switch, you can safely leave it on all the time—it draws only 50 mA. The amplifier also seems capable of negative gain—either that or the unit we received was extraordinarily insensitive at the lower limit of its amplification range. If you live in a very strong signal area, or are plagued by ghosts caused by signal reflections (which may be weaker than the signal arriving directly at the antenna) reducing the gain might make for better reception. Unfortunately, we live in a ghost-free area, so we could not test that feature.

In addition to providing coverage of the VHF and UHF TV bands, the TV600 also functions—and pretty well, we might add—as an FM antenna. That makes sense, since the VHF band is split into two parts between TV Channels 6 and 7 and, among the other things found in the gap, are the frequencies between 88 and 108 MHz; that of course, is the FM broadcast band.

The Recoton antenna worked well for us while we had it, although we did have to keep the elements pretty well extended to get the noise out of the picture. We have so much hardware floating around here that an oversize antenna or two doesn't make much of a difference, one way or the other, in the way things look. If you're planning to use this antenna in a small apartment, though, you'd better reserve a tall bookshelf for it. ■

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3-D TV: AN IN-DEPTH REPORT

3-D TV MODEL 2001 HOME STEREO THEATER. Manufactured by: 3-D TV Corporation, Box 13059, San Rafael, CA 94913-3059. Price: $189.95.

CIRCLE 55 ON FREE INFORMATION CARD

It seems that whenever a 3-D movie appears there are always crowds waiting to get in to see it. Movies in 3-D are a lot rarer now than they were during their heyday in the '50's, but they still show up from time to time. A few years ago there was a revival of black-and-white 3-D movies on TV; you went down to a local fast-food outlet and picked up a pair of the red-and-green-filtered cardboard viewing "glasses" for a dollar. If you didn't get there fast, there weren't any left.

There haven't been any 3-D movies on broadcast or cable TV lately, but now with the *Model 2001 Home Stereo Theater* from California's *3-D TV Corporation* you can have them at home from your VCR any time you want. The system comes in what's billed as a "Video LunchBox," containing the StereoVisor viewing device, a sample 3-D cassette, and the StereoDriver, which connects the visor to your VCR. A deluxe LunchBox containing two StereoVisors (up to four can be connected to a single driver box using two-to-one mini-plug adapters) and two sample cassettes is available if you want to share the experience with a friend. You can pack up all your equipment in the lunchbox and carry it over to her house for an evening of 3-D thrills and chills.

This is no red-and-green-cellophane system. The 3-D TV system gives you full color! And now comes the point where we digress briefly to a discussion of how 3-D films are created. If all you're interested in is how well the unit performed, you may as well skip to the end.

Stereoscopic films require that two images—one corresponding to what the left eye sees, and one to that seen by the right eye—be recorded. Sometimes two separate cameras mounted side-by-side are used, and sometimes a complex system of optics is used to record the left- and right-eye images on the same piece of film (typically one image above the other). That's the easy part. The hard part comes in turning those two two-dimensional images back into a three-dimensional one inside your head.

What has to be done is to keep your left eye from seeing the right-eye image, and vice-versa. If you use a device similar to a View Master viewer, where the two images are separate and where each is channeled to the proper eye via its own optical system, the problem is easily solved. That type of stereopticon viewing system, though, restricts enjoyment of a stereo production to a single person at a time. In black-and-white (more properly, monochrome) motion-picture stereoscopy, the two images are projected on a single screen, one through a red filter and one through a green one. Red and green being complementary colors, one cancels the other. If you view the movie screen through a pair of those cardboard-frame glasses your red-filtered eye sees only the red image, and the green-filtered one the other. After what may be a brief period of protest, your brain accepts the left-and-right-eye information as "real" and you think you're seeing a movie in three dimensions.

Color is another matter, though. If you use colored filters in front of your eyes, the colors recorded on film will be distorted. (Although, during the recent TV 3-D revival, some freshly taped introductory sequences could be seen stereoscopically in color through the fast-food glasses.) Traditionally, color 3-D films have been projected through polarizing filters, with the light for one image polarized 90° away from the light for the other. Viewing through cross-polarized lenses, which block from one eye the image intended for the other, a viewer perceives a three-dimensional image. A bit dim, but three-dimensional.

That method won't work at home on a color TV set (unless you own two front-projection TV's) since a conventional color CRT doesn't generate polarized light, not to mention light with two different polarizations. Another method must be used to keep the left- and right-eye images separate.

The solution, at least for the moment and the one used by the 3-D TV process, is to use a field-sequential system. In the normal NTSC television system used in this country and a few others, thirty frames of video are displayed per second. Each frame consists of two fields of video lasting 1/60 second apiece. One field uses the even-numbered scan lines, the other the odd-numbered ones. Interlaced, they provide a flicker-free picture. What the 3-D TV system does is to assign one set of fields to the stereoscopic left-eye images, and the other set to the right-eye ones. The images alternate—left, right, left, right—whence the term "field sequential." Then all that remains to be done is to keep one eye from seeing the other's pictures.

That is the purpose of the StereoVisor, which fits over your eyes somewhat like a lightweight welder's helmet—there's also an "eyeglass" version if you're concerned about messing up your hair—and is connected to your VCR's video out jack by a small box that synchronizes its operation with what appears on the screen. Each "lens" of the visor is actually a sheet of liquid-crystal material. By applying an electric potential to that material, it can be made to change its polarization and, if a piece of cross-polarized material is also included in the light path, light is blocked. Therefore, when voltage is present, light is blocked; when it's not, light passes. If light to the left eye is blocked while the

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right-eye image is present, and vice-versa, each eye gets the information intended for it. Again, the brain considers that and (usually) decides that it's seeing a stereoscopic picture.

The process is not perfect, its principal disadvantage being flicker. The NTSC system uses 60 fields per second precisely because that scheme *eliminates* flicker. When each eye sees only 30 fields per second—each one separated from the next by 1/30-second of black—the result is less than ideal. The phenomenon shows up best (or worst) in light areas of the picture, and the manufacturer of the 3-D TV system suggests you turn down your TV's brightness as much as you can. Since the lenses in the visor cut out some light even when they're not polarized, we didn't find that to be a very practical suggestion. As much as possible, we let ourselves be mesmerized by the 3-D effect, and ignored the flicker.

We had a lot of fun using the 3-D Home Stereo Theater. The manufacturer provided us with a couple of "sampler" cassettes as well as a tape of a portion of a 1950's western shot in 3-D, and an animated 3-D short. The stereo effect was variable, and depended on the care with which the film had been made. Sometimes it was barely there; sometimes the left and right camera lenses had been set so far apart that the slightest variation in distance from the camera resulted in an exaggerated and very artificial look—in a couple of clips from the sampler cassette people's heads and necks took on the appearance of those of turtles; they always looked like they were craning to hear or see something. Still it was fun, especially when objects seemed to float right out of the screen.

Stereoscopic movies have not been noted for the quality of their photography or acting, nor for their lavish budgets. (There are a few exceptions—Alfred Hitchcock's *Dial M for Murder*, for one.) Apparently, backers rarely want to put a lot of money into 3-D productions, and it shows. Just about everything we saw was of "B-picture" quality—except for the material that was worse. A lot of what's available comes from the '50's, although a number of items listed in the 3-D TV catalog were produced in the '80's.

While you can purchase a Video LunchBox, as well as cassettes (about $50 each for VHS, $60 for Beta and 8mm), if you're fortunate you can go down to your local video-rental place and take home a system and tape or two just for the evening. Then, having had a diverting and entertaining experience, you can return to normal video until the 3-D urge strikes you again. In view of their technical and artistic achievement, we would certainly not want 3-D movies as a steady diet. But they are different. ■

SIMPLE FAX

(Continued from page 5)

you're supposed to fill in carefully with pencil are printed in a light color known as "non-repro blue," which means that they won't show up when run through most reproduction processes ... including photocopying. The 3200 works as a copier, but it won't copy those blue boxes. Anyway, pencil marks don't take well on fax paper.

You can get more OMR sheets from your local Toshiba dealer. However, we did a quick check of the Yellow Pages in the phone book of the community where we're writing this review, and there's no Toshiba dealer listed. Well, you can also order them from Toshiba directly by mail (card enclosed with the machine) or by calling a toll-free number. Imagine this scenario:

"Hello, Toshiba? I'm calling long distance from Pitcairn Island. Right, way out in the Pacific where the Bounty mutineers were put ashore. My 3200 fax just arrived yesterday and I need a package of OMR sheets ... the ones that came with it got ruined by the salt water.

"Federal Express? No, I don't think so. The next boat? Sometime in February ... maybe March ..."

Our manual (we understand that there are later, possibly clearer, versions) included a note at the bottom of the section on function-programming that looked as if it had been transcribed directly from a piece of paper that was paper-clipped by a technical editor to the original manuscript. It read:

"NOTE: Somewhere there should be an indication that an (*sic*) preset functions can be overridden by manual pushing of keys."

When we called Toshiba we asked, "Keys? What keys?" They responded, "Keys? What keys?" So much for bypassing OMR programming.

The auto-switching feature—which you enable using an OMR sheet—allows you to leave the 3200 turned on and, if you don't answer the phone yourself (the machine does have a built-in phone), have the fax machine answer for you. The manual is somewhat unclear about how the process works. But, here comes another "gotcha." Most home offices make use of phone-answering machines to answer the phone when the "boss" is away or after hours. The 3200 does not get along with answering machines at all. First of all, there's no place on the fax to plug in an answering machine. Second, once the 3200 has answered the phone, it seizes complete control of the line (although we must admit that there are many other fax machines that do that, too), and any other device is excluded.

We think that Toshiba has made a serious error in oversimplifying the 3200 to the point where it doesn't do enough, and what it *does* do it does only with considerable inconvenience to you. We're sorry, Toshiba. All we wanted was a nice, simple, inexpensive fax machine. But not *that* simple! At least its output isn't bad, though. ■

ELECTRONICS WISH LIST

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

Northern Telecom Caller-Identifying Telephone

Caller ID Phone

Who's that calling? For areas that are equipped to support CLASS (Custom Local Area Signaling Services), *Northern Telecom* (Northern Telecom Plaza, 200 Athens Way, Nashville, TN 37228) has introduced a phone that can show the number of the originator of an incoming call. The *Maestro* features a digital display panel that allows you to know who's calling (or at least, his phone number) before you answer. In addition, the new phone remembers and displays the numbers of as many as 15 unanswered incoming calls and, with the touch of a button, can call each number back. Since the multi-digit codes required for access to CLASS vary from region to region, the Maestro phone is equipped with a "macro" feature that allows the user to program in the code once, and then recall it with the press of a single button. Also standard are a hold button, handset volume control, and adjustable brackets for wall or desk mounting. Price: $136.

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ELECTRONICS WISH LIST

Stick-'em-Up

If your full-size camcorder is getting to be a bit much to *schlep* around, you may want to try *Sima's* (8707 North Skokie Boulevard, Skokie, IL 80077) *CamPocket* camcorder holster. Based on a smaller (8mm and VHS-C) version that won a design innovation award at last year's summer Consumer Electronics Show, the carrier uses a tough padded-nylon construction with broad, adjustable shoulder and safety straps. In addition to holding the camcorder at the ready, the holster has a pocket for a spare tape or battery pack, and for inclement weather there's a rain cape with drawstring closure. Now what you need is a "shotgun" mike. Price: $47.95.

CIRCLE 57 ON FREE INFORMATION CARD

Sima's Camcorder Carrier

Powerful Car Amp

Harmon Kardon's (240 Crossways Park West, Woodbury, NY 11797) top-of-the-line car amplifier, the *TC600*, can deliver 200 watts of continuous power per channel into four ohms, and is bridgeable to provide 600 watts into the same load monophonically. To deal with the enormous amount of heat generated in handling that amount of power, a method known as "transverse tunnel cooling" is used. The primary heat-producing components of the amplifier are grouped together and mounted directly on a large central heat sink; the preamplifier section is located at the front of the unit, and the regulated power supply at the rear. The heat sink is enclosed in the "transverse tunnel" and a fan at one end draws air into that passage and over the components, and exhausts it from the other. The amplifier remains cool to the touch. The amp includes a continuously-variable-gain input adjustable over a range of 250 millivolts to 2.5 volts for level-matching with either input (preamplifiers) or output (speakers) devices. Frequency response is 10 Hz to 100 kHz. Price: $1300.

CIRCLE 58 ON FREE INFORMATION CARD

Harmon Kardon Autosound Amplifier

CD Changer

The *GCD-MRI* is *Goldstar's* (1000 Sylvan Avenue, Englewood Cliffs, NJ 07632) entry into the CD-changer market. The player uses magazines holding six discs each for a total playing time of as much as seven-and-a-half hours. The unit, which includes a four-times-oversampling digital filter, offers a 32-program memory, six-disc calendar memory, direct-program and multiple-repeat modes, and random-play capability. Price: $269.95.

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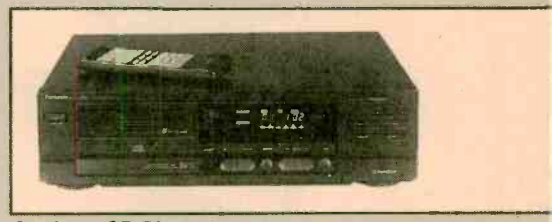

Goldstar CD Player

Satellite Receiver

R.L. Drake's (P.O. Box 112, Miamisburg, OH 45342) *ESR1424* is the flagship model in a new line of satellite receivers. The integrated receiver decoder (IRD) incorporates a full-function UHF remote control and on-screen programming making use of color graphics to simplify the job. A VideoCipher II Plus descrambler is built in. The unit stores 100 audio and 100 video presets, has a parental-lockout feature, and can display program names assigned to various channels. Audio can be received in discrete, matrix, or digital-stereo form, depending on the program source. The IRD includes a built-in actuator system that moves the antenna precisely to any of 50 satellite positions. Switching between C- and Ku bands is automatic. Finally, there's an eight-event VCR timer built in, a terrestrial-interference filter, and switchable audio-bandwidth filters. Price: $1689.

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Drake Satellite Receiver

Portable VCR/TV

The *PV-M429 A/V Pocket Watch* is a combination full-size VHS VCR and flip-up four-inch-screen LCD TV housed in a five-pound (less its rechargeable battery) package. *Panasonic's* (One Panasonic Way, Secaucus, NJ 07094) dictionary-size unit can record from its tuner or from a signal supplied to its separate video inputs. Audio can be enjoyed from a built-in speaker or through headphones. A shoulder strap adds to the little entertainment center's portability. Price: $1399.

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Panasonic Portable TV/VCR

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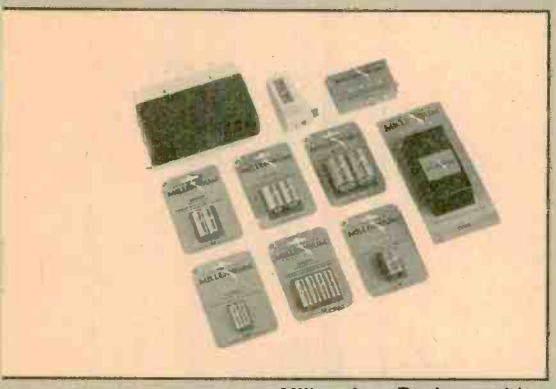

Millennium Rechargeables

Lifetime Guarantee Rechargeables

Gates Energy Products (Post Office Box 23649, Gainesville, FL 32602), which supplies 95 percent of the free world's space satellites with nickel-cadmium and nickel-hydrogen batteries, is now entering the consumer market with its *Millenium Power Cells* line of nickel-cadmium rechargeables. There are five sizes available: AAA, AA, C, D, and 9-volt "transistor"; in addition, ten different rechargeable Millennium nickel-cadmium power packs are designed for after-market replacement of the power packs found in 90 percent of the camcorders currently in use. Millennium cells can be recharged in as little as three hours using Millennium's RapidCharger, and are said to have a 33% longer run time than traditional rechargeables. What really makes these cells different, though, is the fact that Millennium warrants them against failure to accept a charge for as long as the purchaser owns them! If, for any reason other than abuse or misuse, a Millennium Power Cell fails to accept and hold a charge, it can be returned to Gates for replacement. Price: $15 (for a two-position RapidCharger with two "AA" cells), and up.

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Soundesign Juvenile Ionizer

Juvenile Ionizer

No, it's not a disintegrator for unruly brats. Rather, *Soundesign's* (Harborside Financial Center, 400 Plaza Two, Jersey City, NJ 07311) *AC-52* juvenile ionizer is an air purifier and negative-ion generator designed to "keep air in the nursery fresh and clean enough for a baby." The compact (about six inches on a side) appliance has a white, textured finish with a jolly circus clown and three of his friends colorfully depicted on the front. A rotating louver panel directs the air flow to front or back, and a low-high switch controls fan speed. The unit can be set to generate ions or not. Also included are a replaceable electret filter, a washable pre-filter, and a chamber for fragrance or medication pellets. Price: $79.95.

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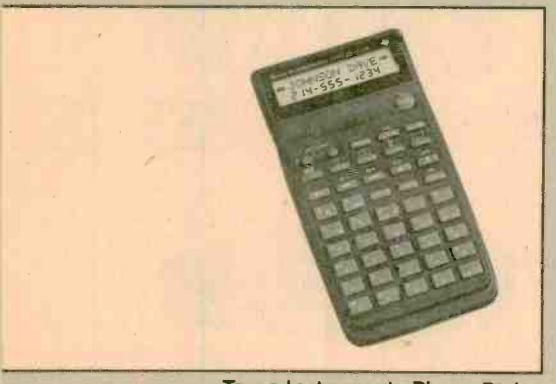

Texas Instruments Phone Dialer

TI Phone Home

The *TI-3200 Pro Dialer* from *Texas Instruments* (P.O. Box 53, Lubbock, TX 79408) is a small, battery-operated (a single lithium cell), calculator-like device that can store 400 names and telephone numbers, each entry up to 24 characters in length. A password feature can protect sensitive information. A "joined" feature allows you to link separate entries (such as a long-distance number preceded by a long-distance access code) for one-button dialing. Two "hot line" buttons can be programmed with emergency or other special numbers. Other features include slow (half-speed) dialing and a "local" feature for travelers that eliminates the area code from an entry. Meant for use with *Touch-Tone* phones, the Pro Dialer is used by holding the unit against the receiver; this, says TI, can be done one-handed leaving the other hand free for note taking and the like. Also included in the five-ounce device are a memo function (up to nine files), phone directory with addresses or comments, appointment schedule, alarm clock, and four-function calculator. Price: $85.

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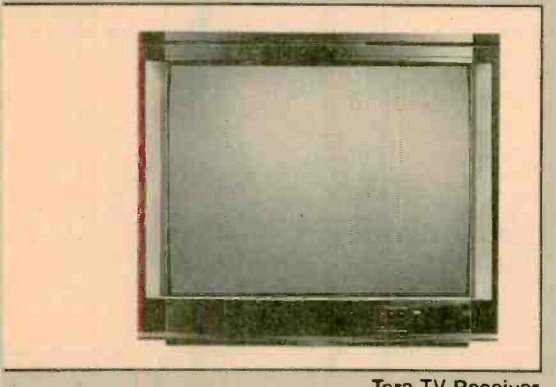

Tera TV Receiver

Super Set

Electronic-compensation circuitry inside the 20-inch *Model 621B* color TV receiver from *Tera* (89 Doug Brown Way, Holliston, MA 01746) is claimed to be the most sophisticated ever built into a TV monitor/receiver. The high-resolution set includes a "double differential" circuit that first identifies the parts of the video signal forming the outlines and edges of objects in the picture and then derives and adds back a peaking signal to provide sharper outlines and crisper edge definition. The high-frequency content of the video signal is also used to control the video amp's bias level, preventing overloading. Other features include an extended black level and gray scale, and video-noise reduction. The set also has an MTS/SAP cable-capable tuner, S-video inputs, comb and SAW filters, and a two-channel eight-watts-per-channel audio amplifier. Price: $999.

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ELECTRONICS WISH LIST

Convertible Clock Radio

The *RS-420 Stereo Clock Radio* from *Proton* (5630 Cerritos Avenue, Cypress, CA 90630) doesn't really become stereo until you add the S-421 stereo extension speaker, but it still has enough to keep you awake and busy for a long time. Among its features are an automatic light-sensor control (with a manual-override dimmer), a snooze function, a stereo-headphone jack, and two separate alarm systems. The alarm can be set for low, medium, or loud volume, and for a gentle wakeup, the volume of the radio ramps up to a preset level over a period of ten seconds. The radio portion has six AM and six FM presets; separate volume, bass, and treble controls; and an output power of three watts into a five-inch speaker. There's also an auxiliary line-level input for a device such as a CD- or tape player. The RS-421 extension speaker has its own amplifier and five-inch speaker and transforms the system into full stereo. For whoever's on that side of the bed, the outboard unit also has its own alarm (with volume control), snooze and sleep control, and preset search. Price: (RS-420 alone) $160; with RS-421, $250.

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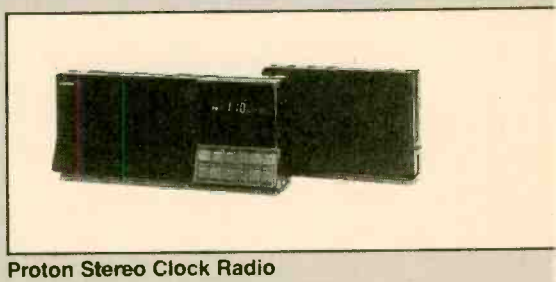

Proton Stereo Clock Radio

Eight-Language Translator

Travelers to Europe or Japan will find *Pacemark's* (100 W. 32nd St., New York, NN 10001) *TT-800 Rand McNally Insta-Phrase* electronic phrase translator a useful companion. Phrases, which are displayed on a two-line, 20-character LCD, are divided into ten travel-related categories such as dining, customs, tours, accommodations, medical emergencies, and so on. By pushing the correct category button (a knowledge of icons is necessary) you can call up phrases in Japanese, English, Dutch, Portuguese, French, Spanish, Italian, and German. The pocket-size unit also includes a hundred-year calendar, a travel alarm clock, and a ten-digit calculator. There's a currency converter, too, that can handle rates for three sets of currencies at once. Price: $150.

CIRCLE 67 ON FREE INFORMATION CARD

Pacemark Translator

Little Speakers, Big Sound

Two wedge-shaped satellite units about the size of a regulation softball, and an unobtrusive bass module, make up the *Acoustimass 3* sound system from *Bose* (The Mountain, Framingham, MA 01701). The Acoustimass 3 bass module, which is responsible for reproducing the non-directional frequencies below 200 Hz, measures 8 × 8 × 14 inches and weighs only 14 pounds. Its placement in a room is not critical; it can even be hidden beneath a piece of furniture. Each of the satellite speakers, which handle the mid and high frequencies, contains a single 2½-inch long-throw transducer and is magnetically shielded to permit close positioning to video monitors. The sculpted enclosures incorporate a removable cover for the connector area, allowing speaker connections to be completely hidden from view. Price: $599.

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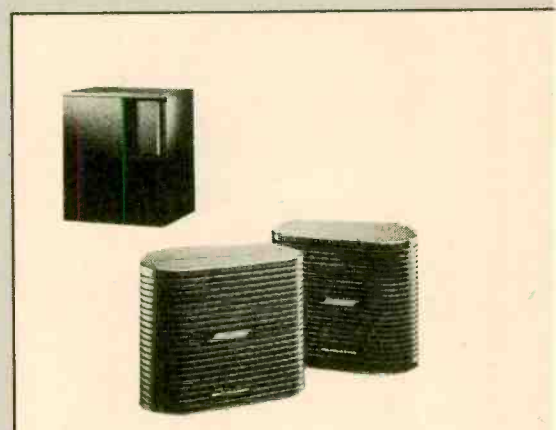

Bose Speakers

Infrared-Interface Printer

"Look Ma, no cables," might be *Hewlett-Packard's* (P.O. Box 10301, Palo Alto, CA 94303-0890) slogan for its infrared-link *HP 82240B* thermal printer. The little (3.6 × 7.3 × 2.5 inches) printer weighs one pound—including a roll of standard 2¼-inch thermal paper—and operates from four "AA" cells or an optional AC adapter. Data is sent to the printer by a 940-nanometer infrared LED that's built into a number of current-production HP calculators. The printer, which has both alphanumeric and graphic capabilities, can operate up to 18 inches away from the calculator's LED, within a 60-degree arc. A power-indicator LED indicates that the printer is turned on, and the unit turns itself off after about ten minutes of inactivity to conserve power. Price: $135.

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Hewlett-Packard Cordless Printer

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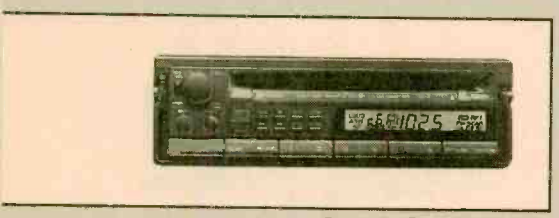
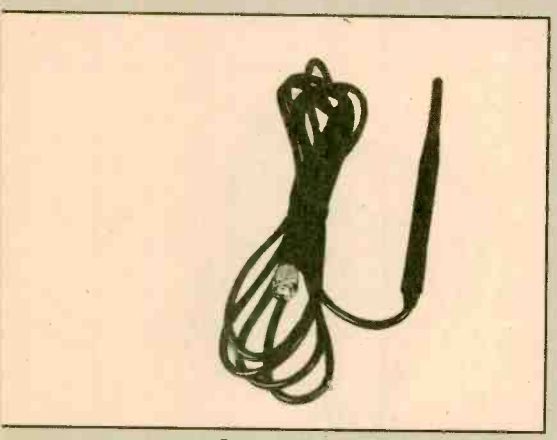


Coustic Car CD Player



Cobra Stick-on Cellular Antenna

Bazooka Powered Auto Subwoofer

Cyrus AM/FM Tuner

AutoPage Radar Detector

In-Dash AM/FM CD Player

Instead of a tape transport, the *Coustic* (*Concept Enterprises*, 4260 Charter Street, Vernon, CA 90058-2596) *CD-3* AM/FM autosound receiver has a CD player. The unit uses a DIN-E-type chassis with locking handle and slide-in/slide-out capability. The player in the 15-watt-per-channel (into two channels) unit uses a three-beam laser system to provide tracking accuracy and can play both three- and five-inch discs without the need for adapters. The tuner section accommodates six AM and twelve FM presets and can find and store an additional twelve (six AM, six FM) of the strongest local stations. The amplifier includes active bass and treble controls incorporating active tone equalizer and line-driver stages for additional amplifier headroom and greater dynamic range. Panel illumination can be changed instantly from amber to green according to the driver's preferences and needs. Finally, an "I-Sens" circuit can provide automatic muting of the audio system when an incoming cellular phone call is detected. How considerate! Price: $599.95.

CIRCLE 70 ON FREE INFORMATION CARD

Temporary-Mount Cellular Antenna

If you and your cellular phone find yourselves in an antenna-less spot, *Alliance Research Corporation* (9410 Owensmouth Avenue, Chatsworth, CA 91311) has what you need—an installation-less (well, almost) antenna. Its *Cobra TM10* temporary-mount cellular antenna attaches to any smooth non-metallic surface inside a vehicle, home, or office by way of suction cups; no hole drilling is required. The antenna comes with 12 feet of RG58/U cable terminated in a TNC connector that attaches to most portable and transportable cellular phones. Price: $19.95.

CIRCLE 71 ON FREE INFORMATION CARD

Amplified Autosound Subwoofer

If Buck Rogers ever gets his hands on one of these *T-62A Bazookas* from *Southern Audio Systems* (10053 Barringer Ct., Baton Rouge, LA 70809) the 21st century will turn out completely differently. These 18¾-inch-long subwoofer speaker tubes, which you install in the back of a car or truck, contain their own 40-watt amplifiers, can accept high- or low-level inputs, and include a variable active-crossover network that can function between 50 and 250 Hz. Frequency response of the bass-reflex units extends down to 20 Hz, ± 1 dB. Price: $299.

CIRCLE 72 ON FREE INFORMATION CARD

Audiophile Tuner

From England, where the audiophile community is a very active one indeed, comes the *Cyrus Tuner*. Imported by *Mission* (18303 8th Avenue, Seattle, WA 98148), the AM/FM digitally synthesized tuner incorporates a full-function remote control, station-by-station tuning, and 59 presets for each band. The tuner is half the width of conventional rack-mount gear, allowing it to be positioned alongside a piece of similarly sized equipment such as a Cyrus integrated amp. Among its unusual features are a station-search mode wherein volume is attenuated by 20 dB—to avoid unpleasant musical shocks, perhaps—and a volume function on the remote that controls the tuner's output level. Price: $649.

CIRCLE 73 ON FREE INFORMATION CARD

Two-Band Radar Detector

AutoPage's (1437 7th Street, Suite 200, Santa Monica, CA 90401) *RD-02* compact radar detector can easily be installed either as a permanent or portable unit. The detector offers simultaneous X- and K-band operation, adjustable audio-signal indication, and multiple mounting systems. Its dual-conversion superheterodyne receiver makes use of temperature-compensated circuitry for greater range and to reduce the likelihood of falsing. A five-LED display gives an indication of signal strength (and thus relative proximity of the radar device) and adjusts automatically to compensate for ambient light conditions. Selectivity of the detector can be switched between city and highway, and the alarm can be audible, visible, or both. Price: $239.95.

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ALL ABOUT BATTERIES

Commonplace and taken for granted, each type of battery has its own often-misunderstood purpose. Here we'll look at the major battery families, and how each can be used to its best advantage.

BY STEPHEN J. BIGELOW

Batteries are perhaps the most commonplace and dependable source of power available. Because of that, like most dependable things they are often taken for granted. Even though a typical home in the United States can use more then ten products operated or backed up by batteries, most people know very little about their principles and operation. Many hobby projects use batteries to provide power, yet the choice of cell often depends on its price rather than its performance. There are several types of batteries available, each having different characteristics and construction. This article will cover the descriptions, construction, characteristics, and ratings of the major battery families. We'll also cover the principles and operation of solar cells, which are finding many uses as battery supplements in solar watches and solar calculators.

History. Batteries are about 200 years old. In 1789, Alessandro Volta placed a copper rod and a zinc rod into a bath of acetic acid. He noticed that an energy potential developed between the copper and zinc electrodes as the zinc dissolved in the acid electrolyte. The battery was thus born, and the potential difference that Volta discovered in his experiments came to be known as the *volt*.

George Leclanche is credited with developing the first practical type of battery in 1868. He used zinc as his negative electrode and a rod compressed from manganese-dioxide powder as his positive terminal. Leclanche used ammonium chloride (also referred to as sal ammoniac) mixed with water as an electrolyte. By suspending the entire electrode assembly in a glass jar, he invented the first practical "wet cell."

Although the wet cell was a working power source, it suffered from several serious drawbacks. First, the glass jar and electrodes were very fragile, and sal ammoniac is a dangerous acid. That limited wet-cell use to only an experienced few who could handle them safely. Second, wet cells had no real shelf life. The zinc would begin to decompose quickly after being submerged in its electrolyte. The search began for a safe, reliable alternative to the Leclanche wet cell.

In 1888, a scientist named Gassner developed the prototype of a dry-cell battery that set the standard for the entire industry. Dr. Gassner used zinc in the battery case as well as in the negative electrode. He also added zinc chloride to the electrolyte paste, which slowed the decomposition of the zinc rod. That significantly extended the shelf life of his dry cell.

Batteries were then ready for mass production. The National Carbon Company of Ohio (later known as Union Carbide) began production of the dry-cell battery in 1890. Dry cells remain almost unchanged to this day, but the demands of America's high-technology industry have encouraged the development of newer, better types of batteries. Modern batteries can use materials ranging from conventional carbon zinc, to mercury, lithium, silver, and cadmium.

Battery Families. Battery families are usually distinguished by the electrode materials used in their construction. A carbon-zinc battery, for example, uses carbon as the positive electrode and zinc as the negative electrode. Within a particular battery family, there may be one or more sizes and shapes of

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TABLE 1—BATTERY CHARACTERISTICS

Battery Family	Carbon Zinc	Zinc Chloride	Alkaline	Mercury	Lithium	Nickel Cadmium	Lead Acid
Type	Primary	Primary	Primary	Primary	Primary	Secondary	Secondary
Volts per Cell	1.5V	1.5V	1.5V	1.35 or 1.4V	3.0V	1.2V	2.0V
Positive Electrode	Manganese Dioxide	Manganese Dioxide	Manganese Dioxide	Mercuric Oxide	Manganese Dioxide	Nickelic Hydroxide	Lead Peroxide
Negative Electrode	Zinc	Zinc	Zinc	Zinc	Lithium	Cadmium	Spongy Lead
Electrolyte	Ammonium and Zinc Chloride	Zinc Chloride	Potassium Hydroxide	Potassium or Sodium Hydroxide	Lithium Perchlorate	Potassium Hydroxide	Sulfuric Acid
Recharge Cycles	N/A	N/A	N/A	N/A	N/A	300 to 2000	>1500
Gassing	Medium	Higher than Carbon Zinc	Low	Very Low	Low	Low	Medium
Limits	Lower Efficiency at Higher Current Drains	High Temp Performance Same As Carbon Zinc	Expensive For Low Current Uses	Poor Performance at Low Temperatures	3 Volt Uses Only	High Initial Cost	Heavy and Delicate
Temperature Effects	Poor Low Temperature Operation	OK at Lower Temps.	Good at Lower Temps.	Good at High Temps. Poor at Low Temps.	OK at Low Temps.	Very Good at Lower Temps. Poor at Higher Temps.	Good at Low Temps.
Features	Readily Available Low Cost	Greater Service Capacity Than Carbon Zinc	Very Efficient at High Loads	Very Flat Discharge Curve	Higher Voltage Good Storage Life	Excellent Cycle Life Very Reliable	High Energy Density

cells, each offering a different current capacity and service life.

Batteries may also be grouped into *primary* and *secondary* cells. Primary cells can not be recharged. Once their chemical reaction is completed, their energy can never be fully restored. Some battery designs allow the chemical reaction to be reversed to restore its energy. Those are called secondary cells, and they can be recharged. Table 1 compares the characteristics of the major battery families. Solar cells are in a class by themselves—sometimes referred to as a *perpetual cell* or a perpetual battery, since their output voltage will remain almost constant virtually forever as long as light is present on their surface.

The Carbon-Zinc Family. Carbon-zinc batteries are often called Leclanche cells since they are virtually unchanged since the time of George Leclanche's work more than 120 years ago. They are very low cost, readily available, and manufactured in a wide variety of sizes for use in light-duty applications such as toys, flashlights, and radios.

Figure 1 is a cutaway view of a typical carbon-zinc battery. Manganese dioxide reacts with the zinc case through an electrolyte paste of ammonium chloride and zinc chloride. The zinc chloride slows down the internal chemical reaction when the battery sits idle, so its shelf life may be up to two years. If carbon-zinc cells are allowed to get old, the zinc case may actually be eaten away in places and allow the dark, pungent electrolyte to seep through.

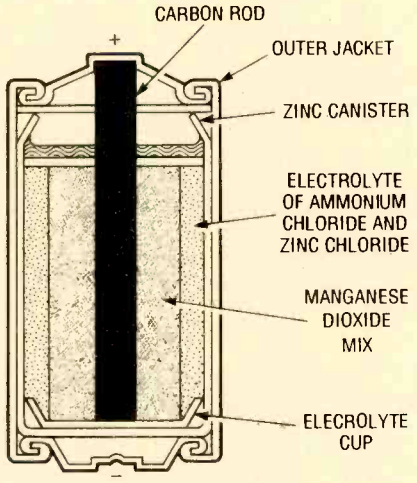

Fig. 1. In a carbon-zinc battery, manganese dioxide reacts with the zinc case through an electrolyte paste of ammonium chloride and zinc chloride.

Carbon-zinc cells are primarily intended for low- to moderate-current applications and their rate of discharge greatly depends on the load placed upon the them. Carbon-zinc cells are commonly available in 1.5-volt D, C, AA, AAA, and N; 9-volt rectangular, and 6-volt lantern sizes.

Temperature is an important factor in carbon-zinc batteries. Extreme heat (above 110°F) will dry out the moisture in the electrolyte. Without moisture to carry the flow of electrons and positive ions that produces the cell's voltage, the battery activity will drop off to nothing. Below 0°F, the extreme cold will slow down the chemical reaction and essentially kill the battery as well. Try to keep the cells above freezing and below 100°F whenever possible. Because of that, carbon-zinc cells are not well suited for use in such things as emergency car flashlights, where they will be subjected to those temperature extremes.

Do NOT ever attempt to recharge carbon-zinc batteries in chargers intended for NiCd or other battery families! They can, however, be slightly revitalized after a partial discharge, but there are some serious restrictions involved in the equipment used. (Battery

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revitalizing will be covered in more detail later on in this article.)

A variation of the carbon-zinc cell is the zinc-chloride cell. Figure 2 is a cutaway view of that cell, often called a "heavy-duty" or a "high-performance" cell. Changes in the structure of the cathode and electrolyte allow the zinc-chloride battery to deliver more current over a longer period of time. They will cost more than their carbon-zinc counterparts, but they can deliver up to 50% more energy—especially under higher current drain. The shelf life of a zinc-chloride battery can exceed three years.

While zinc-chloride cells are also susceptible to electrolyte drying at high temperatures, they are even more sensitive to lower temperatures than a carbon-zinc battery. Temperatures as low as 20°F can reduce the cell's chemical reaction and adversely effect its performance. Zinc-chloride cells are also available in 1.5 volt D, C, AA, AAA, N, 9 volt rectangular, and 6 volt lantern sizes.

Unlike the carbon-zinc battery, moisture in the zinc-chloride electrolyte is used up during the cell's life, and will become dry when the cell is exhausted. Therefore, the zinc-chloride battery will not tend to leak as it grows old. Zinc-chloride batteries are primary cells. They can be revitalized to some extent, but not recharged fully.

The Alkaline Family. Alkaline batteries offer significant advantages over carbon-zinc and zinc-chloride batteries. A radically different electrolyte chemistry and electrode construction allow the alkaline cell to provide as much as ten times the energy capacity of carbon-zinc cells. That makes them perfect for use in devices that require high currents for prolonged periods of time such as high-brightness flashlights, cassette recorders, and other motor-driven devices, or any electronic project that will draw large currents.

Figure 3 shows the cutaway diagram of a typical alkaline battery. Technically, an alkaline battery is actually an alkaline-manganese dioxide battery because manganese dioxide reacts with the powdered zinc through an extremely conductive potassium-hydroxide electrolyte. A brass strip collects the energy generated by the chemical reaction and conducts that energy to the positive terminal. It is the large area of zinc and the high conductivity of the electrolyte that provides the high-energy capacity of the battery. The large

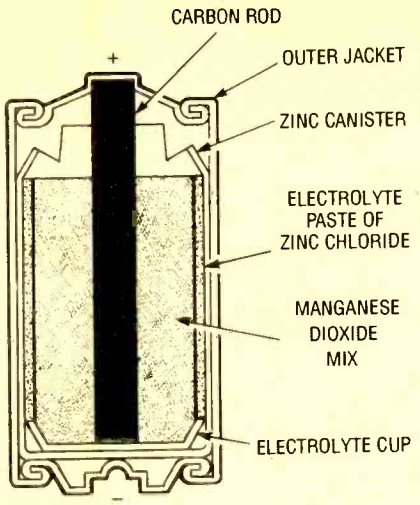

Fig. 2. Often called a "heavy-duty" or a "high-performance" cell, changes in the structure of the cathode and electrolyte allow a zinc-chloride battery to deliver more current over a longer period of time.

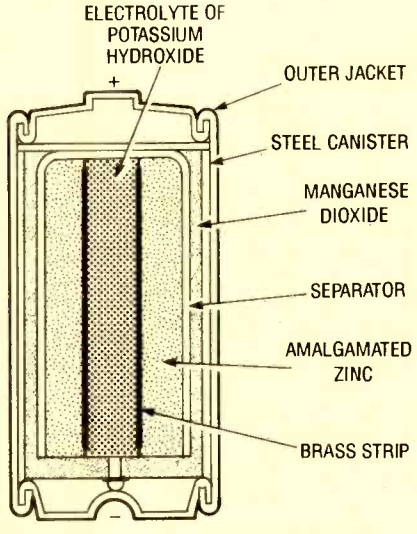

Fig. 3. A radically different electrolyte chemistry and electrode construction allow alkaline cells to provide as much as ten times the energy capacity of carbon-zinc cells.

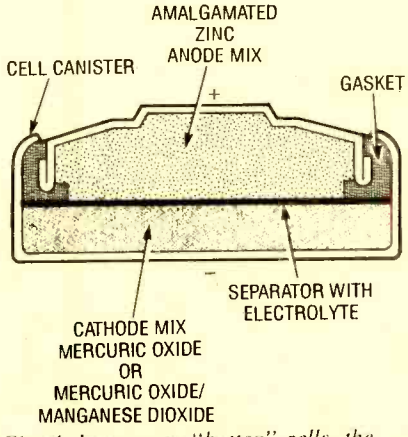

Fig. 4. In mercury "button" cells, the cathode material determines the cell's discharge rate, while the electrolyte will select the cell's current capacity.

volume of electrolyte also allows the alkaline cell to enjoy a long shelf life. It will retain up to 90% of its capacity for 2 years, and up to 80% of its capacity for 4 years.

Alkaline cells discharge much slower than general-purpose carbon-zinc cells under similar load conditions. Alkaline cells are also better at withstanding extremes of temperature. They work well below freezing, down to below 0°F, and as high as 110°F without ruining the electrolyte. This is because the cell assembly is housed inside a steel "can" that will retain electrolyte moisture much better than zinc-housed cells.

Alkaline batteries can not be recharged or rejuvenated. **Attempting to restore an alkaline cell may cause it to explode.** They are commonly available in 1.5-volt D, C, AA, AAA, N; 9-volt rectangular; and 6-volt lantern sizes. They are more expensive than carbon-zinc and zinc-chloride cells, but the extra energy capacity is well worth the price in high-current and/or harsh-environment applications. Their cost has steadily declined since their invention more than 20 years ago.

The Mercury Family. Mercury cells, also called mercuric-oxide cells, provide an almost constant output voltage throughout their working life. They are ideal for any low-current device or project that requires a constant voltage level, such as LCD watches, calculators, and light-sensing cameras. Mercury cells are typically manufactured in small cylindrical or button shapes. They will provide 1.35 or 1.4 volts to a circuit depending on the type of mercury cell chosen.

Figure 4 shows a cutaway view of a common mercury cell. Output voltage is produced when the anode of amalgamated zinc reacts with the cathode of either mercuric oxide or a mix of mercuric oxide and manganese dioxide through a highly conductive electrolyte of either potassium hydroxide or sodium hydroxide. The cathode material determines the cell's discharge rate while the choice of electrolyte will select the cell's current capacity. Mercury cells using a sodium-hydroxide electrolyte can only put out up to about 150 microamps, while a potassium-hydroxide electrolyte will allow up to 2 milliamps to be generated.

Mercury cells must be operated above the freezing point, and should never be exposed to temperatures above 110°F for long periods of time.

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Although they have a high energy density, their construction and chemistry makes them much more susceptible to temperature than alkaline cells. Also, **mercury cells can easily explode if a recharge is attempted**.

The Lithium Family. Lithium cells (also called lithium-manganese dioxide cells) are very widely used to provide power in many high-technology applications such as watches, scientific calculators, memory-circuit backup, pacemakers, and a variety of military uses. Their unique chemistry allows only a slow self-discharge, so they can enjoy a shelf life exceeding 5 years.

Lithium cells can be manufactured in a wide array of physical shapes and sizes, but it is most commonly found as a flat button cell as shown in Fig. 5. In the cell, manganese dioxide, mixed with carbon to aid conductivity, reacts with a thin layer of lithium that is electroplated onto a stainless-steel container.

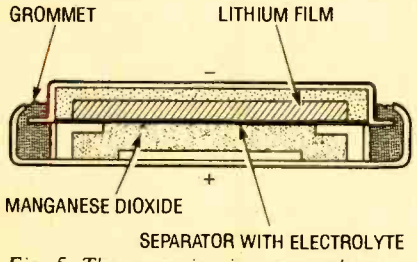

Fig. 5. The open-circuit output voltage from a lithium cell is 3.0 volts, and remains virtually constant over the entire life of the cell. Due to the sensitive nature of the materials used in the cells, they must be assembled in an atmosphere of inert gas, such as pure argon.

The chemical reaction is supported through an electrolyte of lithium perchlorate suspended in propylene carbonate. That means that the electrolyte is virtually dry. As a result, the battery has an operating range of from below – 20°F to more than + 120°F. Due to the sensitive nature of the materials, lithium cells must be assembled in an atmosphere of inert gas, such as pure argon.

The open-circuit output voltage from a lithium cell is 3.0 volts, and remains virtually constant over the entire life of the cell. Even though a lithium cell can not source much current, its output is extremely stable over a very long time. **You should never attempt to recharge a lithium cell.**

The Lead-Acid Family. Lead-acid batteries are one of the few wet-cell power sources still in commercial use today. Automobiles use lead-acid batteries for their high surge-current capacity, which is needed to start car engines. Each individual cell within a commercial lead-acid battery can generate up to 2 volts. A 12-volt battery therefore uses 6 of those cells in series to provide the 12 volts available at the output terminals.

A simple cross-sectional view of a lead-acid battery is shown in Fig. 6. A liquid electrolyte of mild sulfuric acid supports the chemical reaction between alternating plates of spongy lead and lead peroxide. The reaction between those plates liberates a gas

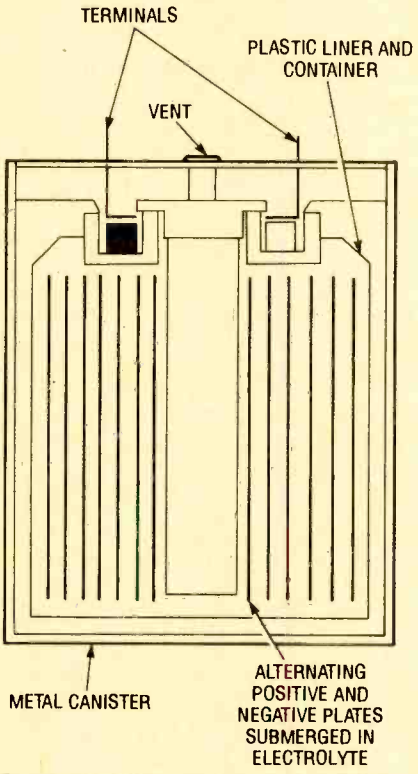

Fig. 6. The only wet cell still in common use, lead-acid batteries can supply the high surge current needed to start an automobile.

that has to be vented from the battery. As a result of that, the liquid level of the electrolyte would gradually decline, and have to be refilled from time to time. Newer lead-acid designs use electrodes fashioned from a lead-calcium alloy that has resulted in what is called a "maintenance free" battery that is sealed and never has to be filled.

Lead-acid cells must be stored in a charged condition, or internal short circuits may form in the battery during charging. Lead-acid batteries are secondary cells, and can be recharged by connecting a DC-voltage source

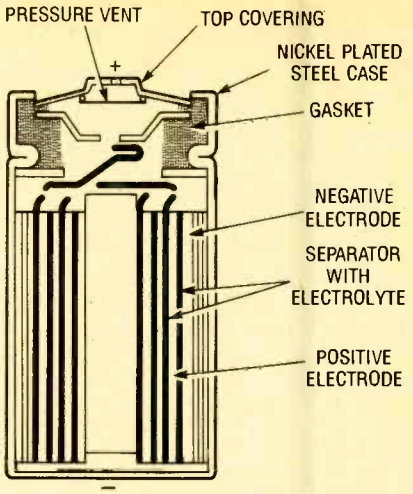

Fig. 7. In a NiCd cell, the discharge process can be reversed by applying an external voltage of opposite polarity across the battery terminals.

across the cell so that current flows in the reverse direction. They can take a fast charge (between 30 to 60 minutes) with little problem, and have a shelf life of several years.

The Nickel-Cadmium Family. The nickel-cadmium (or NiCd) battery is probably one of the most cost-effective power sources available. Although they initially cost more, and have less service capacity than a comparable alkaline cell, NiCd's may be recharged many times, often recovering their initial cost several times over.

Figure 7 is a cross-sectional view of a typical NiCd cell. Power is generated when the positive electrode of nickel-hydroxide reacts with the negative electrode of metallic cadmium across a porous separator of potassium-hydroxide electrolyte. During the operation of the cell, the negative electrode oxidizes, or absorbs oxygen. That absorption equals the oxygen lost at the positive electrode. In a NiCd cell, the process is reversible: An external voltage forces the direction of the reaction to reverse, in effect recharging the battery. The NiCd battery is designed with a vent mechanism that allows any excess pressure to be released during charging, so the cell may be left in the charger for long periods of time without damage. Nickel-cadmium cells are available in 1.5-volt D, C, AA, and AAA, and 9-volt rectangular packages.

Even though NiCd batteries may be stored in the charged or discharged state, they have a poor storage life when charged. At room temperature, a typical NiCd will self-discharge at up to

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Battery Glossary

Ampere-Hours (Ah)—This is a term used to represent the service capacity of a battery. It is the current flowing from the battery multiplied by the time that current is drawn (Ah = Amps × hours).

Average Drain—The average amount of current supplied from the battery. That value can be determined by calculating or measuring the current draw from the battery when it is discharged 50%.

Cell Reversal—A condition where a cell's polarity becomes reversed due to overcharging. In a battery made up of several cells, that effect will reduce the final output voltage and shorten service life.

Charge Rate—The amount of current used to charge a secondary cell.

Constant-Current Charging—A charging technique where charging current remains constant. That technique can easily damage some secondary cells by overcharging if care is not taken to remove the charged cells after some set period of time.

Cutoff Voltage—The amount of voltage where battery discharge ends or charging is completed. In a discharge cycle, the cutoff usually takes place when the battery voltage is too low to properly drive a load circuit.

Cycle Life—The number of charge and discharge cycles that secondary cells can withstand before becoming bad.

Discharge Rate—The amount of current that is being drawn from the battery while it is discharging.

Dry Cell—A type of cell in which the electrolyte is held immobile in a paste or a gel, or is absorbed into the separating layer.

Entrainment—Battery failure where gasses generated in the cell will force electrolyte through the venting mechanism. That often happens when a battery is shorted, or very severely loaded.

Functional End Point (FEP)—The battery voltage below which the attached load will not operate correctly.

Memory Effect—When nickel-cadmium cells are repeatedly charged and discharged to the same point, the remainder of its capacity will become unusable in regular operation.

Overcharging—The continuing charge of a secondary cell after its maximum charge has been reached. That can cause cell damage in some types of batteries.

Primary Cell—A battery configuration made to be discharged only once and then discarded. It can not be recharged to any appreciable extent.

Secondary Cell—A battery configuration using electrochemical reactions that can be reversed in order to restore the cells' charge.

Shelf Life—The time that a battery will retain some portion of its rated output.

Trickle Charge—Also called a *Standby Charge*. It is some small amount of overcharging current continually applied to a secondary cell to keep it at full charge. These small currents are small enough to prevent battery damage. ■

2% per day, so it would have to be recharged after about 50 to 60 days. Also, never store NiCd batteries under a continuous load for a long time (such as leaving a toy with the switch ON). Continuous loading on a discharged NiCd battery may cause it to leak. However, a NiCd may be stored under a trickle charge indefinitely.

Nickel-cadmium batteries can form a "memory." That phenomenon occurs when a NiCd cell is repeatedly charged and discharged to the same levels. When a NiCd memory forms, the cell service capacity can be seriously reduced—the battery will only source power down to that "memory" point, then it will appear to quickly go dead. A NiCd memory problem can be corrected by leaving the battery temporarily loaded in order to discharge it fully, then charging it fully at the recommended charging current. This may have to be done several times to completely restore the cell's full capacity. When handled correctly, NiCd cells can provide a long and reliable service life.

Solar Cells. Solar cells (see Fig. 8) are an intriguing source of alternate energy, and are often considered to be "perpetual batteries." As long as they are exposed to a steady source of illumination, their output will remain very steady over a long time. Solar cells are finding increasing uses in consumer electronics, especially in commercial calculators and watches. They are also used as light sensors in photographic meters and other instrumentation.

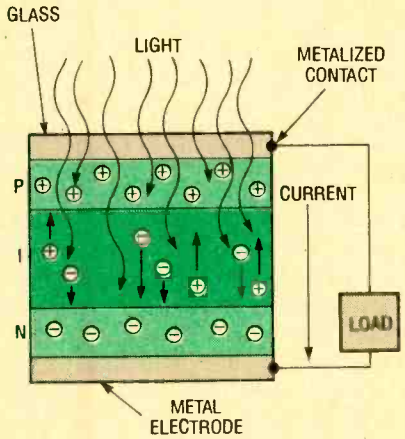

Fig. 8. Solar cells can generate a voltage as long as they are exposed to light.

A solar cell is little more than a large, flat p-n junction. Semiconductor materials are very sensitive to the presence of light, but regular semiconductors like diodes and transistors are totally encapsulated in plastic so they show no sign of that sensitivity. In a working solar cell, photons of light will pass through the top covering of glass and strike the p-type material. That liberates free electrons that then move through a wide interim layer across the junction. That movement of electrons creates a potential difference at the output terminals of the solar cell. The amount of current that is available to the load is proportional to the amount of light that reaches the surface of the cell. Typical solar cells can generate from 0.4 volts at 60 milliamps to 1.6 volts at 80 milliamps, or 3.2 volts at 40 milliamps. That assumes that the cells are exposed to bright sunlight (about 100 milliwatts/cm^2).

Selenium and silicon are the two most common solar-cell materials, although gallium arsenide (GaAs), indium arsenide (InAs), and cadmium sulfide (CdS) cells are also in use. A selenium solar cell is best stimulated by light in the visible spectrum at about 5000 angstroms. Their response to light is so similar to that of the human eye that they are widely used in photo meters. Silicon cells will respond to visible light, but are most effective with light in the near infrared region at about 8000 angstroms.

Solar cells may also be connected in series to power a circuit as shown in Fig. 9. The voltage of each solar cell adds up to provide a total of 1.6 volts to the load, as well as to keep the battery charged. The Schottky barrier diode (D1) in the circuit keeps the battery current from flowing back into the solar cells when they are dark.

Ampere-Hour Ratings. Perhaps the most useful term in battery technology is the ampere-hour (or Ah). The service capacity of all batteries is given in terms of ampere-hours. It is the value of

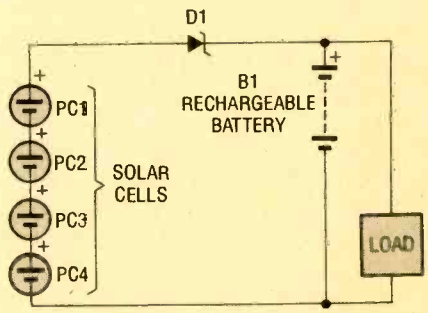

Fig. 9. A simple solar-power circuit. When illuminated, the cells supply power to the load and keeps the battery in the circuit fully charged; when dark, the battery supplies the power to the load.

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TABLE 2—BATTERY RATINGS

Battery Family		Carbon Zinc	Zinc Chloride	Alkaline	Mercury	Lithium	Nickel Cadmium	Lead Acid
Typical Service Range		Up to 5 Ah	Up to 7.4 Ah	Up to 23 Ah	Up to 28 Ah	Up to 200 mAh	Up to 4 Ah	Up to 50 Ah
Current Limits	D Size	0-150 mA	0-150 mA	0-650 mA	N/A	N/A	0-4.8 A	N/A
	C Size	0-80 mA	0-80 mA	0-480 mA	N/A	N/A	0-4.8 A	N/A
	AA Size	0-25 mA	0-25 mA	0-250 mA	N/A	N/A	0-2 A	N/A
	AAA Size	N/A	0-20 mA	0-170 mA	N/A	N/A	0-250 mA	N/A
	N Size	N/A	0-85 mA	0-85 mA	N/A	N/A	N/A	N/A
	9V Rectangular	0-15 mA	0-15 mA	0-100 mA	N/A	N/A	0-1A	N/A
	6V Lantern	0-250 mA	0-250 mA	N/A	N/A	N/A	N/A	N/A
	Button Cells	N/A	N/A	0-100μA	0-2 mA	0-400μA	N/A	N/A
	12V Car	N/A	N/A	N/A	N/A	N/A	N/A	0-20 A

current capacity of the cell multiplied by time, or Ah = current (in amps) × time (in hours).

For example, a 1.5 volt alkaline D-size cell has an ampere-hour rating of about 23 Ah; that is, if 1 amp is drawn from the cell, it should last about 23 hours (23 Ah/1 A = 23 hrs). If 500 milliamps are drawn from the battery (.5 amps), it should last up to 46 hours (23 Ah/0.5 A = 46 hrs), and so on. As long as the current draw does not exceed the maximum recommended current, that relationship will basically hold true.

If the load current of a circuit is determined and the ampere-hour rating is known, it is possible to calculate the life expectancy of the battery in that circuit. Table 2 lists the ampere-hour ratings and maximum recommended currents for each major battery family. As is shown in the table, among battery families ampere-hour capacity is roughly proportional to the physical size of the container.

Evaluating a Battery. Batteries can be peculiar devices. The energy that their chemical reaction produces depends heavily upon the load they are connected to, as well as their duration of use (or duty cycle). That means that their service capacity will change as their load and frequency of use changes. For example, a battery that is used only two hours per day will have a different service capacity than a battery used eight hours per day. As a result, it is almost impossible to determine the exact amount of energy remaining in a battery. However, by measuring the terminal voltage of a battery under a load, it is possible to approximate the remaining service capacity as "good," "weak," or "bad."

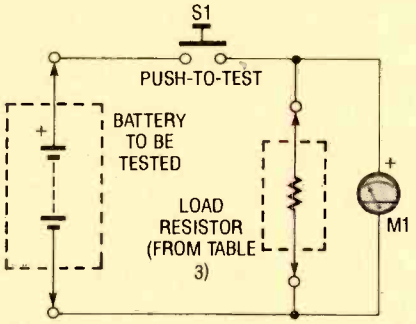

Fig. 10. To properly evaluate a battery, it must be tested under load. Use Table 3 to select the appropriate load resistor.

To evaluate a battery, it must be properly loaded. Figure 10 shows an ideal test circuit that can be used to load a battery while measuring battery voltage with a DC voltmeter. Table 3 lists some common values of load resistors for each major type of battery. Insert the proper load resistor in the test circuit and connect the battery to be tested to the points indicated. Momentarily press S1 and read the loaded battery voltage from the voltmeter. If the reading is more than 75% of the voltage labeled on the battery, then that battery can be considered "good" with some amount of useful life left. If the reading is between 60% and 75% of the labeled battery voltage, the battery is "weak"—that is, it is approaching the end of its useful service life and it will have to be replaced in the near future. A reading below 60% of the rated voltage suggests a "bad" battery that has reached the end of its service life and can no longer generate enough energy to drive most circuits correctly. Bad cells should be replaced immediately.

TABLE 3—LOAD RESISTANCE

Voltage	Battery Size	Load Resistor
1.5V	D,C,AA general purpose	10Ω ½w
1.5V	D,C,AA heavy duty	2.25Ω 1w
1.5V	AAA	3Ω 1w
6V	Lantern	5Ω 10w
9V	Rectangular	250Ω ½w
1.35 or 1.4V	Mercury Button	1500Ω ¼w
3.0V	Lithium Button	3000Ω ¼w

As an example, if a 1.5 volt carbon-zinc D-size cell is tested in the circuit of Fig. 10, it should be loaded with a 10-ohm, ½-watt resistor as given in Table 3. When S1 is closed, a reading is taken from the DC voltmeter. If that reading is above 1.125 volts (75% of 1.5 volts or greater), then the cell may be considered "good." If the reading falls between 0.9 and 1.125 volts (60 to 75% of 1.5 volts), the cell is "weak" and may be replaced at the discretion of the operator. It may be just good enough to power a particular circuit a bit longer. A reading below 0.9-volt (below 60% of 1.5 volts) indicates a "bad" battery that should be replaced if possible. Even if it

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appears to be powering a circuit correctly, it probably won't for much longer.

Rejuvenating Primary Cells. As stated previously, primary cells generate power through a chemical reaction that can not be fully reversed. Once a primary cell is discharged, it can never be recharged. However, it is possible to extend the service life of carbon-zinc and zinc-chloride batteries by rejuvenating, or "semi-charging" them. **Never attempt to revitalize alkaline, mercury, or lithium cells—they can easily explode.**

Revitalizing is very much like charging in that an external potential is placed across a cell to reverse a chemical reaction. In this case, however, the external potential serves to "excite" the primary cell and stimulate its chemical reaction. When done in the correct fashion, that process can extend the useful life of the cell. **Becuase of its high charging current, a charger intended for use with NiCd batteries should never be used to rejuvenate primary cells.** Only use chargers intended for use with such cells. One such charger is the Radio Shack 23-120; that unit is designed to revitalize pairs of 1.5-volt D, C, or AA cells, or one 9-volt rectangular battery using low currents in the range of 5 to 12 milliamps.

There are a number of important principles to keep in mind when attempting to rejuvenate primary cells:

- Use low currents. Primary cells simply can not be forced to sustain large charge currents like a NiCd cell can, so charge very slowly and allow up to 16 hours for the cell to be revitalized.
- Never attempt to revitalize a cell after its loaded output voltage has dropped below 1.0 volt. At that point, its service capacity has dropped too much to accept any real revitalization.
- Batteries should be rejuvenated immediately after they are removed from their load, and should be used immediately afterwards. Primary cells that are revitalized have a very poor shelf life.
- The capacity of recharge must be as much as 150% of the discharged capacity. For example, if 1Ah of battery capacity is used, it will have to be rejuvenated with up to 1.5 × 1Ah = 1.5Ah of energy. Revitalizing primary cells is very inefficient.

Charging Secondary Cells. The chemistry of secondary cells allows their chemical reaction to be reversed in order to restore the service capacity of the cell. That's done by applying an external voltage to the battery in such a way that current flows *into* the battery instead of out. Up to 140% of the used service capacity must be replaced to charge a NiCd battery. For example, if 0.5Ah of service capacity has been used, 1.4 × 0.5Ah = 0.7Ah of energy should be delivered to the cell to charge it properly.

The charge rate (called C) of a NiCd cell is equal to its ampere-hour service capacity. For a 3Ah battery, its charge rate would be 3 amps (C = 3). However, that rate of charge is often much too high for most cells so a lower charge rate must be used. The one most often used is the "ten-hour" charging rate; that rate is also called the C/10 rate since it is 1/10 of C. The ten-hour charge rate for the 3Ah battery discussed above would be 3/10, or 0.3 amps. That rate is much more suitable for commercial NiCd cells.

Most NiCd cells require a constant-current type of charge for optimum charging. There are many different types of NiCd battery chargers for a wide variety of applications, but each type of charger falls into one of three categories: A "fast-charge" circuit provides a heavy current to charge cells; the charge rate of such a circuit can range between C/3 and C/10. Fast charging can be dangerous—the battery must be designed to accept such a charge.

Most consumer NiCd cells are made to charge more slowly and can be damaged by a fast charge. A "normal-charge" circuit uses a rate from C/10 to C/30; that rate will not damage the majority of NiCd cells. Most commercial chargers are made to operate in that range and will hold a NiCd cell at full charge for a long time with little degradation. A "trickle-charge" circuit uses a charge rate between C/30 and C/50. That very low current can keep a NiCd battery ready for service indefinitely.

Lead-acid cells, on the other hand, do not usually work well with constant-current charging. Even when the cell is fully charged, a significant current into the battery can cause premature aging of the battery plates, not to mention the decomposition of the cell's electrolyte. Charging voltage is also an issue in lead-acid cells. Excessive charging voltage will force a higher charge current into the battery, which in turn will result in battery degradation. A low charging voltage will not source enough current to allow a full charge on the battery. That may allow some lead sulfate to stay fixed on the battery plates and reduce its charged service capacity. Regulated chargers are recommended for most lead acid batteries.

Battery Guidelines. Designing projects with batteries is usually a very simple and straightforward procedure, but there are several important factors to consider that may dramatically improve the life of the cells and the performance of the project.

- Try to use common types of batteries that are readily available from a variety of sources.
- Many types of cells (especially alkaline cells) use steel jackets. Be sure that the battery holder will insulate the battery from all other circuit components to prevent a short circuit.
- Batteries can leak electrolyte if they become old or damaged. Secondary cells can also leak if they are drained excessively, or are seriously overcharged. Select the battery holder and design the battery compartment to protect the circuit from any possible leakage damage.
- A battery must be allowed to

(Continued on page 99)

For More Information

There are several sources of more information on batteries and solar cells. The *Handbook of Batteries and Fuel Cells* is a comprehensive, 1088-page reference text book covering all types of battery systems and fuel cells. It is edited by David Linden (1984) and published by the McGraw-Hill Book Company of New York.

Academic Press of London publishes a complete reference text called *Lithium Batteries*. It is edited by Jean-Paul Gabano (1983). This is a very in-depth discussion of various types of lithium batteries and their applications.

Dynamic Learning Systems has recently added two new disk-based learning packages to their emerging line of educational/consumer software. *The Battery Tutor* and *The Solar Cell Tutor* are designed to run on IBM and compatible systems with more than 256K of memory. These inexpensive and informative packages use interactive text and graphics to explain the operation and principles of major battery families. They can also provide invaluable aid to hobbyists by modeling ampere-hour performance and assisting with battery evaluation. For more information on those software packages send a self-addressed, stamped envelope to Dynamic Learning Systems, P.O. Box 1393 Federal Station, Worcester, MA 01601. ■

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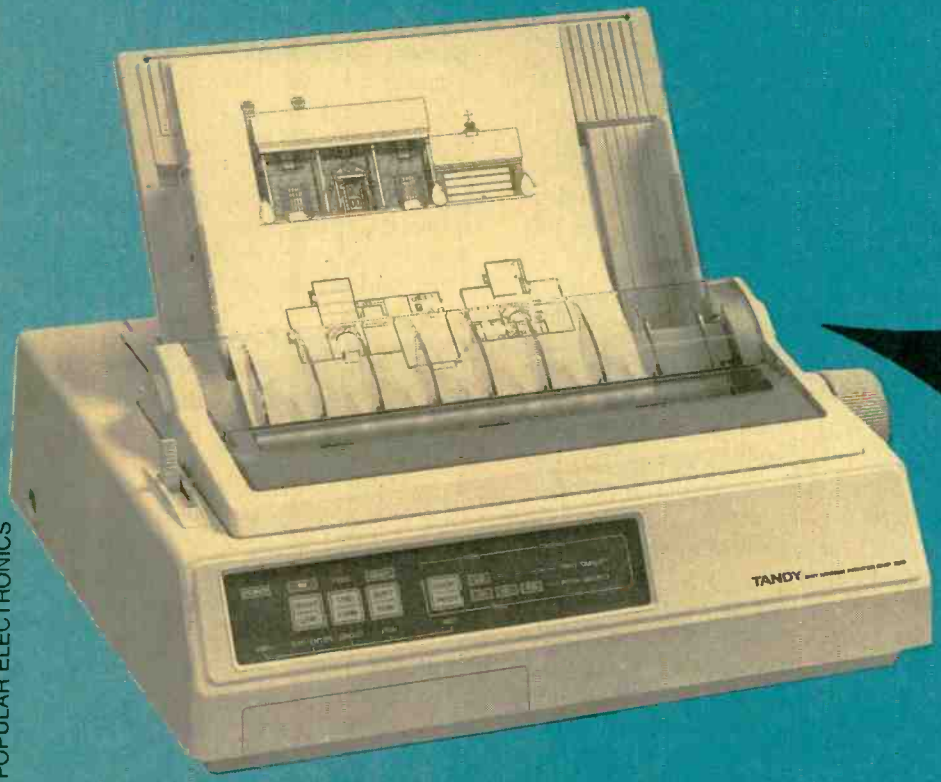
THE COMPUTER CONNECTION

BY JOSEPH J. CARR

Over the years many different ways of interfacing computers have come into being; each considered the "standard" of its time. The odd thing is that once such a "standard" becomes technically awkward, it is not completely replaced by any new schemes. Even though a new standard is adopted, the older interface schemes still enjoy wide popularity. That has lead to the coexistence of many incompatible interface methods. The pupose of this article will be to familiarize you with some of the more popular interface schemes around, and to give you some ideas on how to overcome their differences.

The Current-Loop Concept. Although most authorities would agree that the 20-mA loop is obsolete for modern designs, there is still a large amount of such older equipment on the market. When replacing old equipment, it is prudent in most cases to simply buy a new unit that operates from a 20-mA loop rather than redesigning the whole system. Also, hobbyists and smaller users sometimes take advantage of the lower-priced 20-mA loop equipment sold as surplus when larger users upgrade their systems.

One of the earliest peripherals was the teletypewriter machine. Those typewriter-like machines used electrical solenoids to either pull in type bars, or (in later models) to position the type cylinder. The original devices used the now-obsolete "baudot code," sent via a 60-mA current. Later versions of the teletypewriter machine used a 20-mA current loop and ASCII code; they were generally more sophisticated than previous designs. Some modern



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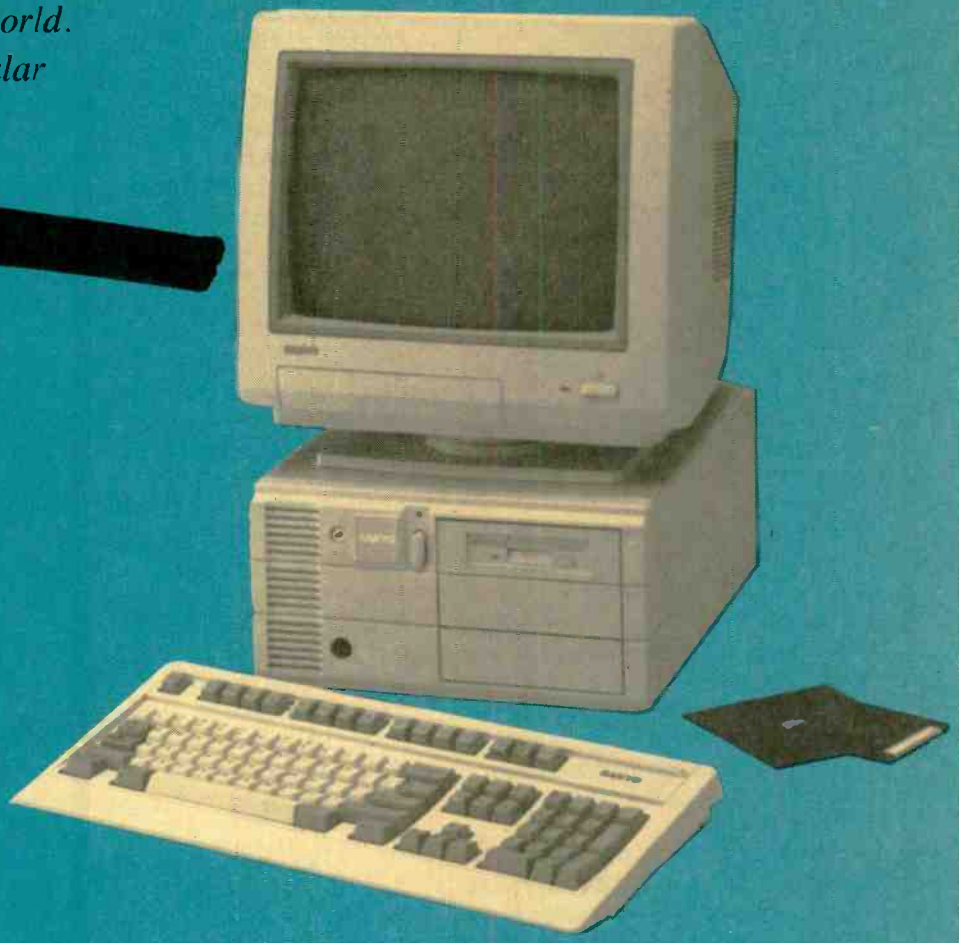
For computers to be truly useful, they need some way to exchange information with the outside world. Here's a look at the most popular interfacing schemes today.



teletypewriters do dot-matrix printing and contain an eight-inch floppy disk to store a magnetic copy of the data transmitted and received.

Figure 1 shows the basic elements of a teletypewriter or other printer based on a 20-mA current loop. (That current level was chosen for the sake of example; a 60-mA loop works the same way.) The keyboard and printer are actually separate, and they usually have to be wired together if a local loop is desired (*i.e.* where the keystroke on the keyboard produces a printed character on the same machine).

Of course that circuit is a gross simplification. In a real teletypewriter, there is an encoder wheel or circuit that produces the baudot- or ASCII-code output. The keyboard consists of a series of switches that actuate the encoder. Since those switches and their associated encoder are in series with the line, a "local switch" (which could really be a relay or solid-state switching circuitry) must be provided to bypass the transmitter section when receiving.

The receiver consists of a decoder and the receive solenoids that actually operate the typebar mechanism. Note in Fig. 1 that a 1N4007 diode is in parallel with the receive solenoid. That is to suppress the inductive spike that is generated when the highly inductive solenoids are de-energized. The diode is placed in the circuit such that it will be reverse-biased under normal operation. It is there to absorb the inductive kick-back from the solenoid. In some older machines, the inductive spike was safely ignored because the mass of the mechanism effectively filtered the spike. But modern (solid-state) equipment is not based on a 20-mA loop. The solid-state components can be damaged by the high-voltage spike, so it is recommended that a 1N4007 be used.

When the loop is closed, the circuit of Fig. 1 will produce a readable signal. Another similarly designed teletypewriter will be able to read the current variations produced by the machine and so communicate.

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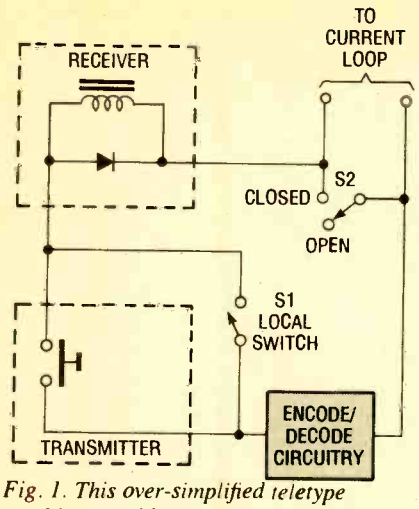

Fig. 1. This over-simplified teletype machine should give you a rough idea of how simple switches and solenoids were used in such devices. Note the protective diode.

A TTL/Current-Loop Interface. Figure 2 shows how to interface 20-mA equipment to serial TTL-compatible hardware. The circuits shown handle only one bit at a time, which is okay for handling serial data or parallel data that's been converted. Of course you could connect one such circuit to each bit output of a parallel device and use them in unison for pure parallel operation.

The circuit in Fig. 2A shows the transmitter arrangement (*i.e.* it receives TTL input and sends that information to the 20-mA device). As shown, the TTL signals are applied to an open-collector TTL inverter that has an LED inside an optoisolator as its load. Thus, when the TTL input is high, the LED turns on and the transistor is saturated. In that condition, the current loop transmits a "mark signal" (equivalent of a logic 1 in binary). With the LED off, the transistor is off and the loop is open, simulating the presence of a "space signal" (the current-loop equivalent of a logic 0).

The receiver half of the interface is shown in Fig. 2B. An optoisolator is used there also, but in "reverse." There, the LED is connected in series with the current loop. Thus, when a mark signal is transmitted, the LED will be turned on; when a space signal is transmitted, the LED is turned off. With the LED on, the optoisolator's phototransistor is saturated, and the input to the TTL inverter is low. That results in a high inverter output to the computer. Without current flowing to the LED, U1's output is low. The capacitor shown in the figure is used for noise suppression.

Both the receiver and transmitter shown in Fig. 2 can be used with 60-mA loops, provided the resistor values are selected accordingly.

RS-232C Serial-Port Standard. The current loops discussed previously were the earliest form of interface to peripherals, and are still in use (although they're declining in popularity). We will now discuss what is probably the most common form of voltage-operated serial-communications standard: RS-232C.

Serial-data communication requires only one channel (*i.e.* a pair of wires, or a radio or telephone channel), so it is ultimately less costly than parallel data transmission. The benefit is especially noticeable on long-line systems where the cost of wire and/or telecommunication channels becomes important. For that reason, if for no other, serial-data transmission is popular.

The Electronic Industries Association (EIA) RS-232C standard concerns itself with serial-data transmission using voltage levels, as opposed to current levels. The standard calls for the use of a 25-pin D-shell standard connector (the DB-25). Most of its pins are each assigned a specific "job," although not all of the assigned pins need be used by a particular device. In that respect it is a "non-standard standard." The loose standard makes it easy to interconnect some devices and hard to interconnect others. The DB-25 connector pin assignments for the RS-232C are shown in Table 1.

Such connectors and cables are readily available on the market. Some companies offer complete cables, including connectors, while other sources offer only the connectors with the view that you will "roll your own." That's because, as we mentioned before, not all of the assigned pins are always used, (more on that later).

Furthermore, a large collection of peripherals (modems, printers, video terminals, etc.) have DB-25 connectors, but some of them don't follow the RS-232C standard in any respect. Thus, the presence of a DB-25 connector on a device is not adequate proof that it is RS-232C compatible.

Interfacing TTL and RS232 equipment. The RS-232C standard is older than most of our present-day digital devices, and so uses an almost obsolete set of voltages. In the RS-232C format, a logic 1 is represented by a voltage between −5 and −15 volts, while a logic 0 is represented by a voltage between

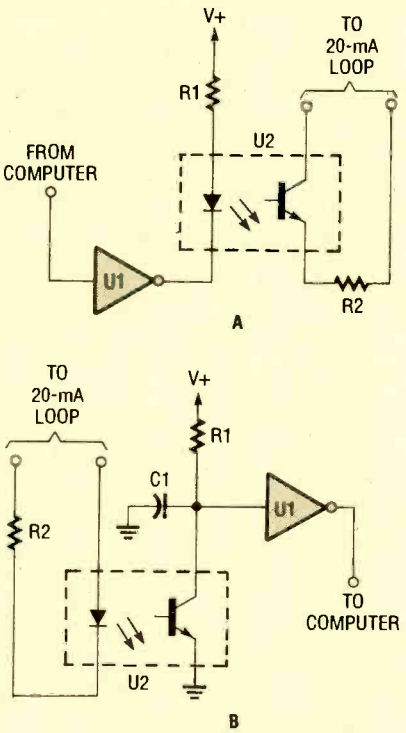

Fig. 2. Conversion between TTL and 20-mA data-transmission formats can be accomplished with circuits as simple as these. These circuits will work with 60-mA loops as well, provided the right resistor values are used.

TABLE 1—RS-232 PIN ASSIGNMENTS FOR DB-25 CONNECTOR

Pin No.	NAME	FUNCTION
1	AA	Chassis ground/ common
2	BA	Data from terminal
3	BB	Data received from modem
4	CA	Request to send
5	CB	Clear to send
6	CC	Data set ready
7	AB	Signal ground
8	CF	Carrier detection
9	(x)	
10	(x)	
11	(x)	
12	(x)	
13	(x)	
14	(x)	
15	DB	Transmitted bit clock (internal)
16	(x)	
17	DD	Received clock bit
18	(x)	
19	(x)	
20	CD	Data terminal ready
21	(x)	
22	CE	Ring indicator
23	(x)	
24	DA	Transmitted bit clock (external)
25	(x)	

(x) = unassigned

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TABLE 2—PARALLEL-PRINTER INTERFACE PIN STANDARDS

Pin No.	Signal Name	In or Out	Function
1	STROBE	IN	Strobe to read data in. Pulse width 0.5 μs
2	DATA1	*	Data bits
3	DATA2	*	" "
4	DATA3	*	" "
5	DATA4	*	" "
6	DATA5	*	" "
7	DATA6	*	" "
8	DATA7	*	" "
9	DATA8	*	" "
10	ACKNLG	OUT	Data received and printer is ready to accept more data. Pulse width 5 μs
11	BUSY	OUT	Printer cannot accept new data.
12	PE	OUT	Out-of-paper signal. Active-high.
13	SLCT	OUT	Printer selected.
14	AUTOFEED XT	IN	Automatic paper-feed signal
15	(x)	NA	
16	OV	"	Logic signal common
17	CHASSISGND	"	Chassis ground (isolated from logic ground).
18	(x)	NA	
19	(return for pin 1)	"	Pins 19-30 are twisted-pair returns for signal pins 1-12, and are at ground potential
20	(return for pin 2)	"	
21	(return for pin 3)	"	
22	(return for pin 4)	"	
23	(return for pin 5)	"	
24	(return for pin 6)	"	
25	(return for pin 7)	"	
26	(return for pin 8)	"	
27	(return for pin 9)	"	
28	(return for pin 10)	"	
29	(return for pin 11)	"	
30	(return for pn 12)	"	
31	INIT	*	Reset printer to initial state. Pulse width 50 μs
32	ERROR	*	Low if "paper-end" state, "off-line" state, or "error" state.
33	GND	NA	(same as pins 19-30)
34	(x)	"	
35	—		Pulled-up to +5 VDC through 3300 ohms
36	SLCTIN		Data entry to printer possible in active-low.

(x) = unassigned
* = IN on receivers (e.g. printer) and OUT on computers

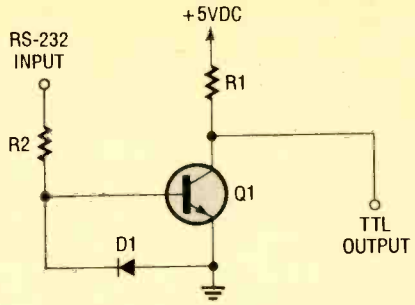

Fig. 3. A one-transistor circuit is all that is needed to convert RS-232C signal levels to their equivalent TTL values. Note the diode used to protect Q1.

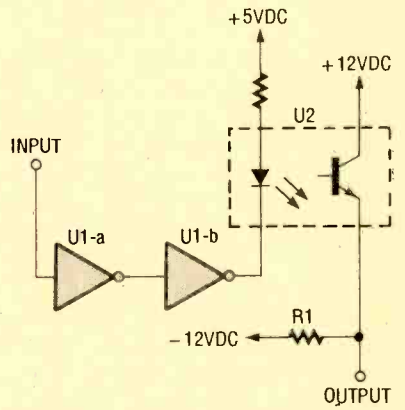

Fig. 4. Two levels of inversion are necessary on the TTL side of this TTL-to-RS-232C converter. That's because most inverters can't be used as a current source for the diode.

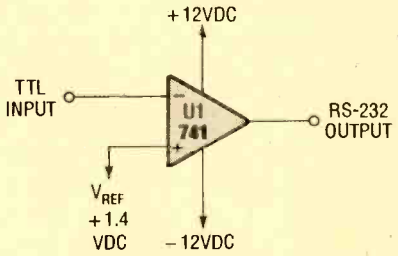

Fig. 5. This is an op-amp version of a TTL-to-RS-232C convertor. It looks nice and simple, but it requires 3 different voltages to work.

+5 and +15 volts. Since most digital equipment today is based on TTL-compatible formats, some level translation is needed to take advantage of the old standard. Perhaps the most common method for doing that is to use the Motorola MC-1488 line-driver and MC-1489 line-receiver chips.

There are other methods, like the one shown in Fig. 3. That circuit converts RS-232C input to TTL output. The active element is an NPN transistor connected in a common-emitter configuration. When the transistor is turned off (*i.e.* unbiased), the circuit produces a TTL high output; but when the transistor is turned on it is saturated, so the output will be close to ground (the TTL low condition). The transistor is controlled by the signal applied between the base and emitter. In the RS-232C high condition, the input is at −12 volts, so the transistor is reverse biased. Under that condition the transistor is turned off, so the output is high. The −12 volts is clipped by the diode (D1) so as to not damage the transistor. During an RS-232C low, the input is at +12 volts, so the transistor is turned on hard (saturated) and a low appears at the TTL output.

The circuit shown in Fig. 4 is used to convert TTL levels to RS-232C levels. The circuit is based on an optoisolator. The driver shown on the LED side of the circuit can be made from a pair of TTL open-collector inverters in cascade as shown, or from a single CMOS non-inverting buffer (B-series CMOS only).

The TTL-to-RS-232C converter circuit shown in Fig. 5 is based on the popular 741 operational amplifier. The −12-VDC and +12-VDC power supplies used for the operational amplifier are the source of the RS-232C voltage levels. The TTL input is biased by a reference voltage (V_{ref}) of 1.4 VDC applied to the non-inverting input to provide some immunity to noise.

RS-232C Devices. Their are two types of devices that are supported by the RS-232C standard: data-terminal

(Continued on page 94)

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TYPING PRACTICE PROGRAM

This simple BASIC program can help you increase your typing speed and accuracy!

BY JAMES E. TARCHINSKI

When they see a computer or typewriter keyboard for the first time, children generally react with their characteristic candor. Although the exact words may vary, the main point still comes across, always modulated by a slight tone of confusion.

"The keys are all mixed up!"

Formulating a response to that statement can be difficult. After all, when someone's right, they're right; the keys on a standard keyboard are poorly arranged (see Fig. 1). Because they have been consistently arranged in that manner for so long, however, there is little hope of ever establishing a logical organization. There is another keyboard type called the Dvorak that has a more logical orginization to its layout, but it hasn't become very popular. All we can do is learn to make the best of the situation.

For both children and adults, making the best of the situation means learning the keys to a point where you can type as fast as possible without sacrificing accuracy. There is only one road which leads to that point, the same path you must take to get to Carnegie Hall: Practice!

To the Rescue. While any form of typing practice will increase your speed, only a logical progression of typing drills will advance your abilities in the shortest period of time. The Typing Practice Program (TYPE-PR.BAS) is a computer program in BASIC designed as a tool to give you that practice. Although the listing given here is for the IBM PC and PC-compatible computers, it is a straight-forward program that can be easily modified to run under other implementations of the BASIC language.

If you've never typed before, now is the time to start. If you've spent years typing with just two fingers, now is the time to teach the other eight to carry their share of the load. If you're an expert typist capable of 160 words per minute with no mistakes, now is the time to skip ahead to the next article...or is it?

Because computer technology changes so rapidly, even a fast typist will probably be using a different machine in a few years time. A new machine means a new keyboard. That, in turn, means teaching your fingers how to type all over again. Granted learning a new keyboard is not nearly as troublesome as the original education from square-one, but TYPE-PR.BAS can be just as useful.

Using TYPE-PR.BAS. Before you can run TYPE-PR you must first load it into your computer's memory. If you're not sure how to accomplish that, consult either your DOS manual (under the section describing the BASICA language), or if you have one, the BASICA manual. A simplified version of the process goes like this:

1) With the DOS disk in drive A, type "BASICA" at the "A" prompt and press the return key.

2) Enter the program exactly as it is shown in Listing 1, being sure to include line numbers.

3) Save the program on a formatted disk (not your DOS disk) by entering the command SAVE "TYPE-PR" and pressing the return key.

Once you've entered the program simply execute the RUN command to get the program started. The first thing you will see, after the screen is cleared, is a prompt requesting you to enter a random number. The computer will use the number you input as a "seed" to allow it to produce different sequences of letters each time you run the program. When you enter a number in the

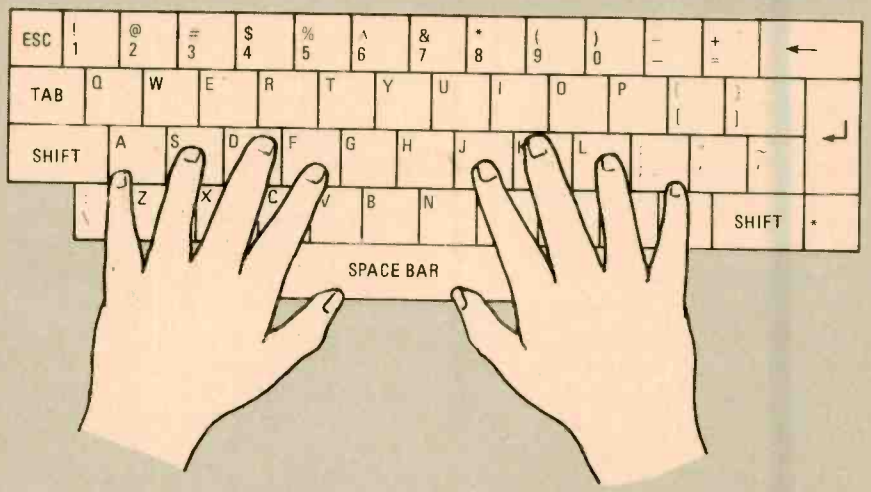

Fig. 1. This diagram of the standard keyboard shows the fingers in the "home" position—their location between key strokes. We'll have to live with this configuration, even though it would be easier to type if the most frequently used keys (such as "E" and "T") were located in the home position.

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given range, the program continues and you'll see a short introduction screen appear.

The Mode-Selection Menu is displayed next. The menu allows you to select one of four modes of operation or, by entering "5" at the prompt, it allows you to exit the program and return to the BASIC language. Of the other four selections on the menu, choices 1–3 are all self explanatory. Selection 4, however, is not so self explanatory, even though it is the most useful mode.

Selecting number 4 (the user definable mode) allows you to tell the program exactly what keys you would like to be quizzed on, up to a maximum of 100. That is how you can use TYPE-PR.BAS to provide a logical progression of typing drills. Start by practicing only a few keys and then, each time you use the program, slowly expand the number keys you use to quiz yourself. It is suggested that you learn the keys in the following order:

ASDFJKL;GHETIOURYPQWBNVMC,X.Z'?.

Also, most typing instructors suggest that you do not look at the keyboard. Keep your eyes fixed on the screen at all times so that your hands, not your eyes, learn where all the keys are.

Program Description. Figure 2 contains a flow chart that illustrates how TYPE-PR.BAS is structured. Although the diagram makes it look quite complex, the program is really fairly simple, consisting of only four main sections. The operation of each of the segments is described as follows:

Program initialization takes place in the first segment of code, which is comprised of lines 1000–1230. First, the program's variables are cleared and the A$ variable is dimensioned to a length of 100. Next, the screen is configured for 80-column text mode, a RANDOMIZE instruction is executed, and the screen is cleared. Finally, in lines 1030–1230, a short introduction/instruction screen is displayed and the program pauses until the user presses a key to continue operation. Line 1220 clears the keyboard buffer while line 1230 actually does the waiting.

In the next section of TYPE-PR.BAS, the segment from line 1240 to line 1370, deals with the program's menu. Besides presenting a choice of four different groups of characters to be quizzed on, as described earlier, the menu also allows the user to exit the program gracefully by selecting item five. If a number less than one or greater than five is entered in line 1340, the error message of line 1360 will be displayed and the menu will again be displayed.

After the user makes a correct selection, the program proceeds to fill the A$

(Continued on page 93)

LISTING 1

```
1000 CLEAR : DIM A$(100) : SCREEN 0,0,0,0 : COLOR 10,0,0
1010 KEY OFF : WIDTH 80 : RANDOMIZE : CLS
1020 '
1030 PRINT "*****************************************************************"
1040 PRINT "*                                                               *"
1050 PRINT "*          TYPE-PR.BAS:  The Typing Practice Program            *"
1060 PRINT "*                                                               *"
1070 PRINT "*               (c) 1988 by James E. Tarchinski                 *"
1080 PRINT "*                                                               *"
1090 PRINT "*****************************************************************"
1100 COLOR 11
1110 PRINT
1120 PRINT "  This program is a flexible aid designed to help you learn to"
1130 PRINT "type faster and more acurately.  You will be given the"
1140 PRINT "opportunity to select which of four modes of operation you"
1150 PRINT "would like to utilize."
1160 PRINT
1170 PRINT "  If you wish to change the mode of operation, or if you wish"
1180 PRINT "to exit the program, just press the 'Esc' key at any time and"
1190 PRINT "the program will return to the mode selection menu."
1200 LOCATE 23,1 : COLOR 7 : PRINT "Press any key ...";
1210 '
1220 INS=INKEY$:IF INS<>"" THEN GOTO 1220
1230 INS=INKEY$:IF INS= "" THEN GOTO 1230
1240 WIDTH 80 : CLS
1250 PRINT
1260 PRINT "-=-=-=-= MODE SELECTION MENU =-=-=-=-"
1270 PRINT
1280 PRINT "Which mode would you like to use?" : PRINT
1290 PRINT "  1. Upper case letters only"
1300 PRINT "  2. Upper and lower case letters"
1310 PRINT "  3. Keypad characters"
1320 PRINT "  4. User Definable"
1330 PRINT "  5. EXIT PROGRAM" : PRINT
1340 INPUT "Your choice (1-5): ",INS : M=VAL(INS)
1350 PRINT
1360 IF M > 5 OR M < 1 THEN  PRINT "PLEASE ENTER A VALID NUMBER!": GOTO 1250
1370 '
1380 CLS
1390 CT=0 : WG=0
1400 IF M=5 THEN END
1410 '
1420 '
1430 '************** GENERATE THE KEY STRINGS ****************************
1440 '
1450 IF M<>1 THEN 1490
1460FOR I=1 TO 26 : A$(I)=CHR$(I+64) : NEXT
1470NC=26 : GOTO 1690
1480 '
1490 IF M<>2 THEN 1540
1500FOR I=1 TO 26 : A$(I)=CHR$(I+64) : NEXT
1510FOR I=27 TO 52 : A$(I)=CHR$(I+70) : NEXT
1520NC=52 : GOTO 1690
1530 '
1540 IF M<>3 THEN 1600
1550FOR I=1 TO 10 : A$(I)=CHR$(I+47) : NEXT
1560A$(11)="." : A$(12)="+" : A$(13)="-" : A$(14)="="
1570NC=14 : GOTO 1690
1580 '
1590 '
1600 I=0 : PRINT "Enter the keys to be quized on (RETURN to exit)." : PRINT
1610 PRINT "Key #";I;": ";
1620 INS=INKEY$ : IF INS="" THEN 1620
1630 IF INS=CHR$(13) THEN 1660
1640I=I+1 : A$(I)=INS : PRINT INS
1650IF I<100 THEN 1610
1660 NC=I
1670 '
1680 '
1690 '************** MAIN PROGRAM LOOP ***********************************
1700 '
1710 WIDTH 40
1720 CLS : PRINT "Correct:                Incorrect: "
1730 LOCATE 1,10 : PRINT CT : LOCATE 1,33 : PRINT WG
1740 KY = INT(RND(1)*NC+1) : IF KY=KY.OLD THEN 1740
1750 KY.OLD = KY
1760 '
1770 LOCATE 15,20 : PRINT A$(KY) : LOCATE 20,1
1780 '
1790 INS=INKEY$ : IF INS="" THEN 1790
1800 IF INS=CHR$(27) THEN 1240
1810 '
1820 IF INS=A$(KY) THEN CT=CT+1 : GOTO 1730
1830 '
1840 BEEP : WG=WG+1 : LOCATE 1,33 : PRINT WG; : GOTO 1790
```


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THE DIGITAL ELECTRONICS COURSE

FLIP-FLOP APPLICATIONS

Learn how flip-flops can be used in real-world applications by performing these simple experiments.

BY ROBERT A. YOUNG

Just as logic gates can be combined to form more complex circuits, so too can flip-flops be combined to form important digital-logic circuits like counter/dividers, signal and clock generators, memories, registers, converters, signal regenerators, and many even-more complex devices.

D Flip-Flop Applications. In order for you to fully comprehend what is being said, lets pose a need and set up a circuit to satisfy it. Let's say that a tube leading to a manufacturing machine must be filled with some material and that the task is accomplished by opening a solenoid valve. The open valve allows the material to flow into the tube when it's empty, and remains open until the tube is full. When the tube is full, the flow is automatically turned off (closes), and remains that way until the tube is completely devoid of the material, at which time the sequence is repeated.

How might that monitoring/regulating task be accomplished? First we'll need some sort of level-sensing device. The level of the material within the tube can be sensed using a photo-detector and a light source in a light-triggered circuit like that covered when we discussed comparators (**Popular Electronics** February 1990).

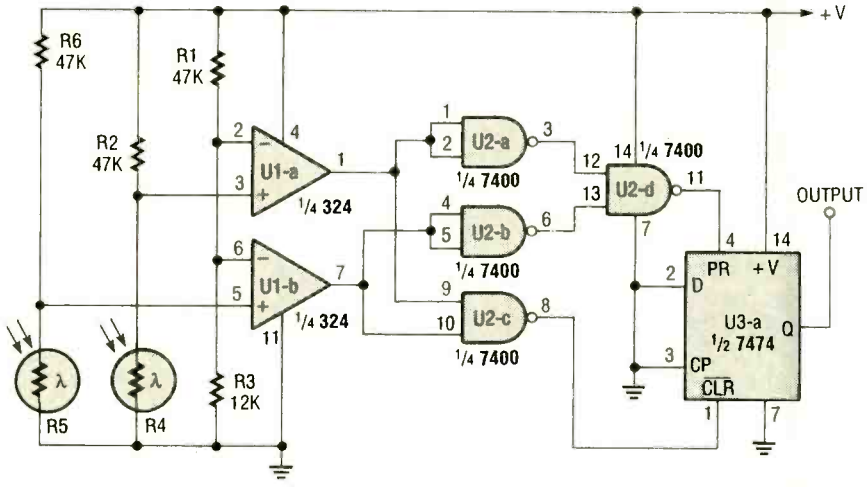

Fig. 1. This D flip-flop based circuit can be used to monitor the amount of material in a supply tube or other container.

The circuit would also need some way of determining the condition of the tube by examining the outputs of the comparators. That task can be handled by a gating (decoder) circuit that would decode the comparator outputs to determine what action to take. The decoded outputs of the gating circuit could then be fed to a flip-flop to control a solenoid with a toggle action, perhaps through a relay (depending on the solenoid's current requirement).

Such a circuit (minus the relay and solenoid) is shown in Fig. 1. In that circuit, the comparator outputs are fed to a NAND gate circuit, which is used to decode the outputs of the comparators (U1-a and U1-b). The decoded outputs of the comparators are then fed to the preset (PR) and clear (CLR) terminals of a D flip-flop.

Now let's imagine that the two sensors (R4 and R5) are placed at opposite ends of the tube to be monitored, each accompanied by a constant light source aimed directly at its respective sensor. When power is applied to the circuit and the tube is empty, the preset terminal of the flip-flop is pulled low, forcing the flip-flop's Q output to go high. When the tube is full, on the other

*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.

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PARTS LIST FOR THE FIG. 1 EXERCISE

U1—LM324 quad op-amp, integrated circuit
U2—7400 quad 2-input NAND gate, integrated circuit
U3—7474 dual D flip-flop, integrated circuit
R1, R2, R6—47,000-ohm, ¼-watt, 5% resistor
R3—12,000-ohm, ¼-watt, 5% resistor
R4, R5—Light-dependent resistor (0.5-megohm dark resistance, 100 ohms in full light)
Breadboard, +5-volt power source, wire, etc.

hand, the clear terminal of the flip-flop is pulled low, causing the Q output of the flip-flop to go low.

Figure 2 shows the same operation implemented using a 7486 exclusive OR (XOR) gate and a 7404 inverter, which together form a XNOR gate, instead of the 7400 NAND gate shown in Fig. 1.

D Flip-Flop Exercise. Breadboard the circuit shown in Fig. 1, and connect a logic probe to the Q output of the flip-flop. Apply power to the circuit, and leave both sensors uncovered to simulate an empty tube. Under that condition, the following should occur:

- The preset ($\overline{PR}$) input terminal should be low. Is it?
- The clear ($\overline{CLR}$) input terminal should be high. Is it?
- The Q output of the flip-flop should be high. Is it?

Next cover both sensors (R5 and R4) to simulate a full tube, and the following conditions should occur:

- The preset ($\overline{PR}$) input of the flip-flop should be high. Is it?
- The clear ($\overline{CLR}$) input terminal should be low. Is it?
- The Q output of the flip-flop should be low. Is it?

If the output your circuit does not follow the above sequence of events, check the wiring to the circuit and repeat the experiment. If it does perform as described, power down the circuit, and breadboard the circuit shown in Fig. 2.

After assembling the circuit, apply power and momentarily cover one of the sensors. Then remove the cover so that both sensors are uncovered to sim-

PARTS LIST FOR THE FIG. 2 EXERCISE

U1—LM324 quad op-amp, integrated circuit
U2—7400 quad 2-input NAND gate, integrated circuit
U3—7474 dual D flip-flop, integrated circuit
U4—7486 quad 2-input XOR gate, integrated circuit
U5—4704 hex inverter, integrated circuit
R1, R2, R6—47,000-ohm, ¼-watt, 5% resistor
R3—12,000-ohm, ¼-watt, 5% resistor
R4, R5—Light-dependent resistor (0.5 megohm dark resistance, 100 ohms in full light)
Breadboard, +5-volt power source, wire, etc.

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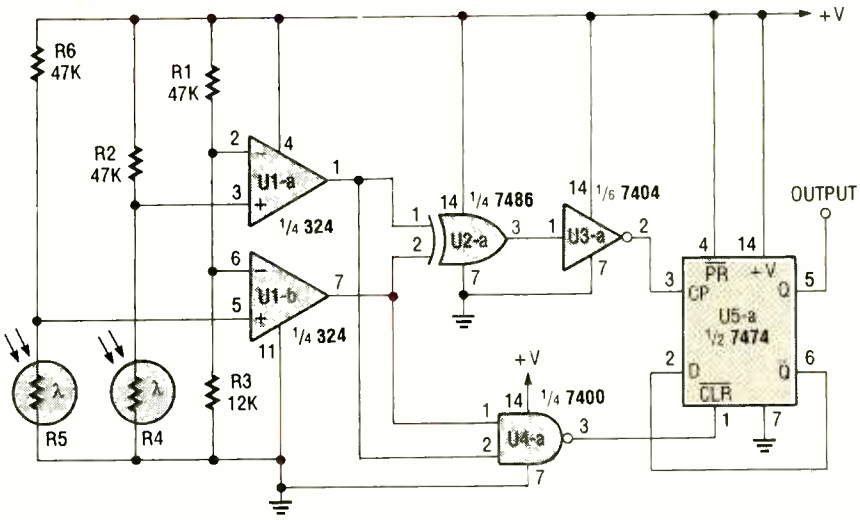

Fig. 2. The NAND-gates in Fig. 1 are replaced here with a 7486 exclusive OR gate and a 7404 inverter.

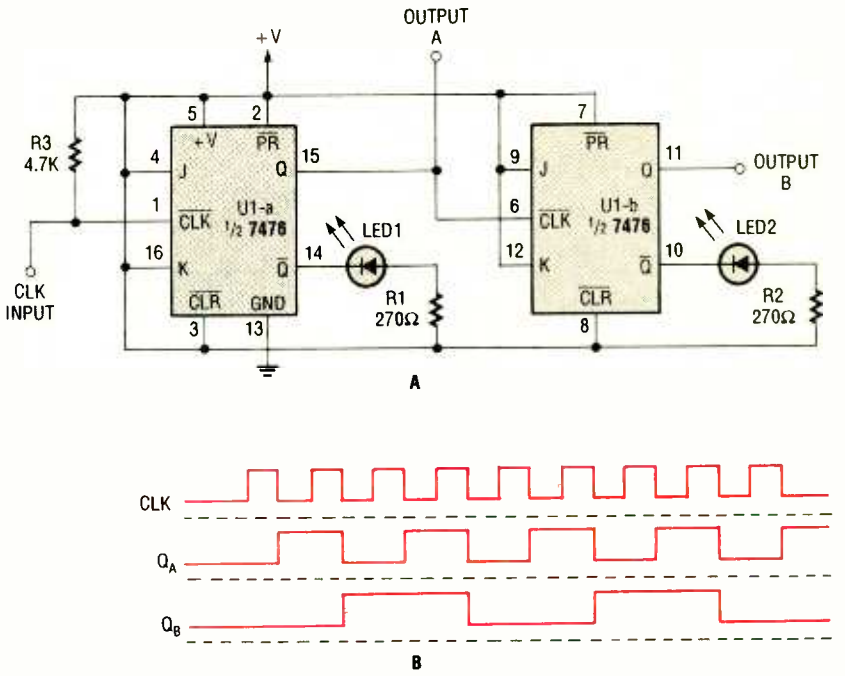

Fig. 3. A 7476 dual JK flip-flop is shown configured as a simple two-stage ripple counter in A. The timing diagram for the circuit is show in B.

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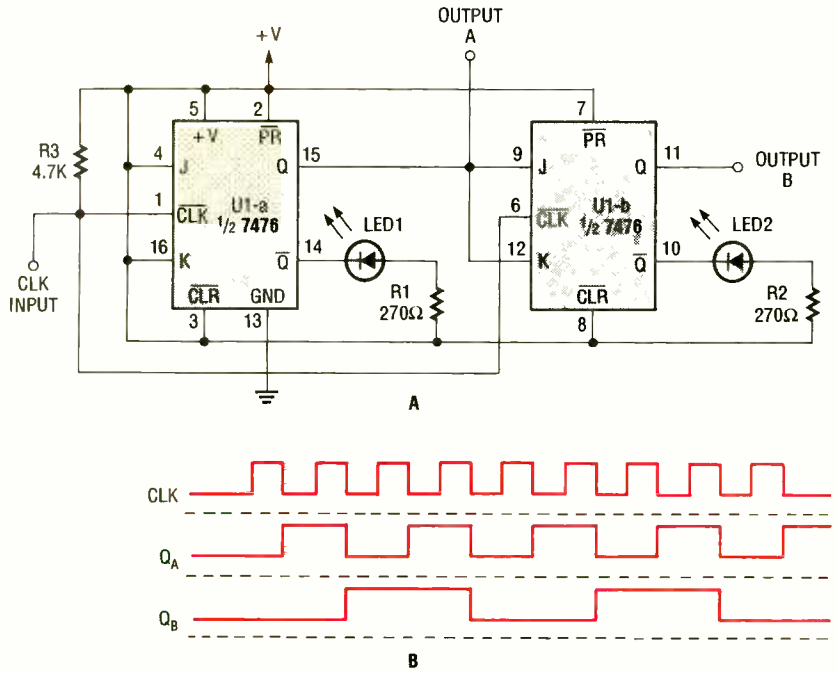

Fig. 4. In a synchronous counter like the one shown in A, all of the clock lines are tied to a common point. The timing diagram for the circuit is shown in B.

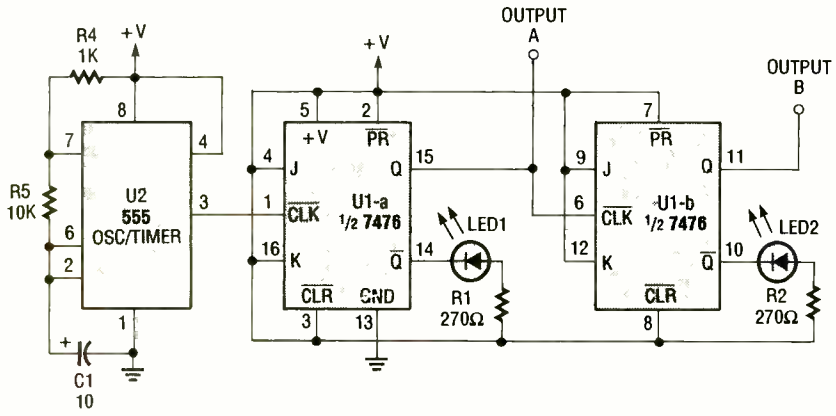

Fig. 5. To test the operation of a ring counter, the circuit of Fig. 3 is modified and the output of a 555-based astable multivibrator is connected to the clock input of U1-a.

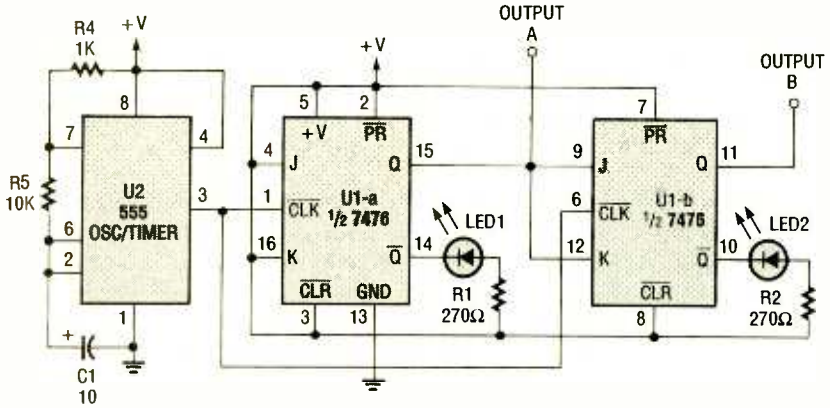

Fig. 6. Use the test circuit shown here to verify that a synchronous counter operates as described in the text.

PARTS LIST FOR THE JK FLIP-FLOP EXERCISE

U1—7476 dual JK flip-flop, integrated circuit
U2—555 oscillator/timer, integrated circuit
LED1, LED2—Jumbo light-emitting diode
R1, R2—270-ohm, ¼-watt, 5% resistor
R3—4700-ohm, ¼-watt, 5% resistor
R4—1000-ohm, ¼-watt, 5% resistor
R5—10,000-ohm, ¼-watt, 5% resistor
C1—10-µF, 16-WVDC, electrolytic capacitor
Breadboard, logic pulser (see text), +5-volt power source, wire, etc.

ulate an empty tube. Doing so should cause the Q output of the flip-flop to go high. Did it?

Next cover one of the sensors to simulate a filling tube, and then the other one to simulate a full tube. The Q output of the flip-flop should now be low. Is it?

JK Flip-Flop Applications. The flip-flop, like the logic gates that comprise them, can be combined (sometimes with additional gating) to form more complex logic circuits; chief among them are counters and dividers. There are two methods of connecting JK flip-flops to perform counting functions. The first and simplest method is as a ripple counter.

Figure 3A shows a 7476 dual JK flip-flop configured as a simple two-stage ripple counter. Such circuits are often used as frequency dividers. That characteristic is illustrated by the waveform diagram in Fig. 3B.

Note that the input clock frequency is twice that at the output of U1-a, and four times that at the output of U1-b. What those waveforms show is that the first flip-flop divides the input frequency by two, *i.e.*, two clock pulses are required for the flip-flop to complete one output cycle, and that the output of the first flip-flop is then divided by a factor of two by the second flip-flop. Also note that each division of the input signal also results in a doubling of the duration of each pulse.

The second counter application of the JK flip-flop is as a synchronous counter, as shown in Fig. 4A. Such counters can be made to count up (1, 2, 3, etc.) or down (9, 8, 7, etc.) in any order by way of some simple design techniques. In a synchronous counter cir-

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A Hands-on Electronics REPORT

GELLER SOFTWARE LABORATORIES' SPELLCODE

CIRCLE 120 ON FREE INFORMATION CARD

Correct the spelling in your databases and spreadsheets with a spelling checker that dares to go where none have gone before.

The corporation's big merger plan is complete and ready for presentation to the chief executive officer and his vice presidents. The chief accountant, the originator of the concept, burned the midnight oil for many evenings to make the entire presentation comprehensive, illuminating, and credible. Now, the big day has come, the meeting convenes, and the merger-plan folders are distributed at the conference table. The accountant is confident because he had his secretary run the text portion of the presentation through the word processor's spelling checker.

All was quiet for a few moments then snickers arose. One VP turns to the plan's originator and asks, "How do you spell separate?" Yes, an error slipped by, several in fact; not in the text, but in sections generated by other programs—spreadsheets, databases, etc. As you can well imagine, the plans were set aside for additional work. The chief accountant certainly did not elevate his stature on that day.

Until a few months ago, there was no suitable spelling-checker software that would have helped our troubled friend. Now there's *SpellCode from Geller Software Laboratories*, the first spelling-checker software aimed specifically at people who use databases, spreadsheets, and run-time programming languages (like BASIC). SpellCode offers unique features not provided by general-purpose, word-processing oriented spelling checkers. Those innovations make SpellCode uniquely suited to the requirements of programmers working in any of a variety of languages, or users of popular database-management and spreadsheet software.

The Theory. SpellCode provides two basic approaches to checking and correcting programs: It can check just the text displayed to users, or the entire contents of program files.

Both methods have their advantages. Professional programmers very often aren't professional spellers, and a *typo*, or misspelling, on a help screen, prompt, menu, or message can make even the best software look amateurish, or at the very least sloppy. That's why the ability to check all the user screens is important.

Checking the complete contents of program files is also beneficial. In this mode, SpellCode checks variable and constant names, in addition to the text the user sees. That can minimize annoying compiler or interpreter errors and greatly reduce certain types of bugs that can be tedious to track down.

SpellCode is supplied with a comprehensive English dictionary for checking ASCII text, and a special dictionary of common computer terms. It can handle statements from a variety of languages such as C, Pascal, BASIC, and Paradox, as well as DOS batch-file instructions. General-purpose checking modes work with ADA, Cobol, PL/I, Fortran, and many other languages.

In addition, SpellCode knows all the keywords used in databases like dBASE III PLUS, dBASE IV, FoxBASE+, FoxPro, Clipper (and the most popular third-party Clipper libraries too), dBXL, R:BASE, and Quicksilver.

The ability to check DBF (Data-Base File) databases and spreadsheets is unique to SpellCode. The header and formatting information in such files befuddles normal spelling checkers. SpellCode understands DBF structures, and allows you to select which character and memo fields to check. Similarly, a user can check the contents of Lotus 1-2-3 and Symphony worksheets.

Since SpellCode's prepackaged dictionary includes popular keywords, it works on program files very quickly; an important characteristic when checking large programs or databases. For example, on a 386/25-MHz machine, SpellCode takes only 34 seconds to check the displayed text from a complex dBASE application consisting of 84 files totaling 304K. Checking all the text

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Product Test Reports

By Len Feldman

Heath GR-9009 TV Receiver Kit

Many, many years ago I assembled a Heathkit color TV set with a good friend of mine. It must have taken us a full work-week to complete the job and another couple of days to properly align the set. How times have changed! Heathkits remain the best "do-it-yourself" electronic products for hobbyists who enjoy assembling kits, but the ease with which they go together these days is in sharp contrast to the drudgery that was involved in such pursuits years ago.

The *Heath GR-9009* 9-inch portable color TV set took no more than a full working day plus a bit of "overtime" to assemble—9 hours and 30 minutes to be exact. The test procedure took another 3 hours, while final assembly after testing took another hour. The total time required: 13 hours and 30 minutes. We'll have more to say about the assembly procedure and the instruction manual later. For the moment, let's consider the many features offered by this fine little TV set.

The set uses a picture tube that is made with reflection-absorbing glass for good contrast and color fidelity. Its black matrix and tinted phosphors provide bright, excellent color purity, while an in-line gun produces good picture detail and sharpness even along the edges and in the corners of the picture.

The TV's tuner can be tuned to all VHF/UHF stations and to 122 cable-channel frequencies. Tuning is electronic and quartz-controlled. The phase-locked loop tuning system has a search position that pulls in off-frequency channels that you might receive from some cable systems, master antenna systems, or video games. Up and down channel scanning is programmable so that you can receive only favorite or locally available channels. There's a two-second delay when you change channels that permits you to enter two-digit channel numbers on the front panel number keys, but if that's too long for you to wait, you can press an enter button after selecting the channel number and the tuner switches over to the new selection instantly.

Automatic color and picture controls maintain accurate color, tint, color saturation, contrast, and brightness. A cross-hatch generator is built into the set and is used for adjusting convergence and for color-purity adjustments. Digital picture-hold circuitry eliminates the need for vertical- and horizontal-hold controls. The chassis itself is assembled using several modules, several of which contain large-scale integrated (LSI) circuits. Each module is completely pretested and factory aligned.

The set is billed as a "portable" since it operates on normal house current or on a 12-volt (DC) negative-ground automobile electrical system. Included with the kit is a fused power cord that plugs into a car's cigarette-lighter socket. An earphone is supplied for private listening and, since the set is likely to be used in an outdoor environment, there's a sun-screen that cuts glare and reduces reflections in strong, outdoor lighting.

CIRCLE 119 ON FREE INFORMATION CARD

Heath GR-9009 9-inch AC/DC portable TV.

Controls. Major operating controls for the Heath GR-9009 are located along the lower section of the front of the set. Those include a push-push power on/off switch, the 0 through 9 channel-selector pushbuttons, the enter button, up and down volume-control buttons, and up and down channel-scanning buttons. An LED display near the power switch shows channel numbers as well as various alphabetic notations. Also located on the front of the set is a skip button that allows you to skip or program out an undesired channel from the scan sequence as well as an AFC (Automatic Frequency Control) button. Finally, a band- selector switch sequentially switches from broadcast frequencies through three types of CATV frequencies (normal, HRC systems, and ICC systems).

Additional, secondary controls along the right side of the TV set include a picture control; a black-level control; and tint, color-level, and sharpness controls. An audio-output/earphone jack is also found on that side. The rear of the set is equipped with a five-pin receptacle that accepts either the supplied AC-power cord or the supplied DC- (car cigarette-lighter) power cord. The F-type antenna connector that's also located at the rear allows for easy hook-up to cable-TV systems or to antennas with 75-ohm coaxial down-leads; for those still using twin lead, a 300-ohm/75-ohm transformer is also provided with the set.

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Building the Set. Relatively few problems were encountered when one of Advanced Product Evaluation Laboratory's (APEL) staff members assembled this set. Of course, a few things did crop up:

The instruction manual and the separate pictorial book (which, by the way, contains some 30 pages of precisely drawn pictorials and illustrations that greatly aid in assembling the set) refer to a "terminal cover" that is to be installed on terminals of the deflection yoke. That cover was missing from the kit we assembled, but of course this did not affect performance.

In the adjustments section of the manual, the builder is told to "turn the G2 control until the entire screen just lights up. Disregard any white diagonal lines on the screen."

No further mention of the G2 control is made in the adjustment instructions. If this control is set even slightly too high, the CRT will not turn off completely for black portions of a picture, resulting in weak blacks, light diagonal lines in dark areas, and limited picture- and black-level-control range. APEL experienced this problem during construction. They feel that it might be so subtle that someone inexperienced in video measurements might not even be aware of it, and that they might therefore not obtain the high-quality picture with the full black-level range that this TV set can deliver. That possible problem would be eliminated if an additional step requiring the builder to set G2 for a black screen were added to the procedure used to set the black-level range.

In all fairness to Heath, however, we must mention that gross misadjustment of G2, where picture and black-level controls have little or no effect and the screen is always brightly lit, is covered in the Troubleshooting section of the manual.

The Test Results. Maximum usable luminance of this set, before noticeable blooming and defocusing occurred, measured 27 foot-lamberts. That is not as bright as APEL has measured for some other small sets, but is adequate for viewing in normal room lighting. In bright sunshine, pictures seemed a bit washed out. The included sun screen did help in this regard, especially when the set was not placed in a position where it could be hit by direct sunlight.

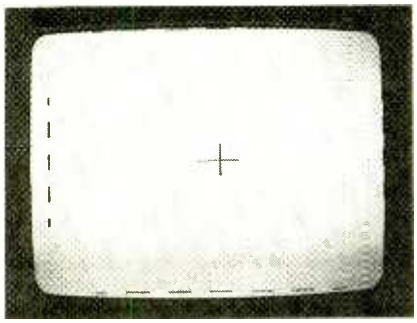

Fig. 1—The GR-9009 display showed overscan and was about 7% off-center.

Horizontal resolution measured 280 lines, which is really quite good for a small set of this type. Most such sets measured between 230 and 250 lines. Bear in mind that the maximum number of lines of resolution that can be broadcast under the NTSC television standard is only 330 lines. As for vertical resolution, it measured an impressively high 400 lines.

Transient response was very good—there was little evidence of the kind of overshoot that causes bright-white borders next to large objects in a scene. Black-level retention was perfect, measuring 100%. APEL found that when the deflection yoke is positioned for best purity and color convergence, the picture is both overscanned (extends beyond the limits of the screen face, thereby causing a loss of some of the picture edges) and about 7% off-center horizontally. Those effects are shown clearly in the photo of Fig. 1. A non-overscanned picture would show two sets of dotted lines near the horizontal and vertical edges of the screen.

When a strong signal was fed to the antenna terminal, the resulting picture was totally free of video noise (snow).

Color quality was deemed to be very good both by APEL and during our own hands-on evaluation of the TV set. Picture quality and tuner sensitivity were judged to be very good, too. When a 1000-microvolt standard video signal was fed to the antenna terminals, the resulting picture was totally free of any noise. When the same still picture was

(Continued on page 98)

TEST RESULTS—HEATH GR-9009 TV RECEIVER KIT

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

SPECIFICATION	APEL MEASURED OR COMMENTS
VIDEO SECTION	
Maximum Usable Luminance	27 Foot-Lamberts
Resolution, Horizontal/Vertical	280/400
Interlace	No Scan Lines Visible
Transient Response	Very Good
Black Level Retention	100%
Color Quality	Very Good
Overscan	10% (7% off center, See Fig. 1)
AUDIO SECTION	
Maximum Output for 3% Harmonic Distortion	0.9 watts
Total Harmonic Distortion, 1 kHz @ −10 dB	0.46%
Signal-to-Noise Ratio, A-weighted	34.7 dB
ADDITIONAL DATA	
Power Consumption	68 W AC; 4.6 amps DC
Picture Size	9-inch (diagonal)
Dimensions (H × W × D, inches)	1¼ × 10½ × 11¾
Weight	18 lbs.
Suggested Retail Price	$249.95 (plus shipping)

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Antique Radio

By Marc Ellis

NEW LIFE FOR TIRED TUBES

You've just completed your first antique-radio-restoration project. That flea-market purchase of last summer, a grimy, battery-operated 3-dialer, now gleams like new under your workshop fluorescents. The antenna and ground are hooked up, and you've checked at least five times to make sure that the set's multiple-conductor battery cable is wired to the proper taps on your newly-purchased battery eliminator.

As you slowly advance the filament rheostats, you're delighted and relieved to see a beautiful golden-yellow glow beginning to come from the filaments of all five 01-A's. It looks as if the tubes are good, so you increase the filament voltage a bit more and begin to tune around to see what you can pick up.

But the results are disappointing at best, and no amount of dial-twiddling can improve them. Your meticulously restored five-tube radio sounds more like a crystal set. Only a few strong local stations are coming in, and even those are just about audible in your headphones.

You can't find anything wrong with your restoration work, power hookup, or antenna system. But a few days later, a borrowed tube tester pin-points the problem. Though the 01-A's all have good filaments, they all test "weak." It would seem that most of the useful lifetime of these tubes had been expended by the time the radio was taken out of service some sixty-odd years ago.

Should you put the set aside until you can locate some better 01-A's and purchase them at what is likely to be considerable expense? Maybe. But not until you've tried a simple technique that the old-timers called *flashing*. Relax, this is not a punishable offense performed in a trench coat. It's actually an often useful technique that just might give your tired, old tubes a new lease on life!

Methods of Electron Emission. As most of you know, the operation of a vacuum tube (sometimes called an electron tube) depends upon a stream of electrons emitted by the tube's filament or cathode. To understand what flashing is and why it works, you have to know something about how the electron stream is produced.

The release of electrons is triggered by heat—the that is heat produced by the passage of an electric current through a metallic element that is centrally located within the tube. That element is called a "filament" when it releases the electrons from its own surface. The element is referred to as a "heater" when it's used to heat up a surrounding "cathode" which, in turn, generates the electron stream.

The latter technique, incidentally, was developed to facilitate the heating of tubes by alternating current. The relatively massive cathode doesn't cool down or warm up as rapidly as its heater. You might say that it has a much greater "heat inertia." Thus, the electron stream it produces remains relatively steady (and so creates very little hum in the receiver's audio) as the current in the tube heater periodically alternates between positive and negative values.

But you can't get a usable electron stream just by heating up any old metallic object. It was found early on that the oxides of certain metals in the "rare-earth" group (thorium, barium, calcium, and strontium) do give off an abundance of electrons when heated. However, those particular metals aren't strong enough, of themselves, to be formed into filaments. And—in any case—they don't conduct electric current very well.

One method of utilizing such oxides was to coat them onto the surface of the tube's filament or cathode. Another method used, especially with thorium, was to impregnate the oxide throughout the tungsten metal used to form the filament (which was also coated with a thin layer of thorium oxide). The impregnated tungsten metal was known as *thoriated tungsten*.

Over a period of time these oxide coatings would become used up, electron emission would drop, and the tube would become weak. When the oxide was present *only* as a coating on the filament or cathode, that meant that the ball game was over and the tube would have to be replaced. But when the tube contained a thoriated-tungsten filament, it was sometimes possible to bring emission back to normal by the rejuvenation technique known as "flashing."

The Why and How of Flashing. When a thoriated-tungsten filament is operated at its rated voltage, the normal evaporation of the thorium-oxide surface coating is constantly replaced by the diffusion of additional thorium from the interior of the filament. Thus, little by little, the thorium atoms are driven out and eventually are completely used up. When that happens electron emission drops, and the tube cannot be rejuvenated.

But when the filament is operated at voltages that are a little too high or too low, replacement does not occur at the same rate as evaporation. When the voltage is a little high, the surface thorium oxide evaporates faster than it is replaced, and electron emission drops. When the voltage is a little low, the replacement process is drastically retarded, and the surface oxide is gradually used up—once again reducing electron emission.

In both of those cases, although the thorium-oxide surface layer has become depleted, there are additional supplies of the rare earth metal locked within the structure of the tungsten fila-

TABLE 1—TUBE REACTIVATION CHART

Tube Type	Flashing Voltage (volts)	Flashing Time (seconds)	Aging Voltage (volts)	Aging Time (minutes)
'99	12	10	4	30
'20	12	10	4	30
'22	12	10	4	30
'01-A	16	10	7	30
'00-A	16	10	7	30
'40	16	10	7	30
'71	16	10	7	30
'10	16	10	9	30

Note: Tube types '11, '12, '00, '26, '27, '45, '50, '80, '81, and '71-A cannot be flashed.

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ment wire. And it is in those cases that the vacuum tube can be rejuvenated by flashing.

The flashing process actually consists of two steps, known as *flashing* and *aging*. The flashing step involves operating the filament at a specified overvoltage (usually at least 300 percent) for a given number of seconds. In the aging step, the voltage is reduced to a specified amount (still an overvoltage, but a much smaller one) and the filament operated for a given number of minutes.

The entire process is carried out with no grid or plate voltages present on the tube. When it is completed, a new supply of thorium will have been driven from the interior of the filament (if any is still present there) and deposited on the surface as an oxide. With that replenished oxide surface coating, emission of the tube will return to normal and performance will be dramatically improved.

Table 1 is based on the flashing and aging schedule recommended in one of the references I used for this article (*Radio Construction And Repairing* by Moyer and Wostrel, McGraw-Hill Book Co., 1933). According to the authors, the schedule was worked out through extensive experimentation in the laboratories of the Radio Corporation of America.

After publication of this chart, few new thoriated tungsten types were produced. In fact, it's safe to assume that any standard receiving tube introduced after 1929 has its electron emitter present only as a coating. Attempts to flash such tubes will not work; it will only destroy them by evaporating the coating.

Practical Considerations. Notice that the list of tubes that can be flashed includes two types commonly used in early battery sets: the '01-A and the '99. Regrettably, the often-sought, but rare, types '11 and '12 cannot be flashed. Also in the "cannot be flashed" section of the table are the tubes (such as the '26, '27, '45, '71-A, and '80) usually found in early AC-operated sets.

Newcomers to the antique-radio hobby may wonder why I've placed an apostrophe before each of the tube numbers mentioned in the last paragraph. Such an apostrophe was used often in the old radio literature to remind readers that the tube's prefix was being dropped. The prefix, usually comprised of two letters and a number, referred to the tube's base style and manufacturer.

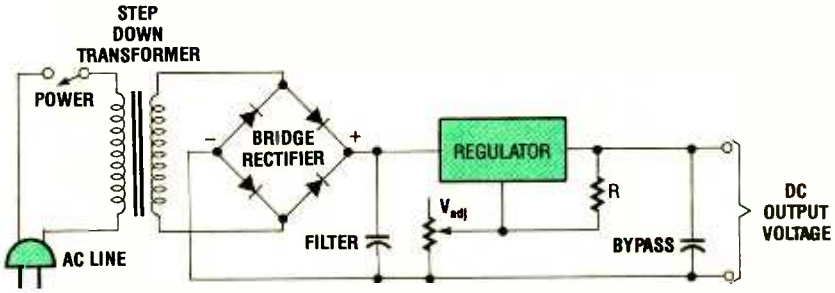

Fig. 1. This schematic shows how simple a variable-voltage power supply using a 3-terminal regulator can be to build.

As an example, the UX201-A was a type '01-A manufactured by RCA and having a base equipped with long pins instead of short stubby ones. The same tube manufactured by Cunningham would bear the designation CX301-A. And in either case, if the base were the stubby-pin type, the "X" would become a "V." But all '01-A's are essentially the same electrically, whatever their base and manufacturer.

I'm using the old-fashioned apostrophe in this text and the accompanying tables to remind you that a particular recommended flashing procedure will apply to any tube of the designated type, regardless of its prefix. (The prefix was dropped from tube designations some time in the early 1930's.)

According to Moyer and Wostrel, who were quoting the RCA recommendations, flashing may be carried out using either AC or DC voltages. It's important to use accurate means to measure the voltages so that they can be set reasonably close to the specified values. Accurate timing is also important. Use a clock with a sweep second hand, and stick closely to the recommended time intervals.

Voltage Sources. A number of different approaches can be used to obtain the necessary flashing voltages. Step-down transformers, rectifiers, and 3-terminal regulators covering the required voltage range are readily available from a number of sources, including Radio Shack. Using those, you can easily put together an inexpensive variable-voltage DC supply suitable for flashing. Though this is not a construction article for building such a unit, I've included a schematic of one (Fig.1) to show you just how simple the circuit can be. You should use components capable of handling loads of about 1.5 amperes.

Another method would be to use AC flashing voltages obtained by means of a small autotransformer (commonly called a "Variac," after its best-known brand name) wired into the primary circuit of a step-down transformer that delivers 20 volts or so (Fig. 2). The autotransformer is then used to vary the primary voltage, giving you precise control over the voltage appearing at the secondary. Small autotransformers in the required 1.5-amp range often turn up at hamfest flea markets, where they may be priced as low as a couple of dollars.

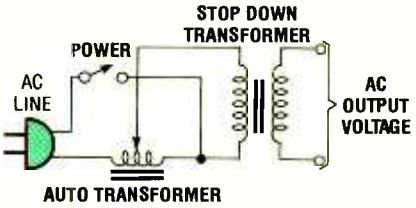

Fig. 2. This alternate power supply for flashing/aging uses a low-voltage transformer. The autotransformer in the primary provides precise control over the voltage available at the secondary.

Obtain a tube socket to fit the tube type you wish to flash, wire its filament connections to your AC or DC power source, and you are all set to go. Just be sure that you have an accurate meter (AC or DC, to match your source) for setting the correct voltage. If you can't get your hands on the correct socket, it's easy enough to rig a temporary alligator-clip connection to the tube's filament pins.

If you have a tube tester that accommodates the type you want to rejuvenate, you can use it to do the flashing as long as it can supply filament voltages close to ones required for the process. Just set the tester correctly for the tube type and select the required filament voltage. Plug in the tube to begin the

(Continued on page 94)

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Computer Bits

By Jeff Holtzman

GETTING ORGANIZED, PART II

Last time I talked about some of the basic concepts involved in database design. The most important ideas are records and fields. A record corresponds to a line in a telephone book; a field corresponds to the name, address, and telephone number on each line.

There are many, many database managers available commercially, as well as through shareware outlets. You can also buy subroutine libraries for most popular languages (BASIC, C, Pascal) that let you build database applications from scratch. For this discussion I will talk about PC-File 5.0, a database manager that is available through both commercial and shareware channels. It requires 512K of RAM and a hard disk. The principles developed here are applicable to other database managers, but the details of implementing them will be different.

An Example. For purposes of discussion, suppose you have a collection of jazz records that you want to be able to search in the following ways:

- Search by title
- Search by band
- Search by label
- Search by category (big band, swing, be-bop, fusion, etc.)
- Search by song (Find all versions of a particular song)
- Search by artist (Find all albums that Charlie Parker plays on)
- Search by date (Find all albums on which Charlie Parker appeared in 1952).
- It would also be nice to store random notes about each album.

Notice that the first task is to define what it is you want to do with the database. Until you know that, you can't start building anything. On the other hand, you don't have to know *every* single thing you might want to do with the database beforehand. Often, after building a database, you think of other things you'd like to do. A quality database manager should let you add fields, delete fields, change field lengths, etc., without having to start over from scratch. The trick is to define fields that are not too general, yet not so specific that you end up with too many fields to keep track of or manipulate conveniently.

Before defining your fields, you should understand the built-in field types your database manager provides. PC-File has five basic built-in field types: character, number, date, logical, and memo.

Character fields contain regular ASCII text and may be a maximum of 254 characters long. Number fields contain values that you want to perform calculations on, not telephone numbers, social security numbers etc. (The latter should go in character fields.) Date fields contain dates in one of two predefined formats. You could store dates in character fields, but you would have no way of ensuring that the dates you entered were valid. Using a date-type field ensures that a record won't be added to the database (or corrected later) unless the field has valid information. Logical fields are one character in length and contain either T (true), F (false), Y (yes), or N (no). Memo fields are like character fields in that they store ASCII text. However, you can't sort a database by memo field, nor can you search it efficiently. The advantage is that a memo field can be 5000-characters long.

Design Decisions. To define the database, "guesstimate" appropriate lengths for each field, calculate the total length of a record by summing field lengths, and then "guesstimate" the total size of the database. If it seems too large, then go back and adjust the field sizes.

We need at least one field for each of the categories specified above. The first three are easy; they're all character fields. Let's arbitrarily say that we'll allow 40 characters for the album title, 40 for the band, and 20 for the label. With PC-File, it's possible to redefine field lengths later, so the exact values are not critical, although it is easier to get them right the first time around!

Category could be either a text or a numeric field. However, if we make it a numeric field, we won't have to worry about typing in album types correctly every time. So let's make it a two-digit numeric field; that will allow 100 different categories.

The song field is difficult. Single albums seldom have more than twelve songs, but multi-album sets could have literally hundreds of songs. If we were building our own database manager using a programming language, we could deal with that problem in a straightforward manner. But we're not, so a compromise is clearly required.

One possibility would be to declare, for example, twelve character fields of length 40. Albums with more than twelve songs simply wouldn't be represented completely. A trick to alert you to the situation would be to insert a "dummy" song as the last field in any record with more than eleven songs; the contents of that field could be "Too Many Songs."

Later, when searching the database for a particular song, you would perform a boolean search (a combined search) for that song or "Too Many Songs." The report would show every record album with either the desired title or "Too Many Songs" in a song field. In the second case, you then would need to check the album itself to see if the desired song was there.

Another possibility would be to declare a single memo field for songs. Then you could type in any number of songs (as long as you didn't exceed the 5000-character limit on memo-field length). However, in PC-File, memo fields are allocated in chunks of 512 bytes; if you type in 513 bytes of data, 1024 bytes will be allocated. In addition, searching memo fields is much slower than searching character fields, in part because you can't index memo fields. And other programs (dBASE, for one) won't allow you to search memo fields at all.

Another trick, combining features of both preceding ideas, would be to define twelve 25-character fields for the songs, a boolean field (MoreThan12), and a memo field (ExtraSongs). If MoreThan12 was false, you would

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TABLE 1—JAZZ RECORD DATABASE SPECIFICATIONS

Length	Type	Description
40	Character	Title
40	Character	Brand
20	Character	Label
02	Numeric	Category
25	Character	Song1
25	Character	Song2
25	Character	Song3
25	Character	Song4
25	Character	Song5
25	Character	Song6
25	Character	Song7
25	Character	Song8
25	Character	Song9
25	Character	Song10
25	Character	Song11
25	Character	Song12
25	Character	Artist1
25	Character	Artist2
25	Character	Artist3
25	Character	Artist4
25	Character	Artist5
25	Character	Artist6
1	Boolean	MoreThan12
?	Memo	ExtraSongs
8	Data	RecDate
?	Memo	Notes

561 Bytes total (less memo fields)

search only the twelve song fields; if MoreThan12 was true, you would search both the song fields and the memo field.

The next field, Artist, presents similar difficulties. How many fields should there be? Is it necessary to track every appearance of every player? A reasonable compromise might be to allow six 25-character fields for the main players.

For the date field, use PC-File's predefined Date type. Doing so tells the program to make sure that valid dates are entered into the field; you can enter dates in either format: YYYYMMDD or MM/DD/YY.

The last field is for your notes about an album. Here you could record any special information you happened to know about a session, the players, etc.

Table 1 summarizes our field definitions thus far. Adding up the lengths of all fields yields a total of 561 bytes, not counting the lengths of memo fields (memo fields occupy no space if not used).

Now suppose you have 400 record albums; 25% are double albums with more than twelve songs, and only a couple are multi-volume sets. That leaves about 300 that will occupy 561 bytes/record, for a total of 168,300 bytes. The 100 doubles will require an additional 512 bytes each, so required space is 100 × (561 + 512) = 7,300 bytes. The multi-volume sets might add a few extra K, so the total without memo fields is 168,300 + 107,300 + 3,000 = 278,000 bytes. Now assume you'll annotate 25% of the entries with a single 512K memo-field chunk, which adds another 51,200 bytes, for a grand total of 329,800 bytes. In other words, the entire database would fit on a single 360K floppy disk.

Another way of looking at the database would say that the average record occupies about 825 bytes (329,800/400). On a 20MB hard disk, you could therefore store information about 25,000 record albums.

Indexing. So far we have ignored the issue of accessing the data. As we saw last time, an indexed file can be searched much quicker than a non-indexed file. In fact, PC-File requires that at least one field be indexed; you can index a maximum of nine fields.

Vendor Information

PC-File 5.0
$129.95 plus $5 shipping
ButtonWare, Inc.
P.O. Box 96058
Bellevue, WA 98009-4469
(206) 454-0479 or (800) JBUTTON

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There are trade-offs involved in the number of indexes. As usual, it's a question of storage space versus processing speed. Indexed fields can be searched much quicker than non-indexed fields, but index files take disk space. In addition, every time you add, update, or delete a record, each index must be updated accordingly.

However, it's difficult to predict how much space an index will occupy; it depends on the size of the database and on the size and type of the field that is indexed. I have one PC-File database that occupies about one megabyte; one index occupies about 225K, or about 25% of the database itself.

It's also worth pointing out that indexes are independent of the order in which data is stored in the file itself. If you maintain the file sorted by band and by title, you can browse the file in a "natural" way—all titles by a given band will be grouped together alphabetically—so you may not need an index at all.

Unfortunately, we're out of space. Next time we'll go into the specifics of setting up the database, searching it, sorting it, and printing reports from it. ■

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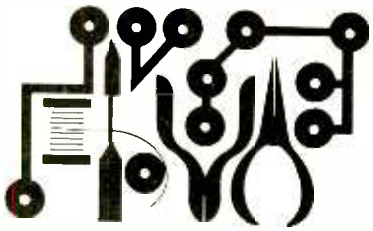

Circuit Circus

By Charles D. Rakes

TAKE YOUR PICK

This month the we're going to take a shotgun approach by presenting a number of unrelated but useful circuits in the hope that at least one of them will find application in an existing project or aid in completing a future one.

Our first circuit came about when we were trying to view a fast-rising pulse using an older oscilloscope that was long past its prime. With the lights out and the scope's intensity set at maximum, a fast-moving positive pulse could barely be seen.

Pulse Stretcher. Figure 1 is a schematic diagram of a pulse-stretcher circuit that can be used to increase the duration of a positive pulse by a factor of 50. When the signal is fed through that circuit, the amplitudes of the input and output are equal, but the pulse stretcher extends the fall time to make the pulse easy to see and follow. Since our only interest was in expanding the positive pulse length, the circuit ignores any negative pulses (much like a half-wave rectifier).

In Fig. 1, op-amp U1-a (¼ of an LM324 quad op-amp) is configured as a voltage follower, which offers a high impedance to the input signal, but does not add gain or invert the input signal. Op-amp U1-b is also connected in a voltage-follower configuration.

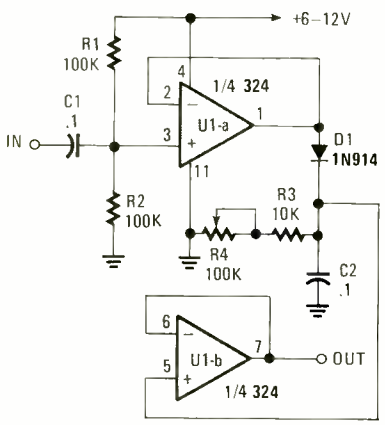

Fig. 1. The pulse stretcher can be used to increase the duration of a positive pulse by a factor of 50, while maintaining the same signal amplitude at the output as at the input.

When a positive pulse is applied to the input of U1-a, its output at pin 1 is fed through D1, causing C2 to begin charging to the peak voltage level of the pulse. The output of U1-a is also fed to U1-b, whose output also rises to the peak voltage. As the input signal to U1-a decreases, which causes its output to decrease, C2 begins to discharge at a rate determined by the combined values of R3 and R4. With R4 set to its maximum resistance, the output pulse will be stretched to its maximum width (duration).

The maximum pulse duration must be set for a period shorter than the period between input pulses or the output will look like a sawtooth waveform. With the component values shown, the circuit can be used with pulses occurring at rates ranging from 100 Hz to over 2 kHz. For higher pulse rates, C2's value should be reduced; and for lower pulse rates, its value should be increased. If the value of C2 is made too large, the output pulses will not reach their peak-voltage level. You can experiment with the values of R4 and C2 to obtain the desired results.

The circuit in Fig. 1 can also be used to stretch negative-going pulses by rearranging C2, D1, R3, and R4 as shown in Fig. 2. In either application, the input pulse levels should be limited to a level that is slightly less than one-half of the supply voltage.

Indicator Circuits. The next two circuits that we'll look at are what I refer to as "had-a-call" indicator circuits. In other words, the circuit is designed to be connected to the phone lines to give an indication when the phone rings. Of course, if you're at home and in hearing range, it's obvious that you don't need an indicator to tell you that the phone is ringing. But if you're out and would like to know if someone has tried to reach you by phone, then either of the indicator circuits can handle that task.

The simpler of the two circuits is shown in Fig. 3. In that circuit, the AC ringing voltage is fed to the gate of SCR1 though a miniature neon lamp (NE1) and a 100,000-ohm resistor (R1). A positive voltage at the gate of SCR1 turns it on, which, in turn, causes LED1 to turn on and remain on indicating that the phone has rung.

In the standby mode, the circuit draws no current from the battery, and when activated, the LED draws about 3 to 5 mA, depending on the battery voltage. An AC-operated power source could be used to save batteries, but if a power failure were to occur, the circuit would automatically reset turning the LED off. A rechargeable battery with an on-line charger would be an ideal an-

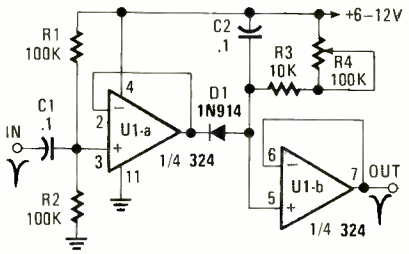

Fig. 2. The circuit in Fig. 1 can be reconfigured to stretch negative-going pulses by re-arranging C2, D1, R3, and R4, as shown here. In either application, the input pulse levels should be limited to slightly less than one-half of the supply voltage.

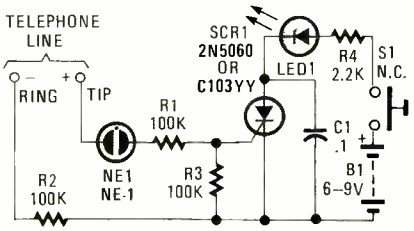

Fig. 3. This circuit is designed to be connected to the phone lines to give an indication when the phone rings and you are not at home or beyond the range of the telephone bell.

swer to the circuit's power requirement.

Our second indicator circuit is shown in Fig. 4; designed to operate with a minimum current drain (1 mA when triggered), it is a good candidate for battery operation.

When SCR1 turns on, its cathode voltage rises to slightly less than the battery (B1) voltage and remains in that condition until the normally-closed reset switch, S1, is pressed. With SCR1 turned

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PARTS LIST FOR FIGS. 1 AND 2

U1—324 quad op-amp, integrated circuit
D1—1N914 small-signal silicon diode
R1, R2—100,000-ohm, ¼-watt, 5% resistor
R3—10,000-ohm, ¼-watt, 5% resistor
R4—100,000-ohm potentiometer
C1, C2—0.1-μF ceramic-disc capacitor
Perfboard materials, 6–12-volt DC power source, wire, solder, hardware, etc.

PARTS LIST FOR FIG. 3

SCR1—2N5060, C103YY, or similar sensitive-gate, silicon-controlled rectifier
LED1—Jumbo light-emitting diode
R1–R3—100,000-ohm, ¼-watt, 5% resistor
R4—2200-ohm, ¼-watt, 5% resistors
C1—0.1-μF, ceramic-disc capacitor
NE1—Miniature neon lamp
B1—9-volt transistor-radio battery
S1—Normally-closed pushbutton switch
Perfboard materials, enclosure, holder and connector, wire, solder, hardware, etc.

on, a voltage is fed through R5 to the gate of SCR2, causing it to turn on. LED1 (the call indicator) is tied to the anode of SCR2, and through current-limiting resistor R6, to one terminal of a normally-open pushbutton switch, S2. Until S2 is closed, no current can flow through the LED or SCR2.

The circuit is triggered in the same manner as the one in Fig. 3. To find out if the circuit has registered a call all you have to do is press S2; if a call has been registered, LED1 lights. Afterward, the circuit can be reset for the next incoming call by pressing S1. Since the actual gate current needed to trigger SCR's varies from unit to unit (and can be as low as a few microamps or as high as 1 mA), it's worthwhile to select the largest resistance value for R5 that will reliably trigger the SCR.

The indicator circuits can easily be built on perfboard and housed in a plastic or metal enclosure. Since there are so few parts and nothing is critical about either circuit, any construction scheme you choose should do.

Preamp. Our next circuit, see Fig. 5, is an impedance-matching preamp that will allow you to use an old crystal microphone with your favorite transmitter, PA amplifier, or tape recorder. Crystal-microphone elements normally have a very high output impedance and thus operate poorly when working into a low-impedance circuit. Using a matching transformer is one way of mating a high-impedance mike with low-impedance circuitry, but both output and frequency response can be degraded with that solution.

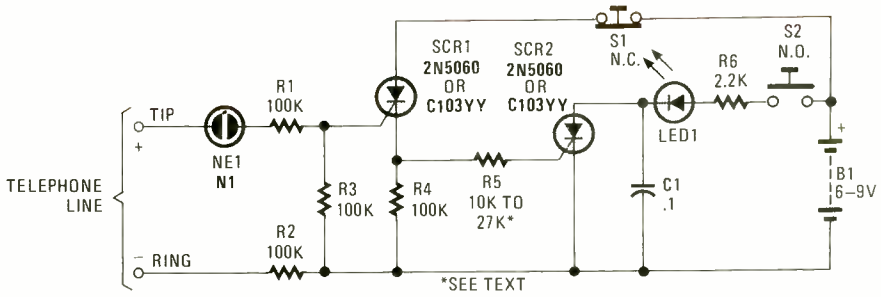

Fig. 4. Although the indicator circuit shown here is built using more parts than the previous one, it is designed to operate with a minimum current drain.

A simpler and better method of accomplishing that task is to use an active device to match the high impedance of the mike element and then add a gain stage with a low-output impedance to drive either a high- or low-impedance circuit. And if your junk box is well stocked, the cost of building such a circuit will be much less than the price of a matching transformer.

In Fig. 5, op-amp U1-a (½ of a 1458 dual op-amp) is set up as a voltage follower that offers a very high, input impedance; the input impedance of the circuit (for practical purposes) is equal to R1 and R2 in parallel, or about 235k. The op-amp's output impedance is very low in comparison to that of its input. Op-amp U1-b is configured as an inverting amplifier with a variable voltage gain (controlled via R6) ranging from less than 1 to over 20.

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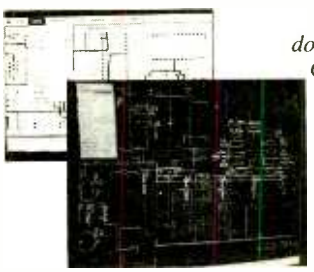

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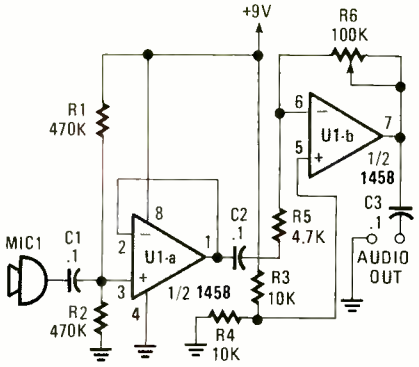

Fig. 5. With this impedance-matching preamp, you can use an old crystal microphone with your favorite transmitter, PA amplifier, or tape recorder.

PARTS LIST FOR FIG. 4

LED1—Jumbo light-emitting diode
SCR1, SCR2—2N5060, C103YY, or similar silicon-controlled rectifier
R1–R4—100,000-ohm, ¼-watt, 5% resistor
R5—10,000–27,000-ohm, ¼-watt, 5% resistor
R6—2200-ohm, ¼-watt, 5% resistor
NE1—Miniature neon lamp
C1—0.1-μF, ceramic-disc capacitor
B1—6–9-volt transistor-radio battery
S1—Normally-closed pushbutton switch
S2—Normally-open pushbutton switch
Perfboard materials, battery holder and connector, wire, solder, hardware, etc.

PARTS LIST FOR FIG. 5

U1—1458 dual op-amp, integrated circuit
R1, R2—470,000-ohm, ¼-watt, 5% resistor
R3, R4—10,000-ohm, ¼-watt, 5% resistor
R5—4700-ohm, ¼-watt, 5% resistor
R6—100,000-ohm potentiometer
C1–C3—0.1-μF, ceramic-disc capacitor
MIC1—Crystal microphone element
Perfboard materials, enclosure, AC molded power plug with line cord, battery(s), battery holder and connector, wire, solder, hardware, etc.

PARTS LIST FOR FIG. 6

U1—317T voltage regulator, integrated circuit
D1–D4—1N4002 1-amp, 100-PIV, silicon rectifier diode
R1—470-ohm, ½-watt resistor
R2—1000-ohm, 1-watt resistor
R3—100-ohm, 20-watt resistor
R4—10,000-ohm potentiometer
C1—1000-μF, 50-WVDC, electrolytic capacitor
T1—12- to 24-volt, 1-amp transformer
S1—SPST switch
S2—SP3T switch
F1—1-amp fuse
M1—DC voltmeter
Perfboard materials, enclosure, AC molded power plug with line cord, test terminals, wire, solder, hardware, etc.

The circuit's power can be keyed on with a push-to-talk switch, which would allow a standard 9-volt transistor-radio battery to power the circuit. If the mike element is located more than a few inches from the circuit and a non-metallic enclosure is used to house the project, a shielded mike cable should be used between the two.

When the circuit is mated with a good quality mike element, that combination will rival a number of the expensive power mikes, which (if purchased new) could set you back fifty bucks or more. And if you check the local flea markets and swap meets, you can probably pick up a clean, older CB desk mike for a few bucks that would make a professional-looking enclosure for your home-brew power mike. Building your own equipment isn't just a fun thing to do, but can be very cost-effective (cheap) as well.

Capacitor Reformer. Our next circuit, see Fig. 6, is a valuable electronic reformer that's worth its weight in joules if you happen to have a surplus of electrolytic capacitors stored away in your treasure chest. Resistors, semiconductors, and most other electronic components have a reasonably long shelf life, but electrolytic capacitors don't fair as well over the long haul.

Even after just a few weeks of lying around, some electrolytic capacitors may require special treatment before they can be placed in service. Often when an electrolytic capacitor is idle for a very long periods without any voltage applied, the internal leakage current will be high until the capacitor has been reformed.

In circuits like heavy-duty power supplies, the filter capacitors are reformed (if needed) each time that power is turned on; but in other circuits where electrolytic capacitors are used for signal coupling, the leakage current can upset the normal bias of the circuit until the capacitor stabilizes. That's why it's a good idea to use an autotransformer to slowly bring up the operating voltage on equipment that's been sitting around unused for some time.

The reformer circuit is actually a slightly modified, variable, DC power supply with a current-limiting resistor placed in series with its output. The actual output voltage of T1 is not critical and just about any transformer with an output of 12 to 24 volts will do. A bridge rectifier converts (rectifies) the input AC voltage to provide DC, which is fed to a 317T adjustable regulator (U1). A 10,000-ohm potentiometer (R4) sets the output voltage of the regulator, while switch S2 selects the current limiting resistor. A DC voltage meter is then used to monitor the circuit's output voltage.

To reform a capacitor, adjust the circuit's output voltage via R4 to the electrolytic's rated voltage and place S2 in position 1. Connect the capacitor to the test terminals and when the voltmeter climbs to the original setting, the reforming is complete. On very large valued capacitors, the charging time can be shortened by switching S2 to position 2, and after the reforming starts to position 3. If, after a time, the voltage remains low or near zero during the reforming process, the capacitor may be a candidate for the trash bin.

We've come to the end of our space. But be sure to join us next time for another discussion on electronic circuitry. ■

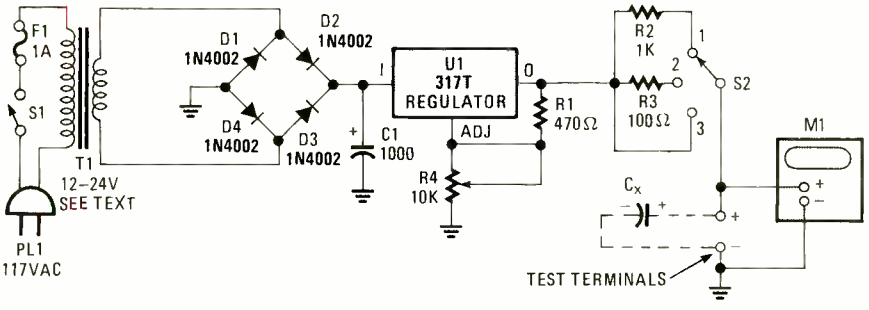

Fig. 6. Even after just a few weeks of lying around, some electrolytic capacitors may require reforming before they can be placed in service. This circuit is designed to handle that job.

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DX Listening

By Don Jensen

A FRONT-ROW SEAT

In quick order, major broadcasting changes came to Poland, Hungary, East Germany, Czechoslovakia, Bulgaria, and Romania! Rigidly controlled broadcasting, often dull and boring programming—which many SWL's had become used to hearing from behind the old Iron Curtain for decades—was gone. In some cases, those changes came in startlingly rapid and dramatic ways, and alert listeners had a front-row seat to hear history being made.

Alan Roe, a British DX'er, tuned in Romania's *Radio Bucharest* on 11,740 kHz as an extraordinary year ended and recorded this remarkable announcement:

"Until Dec. 22, we were not allowed to transmit, and so you could not hear the voice of real Romania...Aware of the wrong we have done to you, we now apologize for the daily flood of lies and misrepresentations we have been broadcasting...The fist of tyranny forced us to say what was convenient to dictatorship..."

"We set out to real work in the first days of the Revolution, at first under a shower of gunfire, so we made the voice of truth from Romania reach your homes. We step into 1990 purified in the heat of the Revolution."

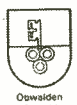
In the British DX bulletin, "Contact," Roe described his monitoring as "fascinating and compelling." Indeed! What shortwave listening could be more dramatic than to hear an announcer, his voice choked with emotion, identify as "This is Radio Bucharest, Free Romania. God, it sounds so wonderful to say this, Free Romania!"

The Curtain Rises. The situation in eastern Europe continues to be unsettled as the people of those nations, as well as those within the Soviet Union itself, continue to improve their economies within the framework of their newfound liberties. Here are some shortwave broadcast times for English-language programming from these stations.

Radio Sofia, Bulgaria, can be heard from 0000 to 0100 UTC. It has been using 11,680 kHz, but you can also try 7,115, 9,700, 11,720, and 11,950 kHz, too. Some other tuning times include 2130 and 2230 UTC.

Czechoslovakia's *Radio Prague* should be a rather easy log during its 0200 to 0300 UTC transmission on 5,930, 7,345, and 9,540 kHz. You may also find Radio Prague broadcasting in English on 21,450 kHz at 1530 UTC and 21,505 kHz at 1730 UTC.

At the time of this writing, East Germany's *Radio Berlin International* was using 6,080, 11,890, and 13,690 kHz for transmissions at 0045 and 0200 UTC. At 0245 UTC, 13,690 kHz is dropped in favor of 11,785 and 15,125 kHz. At 0400 UTC the latter two frequencies continue and 13,690 kHz returns.



Samen – Blick vom Landenberg
Samen – Vue prise du sommet du Landenberg
Samen – Panorama visto dal Landenberg
Samen – View from the summit of the Landenberg
Samen – Vista desde la cumbre del Landenberg
Samen – Paisagem vista do cimo do Monte Landenberg

This multi-lingual viewcard is one of a series sent to faithful listeners by Swiss Radio International.

Transmissions from Hungary's *Radio Budapest* are beamed in English to North America from 0130 to 0200 and 0230 to 0300 UTC on 6,110, 9,520, 9,585, 11,910, and 15,160 kHz.

Radio Polonia, from Warsaw, Poland, does not have the North American "prime time" evening programming of some of the other East-European stations. But you may try tuning for its English broadcasts at 2230 UTC on 7,185 and 7,270 kHz.

From Romania, *Radio Bucharest*'s "post-revolution" schedule of English transmissions to North America has been 0200 to 0255 UTC and 0400 to 0425 UTC on 5,990, 6,155, 9,510, 9,570, 11,830, and 11,940 kHz.

Please remember, though, that stations do change frequencies with the season. Our "lead time" sometimes means that some frequencies may have changed by the time you read the column. Often, however, you will still find the station by hunting around the same bands.

Feedback. Your comments and questions about shortwave listening, station logging observations, and photographs of you and your receiver in your "DX shack" are always welcome. Send your letters to "DX Listening," **Popular Electronics,** 500-B Bi-County Blvd., Farmingdale, NY 11735.

This month's first note comes from Paul Solyn of Oberlin, OH, who questions a bit of information in a recent column. "Did you really mean to place Radio Budapest in "Bulgaria?" Paul asks. "Try Hungary. Bulgaria has Radio Sofia, but I haven't heard it."

I'm red faced, Paul, since Radio Budapest is a station I first heard on shortwave back in the 1950's. Yes, of course, the station is in Hungary. Can I get away with blaming it all on gremlins in the word processor? Thanks, and perhaps the information above will assist you in logging Radio Sofia.

Paul also passes along a tip on West Germany's shortwave voice, *Deutsche Welle*. "It's broadcast at 0300 UTC on 9,605 kHz was announced as coming from the Malta relay, a new one for me. The same programming on 9,545 kHz is relayed by the station at Antigua in the West Indies, but I think the service on 6,130 kHz comes from a transmitter in the Federal Republic of Germany."

Lionel Marchant, West Vancouver, British Columbia, Canada, says he enjoys "DX Listening." "I write a list of the stations you show and then I try to hear

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them." But Tahiti, referred to in a recent column, already was Lionel's favorite shortwave-listening target, and for a very good reason. "I was able to have two vacations in Tahiti of six weeks each. Love their music! As I write, I am listening to the station on 15,170 kHz at 0440 UTC. I generally can hear it on 11,825 kHz, but not tonight."

"In summer, 15,170 kHz is so clear and noise free here in British Columbia that I have taped the programs. My shortwave receiver goes through my Sony audio/video control center to give me better tone in the music. Still I use the headphones for serious DX listening, though."

RFO, which is the abbreviation for the station's rather lengthy French name, *Societe Nationale de Radio Television Francaise d'Outre Mer*, long has been one of my favorite stations too, Lionel...And, the Tahitian music and those pulse-racing drums! *Tres exotique!*

Down the Dial. Here are some of the shortwave stations that listeners have been logging recently.

Afars and Issas—4,780 kHz. *RTVD*, in out-of-the-way DJibouti on Africa's "horn," is again being heard signing on at 0300 UTC with Somali-language announcements and Arabic music. Interference is reported.

Alaska—7,365 kHz. *KNLS* is a religious broadcaster located at Anchor Point, Alaska, which broadcasts over the North Pole to the USSR and Asia. Look for its 0800 UTC sign on with the theme from "Chariots of Fire" as an interval signal.

Australia—7,205 kHz. *Radio Australia* in English has been noted at 1300 UTC. Also try other frequencies at this time, including 7,215 and 9,580 kHz.

Chad—4,904 kHz. *Radioifusion Nationale Tchadienne* is heard around 0430 UTC with French identification and African music.

China—3,280 kHz. The *Voice of Pujiang* in Shanghai is noted on this frequency, in parallel with a weaker 3,990-kHz outlet at around 1200 UTC.

Colombia—5,075 kHz. *CARACOL* is one of Colombia's major broadcasting networks. The key station in the net is CARACOL Bogota, broadcasting from this South American capital. Look for CARACOL one evening at around 0100 UTC.

Galapagos Islands—4,810 kHz. *La Voz de Galapagos*, in Ecuador's Pacific islands, is noted with Latin-American dance music and Spanish announcements until sign off at about 0145 UTC.

Greece—11,645 kHz. The *Voice of Greece* has been noted on this channel at 2340 UTC with English news about Greece. At the same time, it can be heard on 9,395 kHz, too.

Luxembourg—6,090 kHz. *Radio Luxembourg* is noted in English on this frequency at around 0000 UTC, despite interference from Deutsche Welle.

Mexico—2,390 kHz. *Radio Huayacocotla* has been reported as a fairly consistent station here at around 1200 UTC with Spanish programming.

Netherlands Antilles—9,535 kHz. *Trans World Radio* on the island of Bonaire is a good bet at 0430 UTC with its English language "Caribbean Night Call" program.

North Korea—9,977 kHz. *Radio Pyongyang* has news and commentary in English at 1140 UTC on this frequency.

Seychelles—9,630 kHz. The *British Broadcasting Corporation's* relay in the Indian Ocean is noted at 1900 UTC in English. ■

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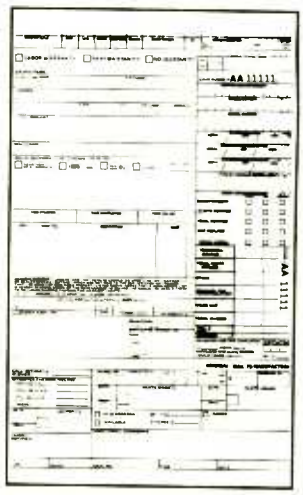

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Ham Radio

A VERSATILE FREQUENCY CONVERTER

By Joseph J. Carr, K4IPV

One of the favorite activities of many amateur-radio operators is to build (and often design) their own electronic projects. While many amateurs also have a general electronics interest (as witnessed by the large number of hams who subscribe to **Popular Electronics**), any project that we will consider in this column is of particular interest to hams. That is, they must somehow relate to radio—especially ham radio—interests. So for the main topic this month, we'll look at a simple WWV-to-80-meters down converter that you can put together in a single evening.

HF Converter. A frequency converter is used to change an input frequency to some output frequency that's either higher or lower than the original signal. The process by which that is done is called heterodyning. Before we get heavily into our discussion, let's consider a little metaphor to see if we understand what heterodyning is, and how it works.

Consider a piano. Strike the note A above middle-C (which is about 440 Hz), and you hear a single tone. Now skip a couple of keys and strike any other key, and what you hear is another single tone distinctly different from the first one. Now simultaneously strike both keys, and you hear a complex combination of the first note, the second note, the sum of the two, and the difference of the two.

In radio, the same thing is accomplished by heterodyning frequency f_1 against frequency f_2, producing outputs of f_1, f_2, $f_1 + f_2$, and $f_1 - f_2$ (other combinations are also produced). The exact expression is:

$$f_{out} = mf_1 \pm nf_2$$

where m and n are integers.

There are any number of devices and circuits that we can use to make a frequency converter. In any case, it is necessary to provide a local oscillator to produce one of the two frequencies (the other frequency, of course, is the over-the-air signal supplied via the antenna), and some means of selecting either the sum or difference signal. The circuit that produces heterodyning is called a mixer, and must be non-linear (linear mixing does not produce heterodyning).

In our discussion, we're going to use the Signetics NE-602N, which contains the circuitry required to make a local oscillator and a dandy Gilbert cell double-balanced mixer (DBM). An advantage of the DBM is that the output contains only the sum and difference signals; the RF-input signal and the local-oscillator signal are suppressed when a balanced output circuit configuration is used.

Although the device appears to trade off a little bit of dynamic range (the difference between minimum and maximum allowable signals) for increased sensitivity, the NE-602N is more than sufficient for most amateur-radio applications.

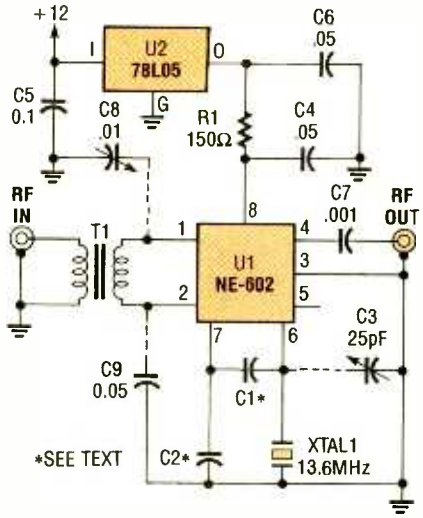

Fig. 1. Our 10-MHz WWV to 80-meter down-converter circuit is built around the NE-602N, which contains a differential amplifier and double-balanced mixer (a combination known as a Gilbert cell).

The Converter Circuit. Figure 1 shows a frequency converter built around the NE-602. Typical examples of what kind of frequency converters might be used by hams include circuits to convert the WWV time/frequency signals to a ham band. The WWV signals occur at 5, 10, and 15 MHz in the HF shortwave band.

Now let's suppose that we want to convert a 10-MHz WWV signal to 3.6 MHz (in the 80-meter ham band). A suitable local-oscillator frequency would be 10 MHz ± 3.6 MHz, or 13.6 MHz and 6.4 MHz. Either of those frequencies would suffice, but 13.6 MHz is further from the output frequency and might cause less trouble.

The NE-602N's local oscillator is internally connected between pins 6 and 7, which represent the base and emitter of an internal transistor. A parallel resonant 13.6-MHz crystal is connected from pin 6 to ground, while a capacitive voltage divider (consisting of C1 and C2) is connected across pins 6 and 7. The values of the capacitors are found from:

$$C1 = 100 \text{ pF}/\sqrt{f_{MHz}}$$

$$C2 = 1000 \text{ pF}/\sqrt{f_{MHz}}$$

In some cases, the optional trimmer capacitor (C3) might be desirable. It will allow adjustment of the actual oscillator frequency. The input circuit in the version of this project that I built is a simple transformer having a 4-μH secondary and a low-impedance primary. The coil was built using the methods discussed here in the April 1990 column.

The adjustable coil core was an Amidon Associates, Inc., (12033 Otsego Street, North Hollywood, CA 91607) type L-57-6 (yellow) adjustable coil form. A toroidal core could also be used if you wish to trade simplicity for no tunability. The secondary was 19 turns of #30 enameled wire, while the primary was 3 turns of the same wire.

Although tuning is not strictly necessary, it is always something that you might want to consider. I tried input tuning and it seemed to make a difference. The secondary of T1 was resonated to 10 MHz by means of a 7- to 60-pF ceramic variable capacitor (C8). Depending on circuit layout, the specifications given here may or may not work for you, but they are close. That's one good reason for using a larger range of tuning capacitance than might otherwise be needed. If the project had been wired on a pre-tested, printed-circuit board, all of the stray ca-

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pacitances would be known, and could be compensated for. But in using perfboard (as I did), anything might happen, so be prepared for a little experimenting.

Other Applications. The Signetics NE-602N is a very versatile "receiver front-end on a chip." The NE-602N can be used as a local oscillator and will produce output frequencies up to a 200 MHz with the mixer working up to 500 MHz. For local-oscillator frequencies of over 200 MHz, you can use an external local oscillator and couple its output to pin 6 through a 0.001- to 0.05-μF capacitor. (Those properties suggest that the NE-602N would make a dandy VHF converter for a low-frequency receiver.)

At one time, it was common among VHF enthusiasts to down-convert the VHF signal to an HF signal and then use the station's shortwave receiver as a variable-frequency IF amplifier. The fixed-frequency converter was placed in the transmission line between the antenna and the receiver. (See Fig. 2.) For example, if a 6-meter converter injects a 40-MHz signal into the mixer, the 50- to 54-MHz band would appear on the shortwave receiver between 10 MHz (50 MHz − 40 MHz = 10 MHz) and 14 MHz (54 MHz − 40 MHz = 14 MHz).

Tuning the shortwave receiver from 10 to 14 MHz would effectively tune the

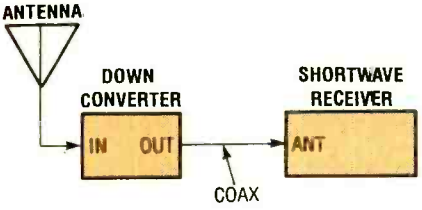

Fig. 2. Adding a VHF converter to a shortwave receiver. At one time, it was common practice to down-convert VHF to HF and then use a shortwave receiver as a variable-frequency IF amplifier. The converter was placed between the antenna and the receiver.

entire 6-meter band. That idea is still viable, and could conceivably result in a receiver that offers more features than all but the higher-grade VHF receivers.

Any tuned circuits used in the down-converter should be broad-band types (*i.e.* low Q) in order to prevent desensitization of the receiver at either end of the band. Alternatively, the tuned tank circuits should be variable over the entire range. Figure 3 shows several alternative input and output circuits that are allowed on the NE-602N. Keep in mind that the suppression of the local oscillator and RF signals (a feature of DBM's) is dependent on balanced input and output circuits.

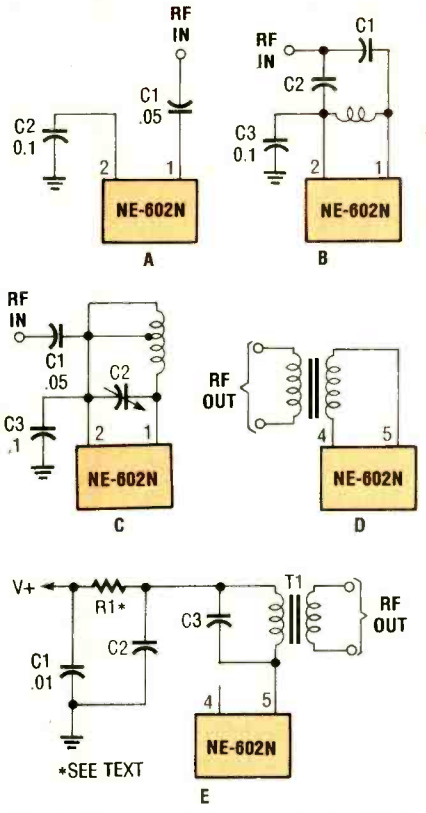

Fig. 3. Here are different methods of input and output coupling for the NE-602N: Shown in A is a simple input circuit (not recommended in most cases), B is a low-Z split-capacitor input, C is a tapped-coil low-Z input, D is a balanced, untuned output, and E is a single-ended tuned output circuit.

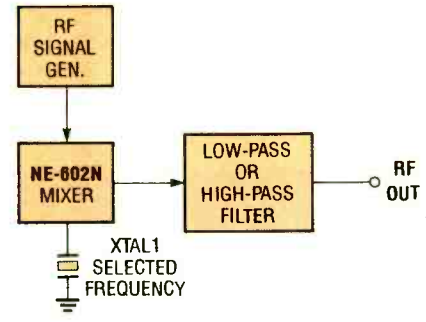

Fig. 4. Another use for the NE-602N is to extend the range (up or down) of a signal generator. The NE-602N-based circuit is placed between the signal generator and either a low-pass or high-pass filter (depending on whether you want to go up or down in frequency).

The NE-602N can also be used as an

(Continued on page 91)

HAM RADIO IS FUN!

It's even more fun for beginners now that they can operate voice and link computers just as soon as they obtain their Novice class license. You can talk to hams all over the world when conditions permit, then switch to a repeater for local coverage, perhaps using a transceiver in your car or handheld unit.

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Scanner Scene

By Marc Saxon

"SNAKES," SEA-SIDE SCANNING, AND CLONES

If you ask a scanner owner what kind of unit he has, and he tells you it's a Snake, don't get alarmed. That's just an insider's pet name for an old favorite—Cobra! But the Cobra that's coiled up to strike now—the *Cobra SR-901* base station unit—is all new in every respect, inside and out.

The SR-901 has ten programmable channels in three frequency bands: 28 to 54 MHz, 136 to 174 MHz, and 400 to 512 MHz. It's small (it tips the scales at a sliver over 1 pound) and it's housed attractively in an off-white cabinet. Moreover, the control panel of the SR-901 presents the user an array of far fewer buttons, knobs, switches, dials, whistles, and bells than many scanners. As the Cobra people told me, the SR-901 is a desktop unit that offers first-time scanner owners a complete break from traditional high-tech, complex, hardware-oriented units that the company provides to the more advanced users of scanners. And, at a suggested retail price of only $149.95, it also offers advanced scanner buffs an inexpensive second unit.

The SR-901 is fully programmable. Cobra's new "Express Tuning System" replaces the traditional multi-button keypad with a three-button design (up/down/fast controls) to simplify tuning and programming. That gives the SR-901 a sleek and uncluttered look, even though you still get features such as channel lockouts, manual step-through of channels, and dual-speed scanning. There's a built-in telescoping antenna, and also an input for an external antenna. A 9-digit LCD readout lets you know what the set is up to. The automatic squelch is factory preset.

It's hard to believe that all of this is contained in a package measuring about 7 × 7 inches, and is only 2 inches high. And yet the specifications are most respectable, with VHF sensitivity at 0.3 μV, UHF at 0.5 μV (+3-kHz deviation, 12-dB SINAD). Its selectivity is −55 dB at +25 kHz.

You can get more information on the SR-901 from Cobra Electronics Group, Dynascan Corp., 6500 West Cortland St., Chicago, IL 60635.

A Bearcat By Any Other Name. Some of the mail we receive notes uncanny similarities between the specifications, circuits, and perhaps even the external appearance of several different scanners, and requests that we offer any information we have on that.

For whatever reasons, some identical models of Uniden Bearcat scanners are available under more than one model number. As far as we can determine, the different model numbers do not represent later, updated, or technically different units, although they might be sold at different prices, or with added accessory packages, to various different markets. However, the Bearcat BC-400XLT is the same as the BC-650XLT, while the BC-200XLT and the BC-205XLT are twins. The same goes for the BC-600XLT and the BC-590XLT, and for the BC-760XLT and the BC-950XLT. Also note that the Bearcat BC-100XLT handheld is the same as the Regency R-4020, while the Bearcat BC-175XL and the Cobra SR-925 are really brothers raised in different households.

So if you see a description of one set accompanied by a photo of its differently numbered clone, you'll understand what's going on. When you go shopping for a particular scanner, you might wish to keep this in mind, since there could be a price differential between two sets that differ only in model numbers.

Lastly, since we've received a ton of mail asking about the differences between the Realistic PRO-2004 and subsequent PRO-2005 scanners, we'll mention them briefly. Yes, the PRO-2005 replaced the PRO-2004. It looks quite different externally, and if you peek inside you'll see that they don't look the same, nor do they have the same numbers for the parts on the schematic. But those are all rather superficial differences, for the circuits and components are the same despite their different numbers and physical layout.

Up a Lazy River. This is the best season of the year to scan the VHF-FM marine band. Those frequencies are interesting to monitor if you're within about 25 miles of any seashore, or navigable river, bay, lake, canal, or other inland waterway.

Every VHF-equipped vessel is required to be able to operate on at least 156.30 and 156.80 MHz (Channels 6 and 16). Channel 6 is used for safety communications, including search and rescue. Channel 16 is used for calling and dis-

Offering a surprising array of features in light of its lack of knobs, buttons, and frills, the Cobra SR-901 is an easy set to learn on, and easy on the wallet, too.

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tress calls, and is constantly monitored by all shore stations as well as (in theory, at least) all radio-equipped vessels. Most vessels can also operate on 157.10 MHz (Channel 22A), which is used for private vessels contacting the Coast Guard. Those are excellent frequencies to keep in your scanner at all times.

Coast Guard and Coast Guard Auxiliary operations take place on 157 05, 157.075, 157.15, and 157.175 MHz, with miscellaneous federal-agency marine activities sometimes observed on 157.125 MHz.

If you live near a major seaport, keep an ear tuned to 156.275, 156 325, 156.55, 156.60, 156.625, 156.70, and 156.725 MHz for port and harbor activity, and also activity near canal locks. Around New York City and New Orleans, 156.55, 156.60, and 156.70 MHz are set aside exclusively for the Coast Guard's Vessel Traffic System.

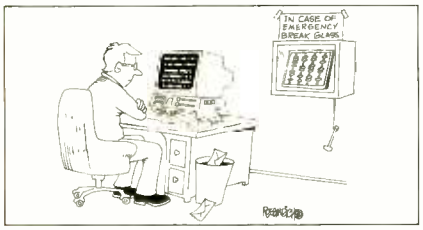
Commercial maritime activities, (tugs, ferries, trawlers, etc.) are heard on 156.35, 156.375, 156.40, 156.45, 156.50, 156.55, 156.90, 156.95, 156.975, and 157.025 MHz.

Pleasure craft and their coastal services (marinas, fishing stations, etc.) use 156.425, 156.45, 156.475, 156.575, 156.625, and 156.925 MHz. The best of those frequencies—filled with boats, yacht clubs, marinas, etc.—is 156.425 MHz. Note that 156.625 MHz is for intership use only (no shore stations) and it usually sounds like a free-for-all!

If you're within range of any major shipping lanes, you'll probably find 156.65 MHz worthy of a listen. That is a short-range navigational channel used mostly on the bridges of large ships as they pass one another or communicate with their tugs. All communications here are with only 1 watt, so you have to be within a mile or two of the shore to hear anything.

There are some other VHF-FM maritime channels, but those are the best ones to monitor this time of the year.

Let's Hear From You!. Our address is *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■



HAM RADIO

(Continued from page 89)

up-converter simply by selecting the sum frequency output rather than the difference frequency. One use for such a circuit is to up-convert the 100- to 540-kHz VLF band to a ham band so that it can be received on the station's ham-band receiver. Alternatively, a low-frequency band could be up-converted to, say, 80 meters in order to add that unusual dimension to your hobby.

Another use for the NE-602N is to extend the range of a signal generator. I can see two such uses (Fig. 4 covers both). In the up-conversion mode, running the local oscillator at a frequency of over 100 MHz would allow my 1- to 65-MHz RF-signal generator to be used in the 2-meter amateur band to troubleshoot receivers or develop circuits. The local oscillator would operate at, say, 100 MHz, so the output would be 165 MHz when the signal generator was tuned to its maximum frequency, and 101 MHz when it was at its low end. A 100-MHz high-pass filter at the output would ensure that only the sum signal was used.

The other use would be to extend the range of a signal generator downward. One of the things that aggravates me about my current array of signal generators is that they do not cover the bands below 1 MHz in one case, and 2 MHz in the other. If I want to align a 455-kHz IF amplifier, then I have to use an elderly model that I also possess. For those who do not have that advantage, it is easy to select an NE-602N local-oscillator frequency in the HF region, and then couple a regular signal generator into the RF input port of the chip (Fig. 4). A low-pass filter at the output would select only the difference frequency.

The NE-602N is a terribly useful little RF chip. I've used it a number of times in the past, so in April 1990 I was delighted to see an article in *Radio-Electronics* (sister publication to **Popular Electronics**) on the NE-602N. Readers who want to delve deeper into the mysteries of the chip might want to either obtain the Signetics data sheet, or read Single-Chip Frequency Converter (by Michael A. Covington), which appeared in the April, 1990 issue of Radio-Electronics. ■

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THINK TANK

(Continued from page 27)

systems motivated me to build my own, and the following design is most effective.

See Fig. 7. Transistor Q1 is switched on by optoisolator U1. When S1 is momentarily closed (for whatever reason), SCR1 is switched on, power is applied to U2—a 556 dual oscillator/timer (the equivalent of two 555's).

When capacitor C2 reaches ⅔ V_{CC}, the output of one of the timers goes low, energizing relay K1. With K1 activated, power is applied to the sounder (sirens, bells, or other noisemakers) through its normally-open contacts.

When capacitor C5 reaches ⅔ V_{CC}, the other timer in that dual unit goes low, switching off the transistor in optoisolator U1, which in turn switches off transistor Q1. That interrupts the anode current of SCR1 so that it too is switched off, de-energizing relay K1. The system is now reset awaiting the next triggering. Since both timers commence timing simultaneously, it is important that the time constant of R6/C2 be less than R7/C5. The time constant of R7/C5 minus R6/C2 gives the maximum time that the alarm will be on.

An additional timer can be added to determine the time that it takes for power to be applied to the collector of Q1 after the main power-supply switch is turned on. Diode D1 is used to protect U2 from high-induced voltages produced when relay K1 is de-energized.

—Elroy Brown, Manchester, Jamaica, WI

Good circuit Elroy. I've found that there are as many circuits and configurations for burglar and intrusion alarms as there are people that want them. We've reproduced your circuit because it seemed innovative, and readers should add their own tailoring specifications as required.

That should do it for this month, and we'll be back again at the same old stand next month. Meanwhile, send your circuits and solutions to our monthly problems to "Think Tank," **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

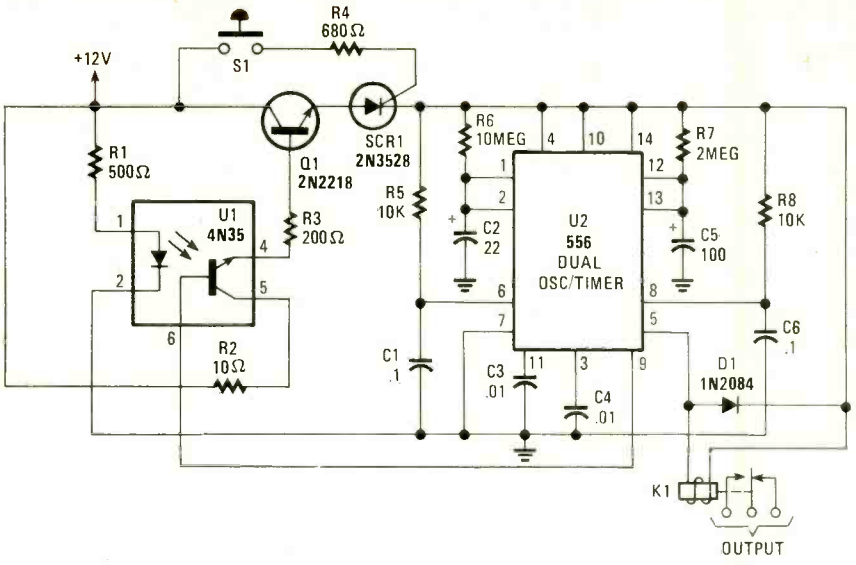

Fig. 7. Switch S1 in this circuit can be replaced by any sensing device that closes its contacts when activated.

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TYPING PROGRAM

(Continued from page 69)

array with characters based upon the mode that was selected. That third section of the program is contained in lines 1380–1680. A close examination of the flow chart in Fig. 2 will reveal the line numbers within the section that are associated with each of the four modes of operation.

The fourth and final block of code for TYPE-PR (the real meat of the program) extends from line 1690 through to the end of the listing at line 1840. Lines 1710 and 1720 change the screen to a 40 column format and initialize the practice screen. Next, a random key number (the variable KY) is generated by line 1740, and checked to make certain it was not the same key that was chosen the last time around (KY.OLD). If KY does equal KY.OLD, the program jumps back to line 1740 to generate a different value to KY.

When a valid key number is generated, the program prints the corresponding character in the center of screen via the PRINT statement of line 1770. Line 1790 then waits for the user's response through the use of another INKEY$ command. If the ESC key is pressed at that point, line 1800 returns the user to the mode-selection menu. If any other key is pressed, however, lines 1820 and 1840 keep track of the totals and then jump back to the appropriate line of the program. A correct answer yields a branch to line 1730, while an incorrect one goes to line 1790 to give the user another chance.

Conclusion. No computer program can teach you to type fast and accurately. The best that TYPE-PR.BAS can do is to help you teach yourself the keyboard by providing you with a logical progression of practice exercises. Practice is the key with this or any other typing-drill software. Once you commit yourself to practicing, you have an excellent chance of increasing your typing proficiency and overcoming the handicap of having to deal with a poorly designed keyboard. ■

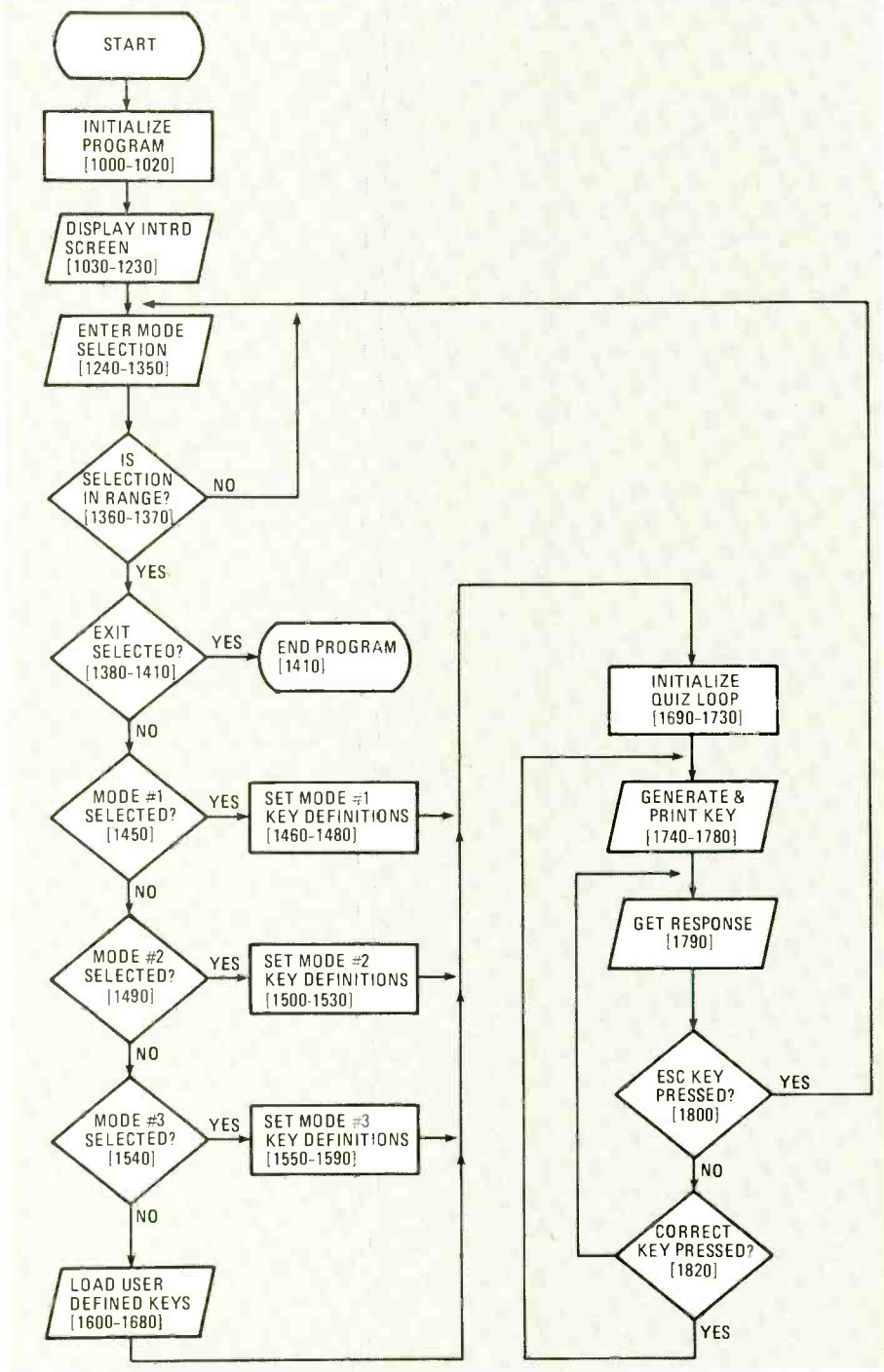

Fig. 2. This flowchart for TYPE-PR.BAS shows the initialization and menu portion of the program on the left, while the right side details the main practice routine.

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ANTIQUE RADIO

(Continued from page 77)

flashing process, but *do not* press any of the test buttons.

When To Rejuvenate. Speaking of tube testers, it's a very good idea to use one to verify that your tube is weak before attempting rejuvenation. The flashing procedure will materially reduce the remaining lifetime of a good tube. Borrow a tester if you have to.

In *Radio Physics Course* (Radio and Technical Publishing Co., 1933), Alfred A. Ghirardi suggested some standards for determining if a tube could benefit from flashing. They were based on the use of a simple emission-type tube tester. Ghirardi's tube-tester circuit is shown as Fig. 3.

Emission testers are not considered to be the best type for general radio-service work because they do not measure overall tube performance. They're fine for our purposes, however, because emission is the only characteristic we're interested in when considering tube rejuvenation.

The idea of the tester is to place a specific amount of plate voltage on the tube (actually "plate-and-grid" voltage, since the two elements are tied together) through a milliammeter and read the resulting current. If the current doesn't meet the minimum standard (Table 2) emission is impaired. Once again, I'm not presenting this as a tested construction project, but rather as an idea source for the more advanced readers.

Your flashing power supply can be used to replace the filament battery and rheostat (just set it for the filament

TABLE 2—EMISSION TEST DATA

Tube Type	Filament Voltage (volts)	Plate Voltage (volts)	Minimum Current (mA)
*'11, '12	1.1	50	6
'99	3.3	50	6
'20	3.3	50	15
'01-A	5.0	50	20
'00-A	5.0	50	14
'40	5.0	50	14
*'71-A	5.0	50	50
'10	6.0	100	85
*'26	1.5	50	35
*'27	2.5	50	35
*'80	5.0	80	100
*'81	7.5	50	200
*'50	7.5	250	560

*Cannot be reactivated—do not flash.

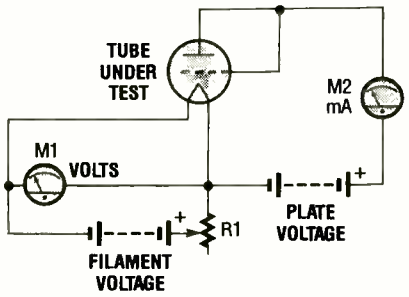

Fig. 3. The more advanced readers can use Ghirardi's schematic of an emission-type tube tester as a basis for designing a working model (see text).

voltage specified in the table), especially if it is a DC power supply. I'm not sure if the given minimum current readings would be correct for an AC supply. The plate-circuit battery could be replaced with a variable high-voltage DC supply delivering the values required by the table. You'll need a voltmeter across it to make the correct settings. But leave the voltage on the tube *only* long enough to read the milliammeter. Otherwise, tube damage could result.

See You Next Month! In the meantime, write me c/o *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

COMPUTER CONNECTION

(Continued from page 67)

equipment (DTE) and data-communications equipment (DCE). A DTE device is capable of acting as a data source and/or data destination. A DCE is a device required to establish, maintain, and terminate a data-transmission connection. For example, a computer can be used as a DTE, whereas a modem is a DCE.

Figure 6A shows the cable required for a DTE (computer) to DCE (modem) hookup. Those connections are "straight across" (*i.e.* the pins on one connector are wired to the equivalent pins on the other connector. Be careful, because the connectors used for DTE and DCE devices are the same and, if confused, will cause trouble.

Figure 6B shows the proper cable for most DTE to DTE connections. Note that certain signals are "crossed over," that is, they are switched in order to make the computers think they are talking through modems.

Centronics Parallel Ports. A parallel

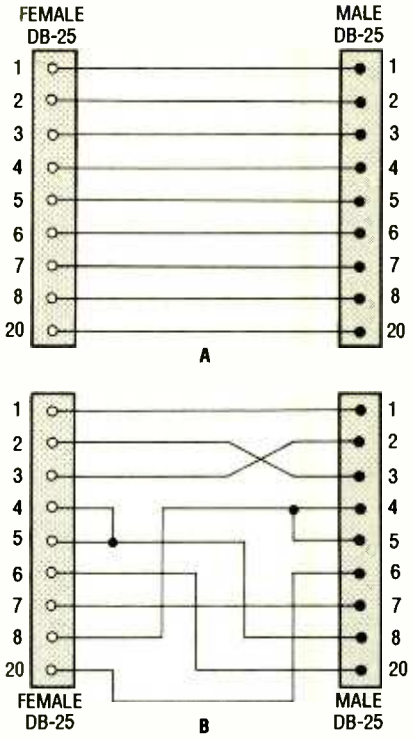

Fig. 6. When connecting DTE devices to DCE devices a straight-through cable can be used (as in A). When you connect two DTE devices together you must trick them into thinking they are each connected to a DCE device by swapping most of their wires.

interface differs from a serial one in that they require one line for each bit on the data bus, plus a return line or common (the ground). Serial systems transmit all bits in sequence over the same communications path, while the parallel format transmits all bits simultaneously. As a result, the parallel format is a lot faster, although it requires more data channels.

The simplest parallel format is the straight-forward eight-bit parallel port. For most parallel printer connections, the Centronics interface is used. Most parallel ports use a standard connector, the Amphenol 57-30360 (see Table 2 for the pinouts). All levels are TTL compatible and the standard has wide acceptance. ■

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TAKE ALONG PHONE

(Continued from page 44)

channel, as long as one is available. When I tried it, it took just a split second to gain access to a channel. Then I keyed in the called party's number in the usual way. If you start to move about, a distinctive warning tone is heard through the handset as you approach the border of the base station's range.

Telepoint has its doubters, such as veteran telecommunications consultant Clifton Bean with Arthur D. Little, Inc., the think tank in Cambridge, MA. He doubts that Telepoint will make it in this country, especially with the steady drop in the cost of cellular phones. However, he does see cordless phones making it big in business. He endorses one concept (now under development at British Telecom's big lab near Ipswich) in which all the phones inside a company building would be of the cordless variety. Whenever an employee left his desk, he could carry his six-ounce phone with him. Because the phones are of the digital variety, it would be very easy for them to tie into the company's private branch exchange (PBX) for transmission of data. Thus, an employee could carry his laptop computer with him to meetings to call up pertinent data without plugging into a wired network.

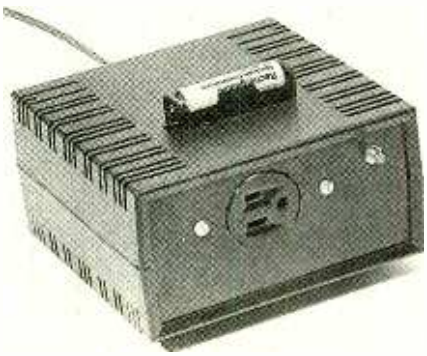
Imagine the convenience of using a phone the size of the one shown here for on-the-go communication. The unit is small enough to fit in the user's pocket; you don't need to be in your car or carry a bulky battery with you.

Wouldn't it be wonderful to have Telepoint in this country? Then those without cellular phones could make calls as needed when on the go even if all available pay phones are in use, out of order, or even if you don't have coins handy to put in the slot. ■

NiCd TESTER

(Continued from page 42)

This view of the NiCd Battery Tester's rear panel reveals that extra heat sinking was used for U3.



The NiCd Battery Tester with the cover in place. Note that S1 and SO1 are front-panel mounted and that the battery holder is mounted to the top of the enclosure.

lead of the meter should be connected to the battery-holder lead.

Connect a DC voltmeter across C1 and apply power. You should get a reading of about 18 volts. Remove the positive meter lead and connect it to the output of U1. Press S1 and the meter should read about 12 volts. Release S1 and the meter should continue reading 12 volts. The current meter should be reading 10 to 200 milliamperes.

Connect the negative lead of the voltmeter to the negative lead of the NiCd battery. Place the voltmeter's positive lead on the slider of potentiometer R3. Turn R3 clockwise until the meter reads 1 volt. Now turn potentiometer R8 clockwise until the milliammeter reads 500 milliamperes.

Disconnect the power, remove the milliammeter, unsolder the temporary wire, and connect the battery holder directly to the board. Attach the cover and the tester is completed. ■

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TOLL TOTALIZER

(Continued from page 36)

counter connected to pin 1 of U2. The output frequency of the pulse generator is set by adjusting R16 to the center position and adjusting R4 for a reading that's as close to the proper frequency as possible. After that, use R16 to fine-tune the output frequency.

A somewhat slower and more tedious process is required if you do not have a frequency meter. This process uses the cost-per-minute rate for calibration and is done in the following manner:

Set R16 to the center position. Reset the counter to zero. Then using a watch, start the counter for a period of exactly one minute. Stop the counter and compare the count with your cost-per-minute rate. Increasing R4 slows the count

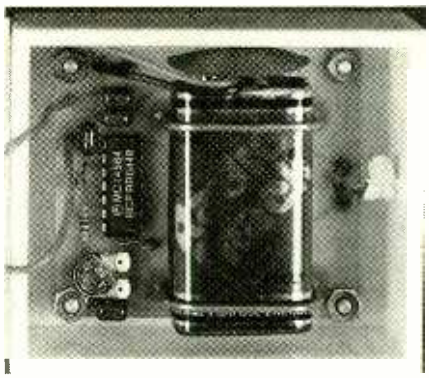
The enclosure housing the Telephone Toll Totalizer was fabricated by the author from pieces of ⅛-inch thick plastic, that was sealed with a piece of dark-red transparent plastic, which also doubles as a display bezel.

while decreasing R4 speeds the count. Make your adjustment to R4 and run the counter for another minute. When you get close to the right cost-per-minute figure, R16 may be used to fine-tune the generator's output frequency. It will take several tries to get the counter to read the cost-per-minute rate in the period of one minute. That method is slow, but it can be done with enough patience since the count change is so slow.

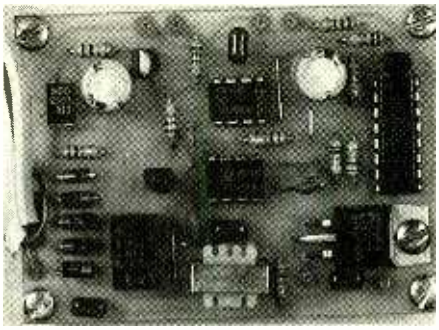
Warning: Once you've built the unit, you may find yourself becoming very cost conscious about the time you spend on the telephone. There is something about seeing the total dollars and cents add up while you are talking that makes you want to complete your business and hang up. Nothing has really changed except that now you can see your money spent while you are on the line. ■

FAX SWITCH

(Continued from page 32)



The transmitter portion of the Remote-Control Fax Switch was housed in a small enclosure, measuring 2⅞ by 2⅞ by 1⅜ inches, made from pieces of ⅛-inch thick plastic sheeting.



Here's the Remote-Control Fax Switch receiver PC board. It is housed in a metal enclosure measuring 5 by 3 by 1¼ inches.

ter until LED1 in the receiver comes on. When the lamp comes on, while holding the transmitter button down, rock variable resistor R1 back and forth to position it in the middle of the range where LED1 is on.

Next, lift the phone off-hook and press the transmitter button; LED2 on the receiver should light indicating that the relay has been activated. The relay should lock on and stay on until the phone is replaced on the hook. Assuming all goes well, that completes the alignment procedure.

The two units can now be physically separated. As long as they are connected to the same telephone line, you should be able to turn on the receiver by pushing the button of the transmitter, and turn it off by hanging up the phone. The Remote-Control Fax Switch is now ready to be connected to the fax machine or remote telephone.

The Remote-Control Fax Switch can save you bucks by eliminating the need for an extra phone line dedicated to fax communications and save valuable desk space in the bargain. ■

SW RECEIVER

(Continued from page 39)

on them to make sure nothing will short when the case is closed.

Final Assembly. Press the channel-indicator knob back on and replace the Phillips-head screw in the center of the dial. Orient the frequency-indicator insert and press it back in place. Carefully place the two halves of the radio back together, keeping the wires in the notched groove so that both halves fit together snugly once again. Replace the Phillips-head screw in the center of the back of the radio. Now place the lid on the project box and insert the four corner screws. Mount the knob on the rotary switch's shaft.

Place three strips of adhesive hook-and-loop (Velcro) fasteners across the width of the radio, making sure you do not cover up the battery compartment or the earphone jack, and then place matching strips across the width of the project box. Press the two boxes together and presto!—you have a compact, portable unit.

Operation. For the best shortwave reception, wait until sunset when the bands begin to open up. Attach 5 to 25 feet of wire to the antenna terminal (alligator clip) and turn your radio on. Slowly adjust the radio's tuning control. If you find nothing, or are receiving some strong local AM broadcast stations, change the setting of S1 and try again. One of the first things you may notice will be the presence of Morse code. You are in the ball park now. If the signals are not very strong, try using a longer antenna or move to a window. It won't be long until you hear an English voice with a distinct accent or even a foreign language.

One problem with this economy model is that there's an awful lot of frequency coverage squeezed together over just a little bit of tuning range. Because of that, you will notice that stations are often found very close together; sometimes two or more stations appear at the same frequency or are very weak. Try changing the setting of S1 one position to the right or left; that may help bring in the station. Also, try using a longer antenna.

My friends are amazed with the power of this little radio and I have been asked to build several more. I hope you have as much fun with this little shortwave radio as I have. ■

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(Continued from page 72)

cuit, unlike the ripple counter, the clock inputs for all of the flip-flops in the chain (in this case U1-a and U1-b) are connected to a common clock signal and therefore all of the flip-flops are clocked simultaneously. A timing diagram for that circuit is shown in Fig. 4B.

JK Flip-Flop Exercise. Breadboard the circuit shown in Fig. 3A. Be sure to connect the clock input of the first flip-flop to the +V bus through a 4.7k resistor. Apply power to the circuit, and apply a pulse train to the clock input of the circuit using a logic pulser. Observe the operation of the circuit as indicated by the LED's (connected to the $\overline{Q}$ outputs of the two flip-flops).

Power down the circuit, remove the 4.7k resistor connected between the clock input and +V power-supply bus, and connect the output of a 555 astable multivibrator to the clock input of the circuit (see Fig. 5). Reapply power to the circuit and monitor the clock input signal, as well as the Q outputs of the two flip-flops, using an oscilloscope triggered from the circuit's clock source. Record your observations. Do the input and output waveforms correspond to those shown in Fig. 3B?

Now power-down the circuit, and breadboard the circuit shown in Fig. 4A. It will be necessary to reinstall the 4.7k resistor from the clock input of the first flip-flop to the +V supply bus. Note that the clock input of the second flip-flop is tied to the clock input of the first flip-flop. Inject several pulses to the clock input of the first flip-flop using your logic pulser. Observe the output of the circuit as indicated by the LED's connected to the $\overline{Q}$ outputs of the two flip-flops.

Power down the circuit, and remove the 4.7k resistor connected between the clock input of the first flip-flop and the +V bus. Connect the output of the 555 astable multivibrator to the clock input of the circuit, as shown in Fig. 6. Apply power to the circuit and, using an oscilloscope, observe the output waveforms at the Q outputs of the two flip-flops. Do the waveforms shown on the oscilloscope correspond to those shown in Fig. 4B? What can be concluded from your observations?

Once all of the experiments have been completed, power down the circuit, but **do not** disassemble it. Portions of that circuit will be used in future exercises. ■

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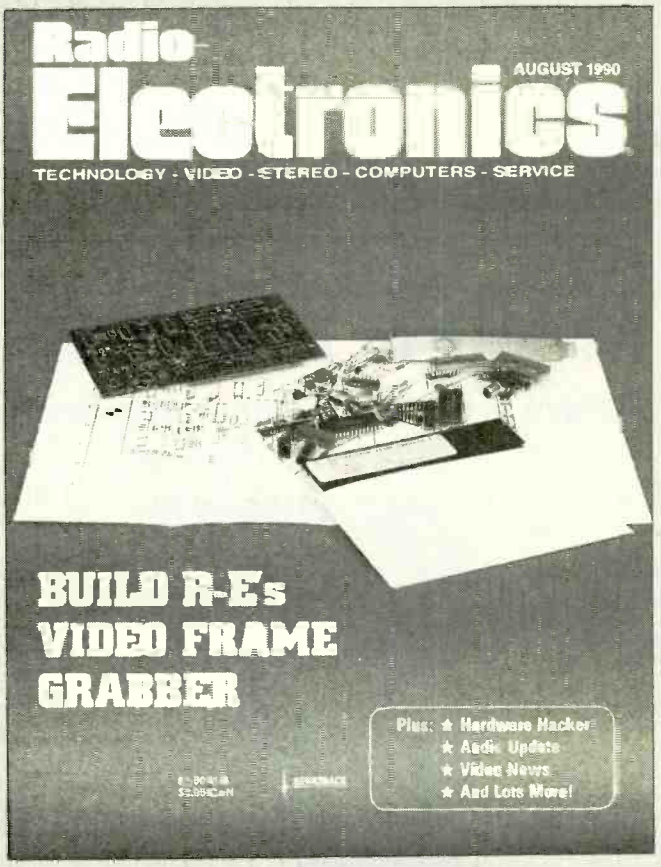

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HEATH TV KIT

(Continued from page 75)

"transmitted" to the set at a signal strength of only 100 microvolts (corresponding to weak signal or fringe-area reception), a very minimal amount of background noise was noted. The picture was still totally acceptable for normal viewing.

APEL measured some of the basic audio-performance characteristics of this set as well. The 3% total harmonic distortion (THD) level was reached when the internal audio amplifier delivered just under 1 watt of audio power. At −10 dB below that maximum power level, distortion decreased to an acceptably low 0.46%. A weighted signal-to-noise ratio measured a rather poor 34.7 dB. The set consumed 68 watts of power when operating from an AC (120 V, 60 Hz) power source. When powered from 12 VDC, current drain was 4.6 amperes. A summary of these measurements appears elsewhere in this report.

Hands-On Tests. We, of course, had no part in the construction of this little TV set. By the time we got our hands on it, it looked for all the world like a "factory built" product. Again, we were surprised at how far Heathkits have come in terms of good looks and styling. The industrial design of this portable rivals that of sets that are assembled by name-brand manufacturers. A carrying handle sits flush with the top of the set, yet is easily pulled up to form a well-balanced handle for transporting the TV set.

Reception using the monopole antenna supplied as part of the set was fair to good, depending upon the channel selected. Generally, higher numbered VHF channels came in with less noise than the lower numbered channels. Our location is some 20 airline miles from the site of most of our area's TV transmitters.

Of course, when we connected the set to an outdoor antenna, reception improved tremendously, with all channels coming in with no trace of "snow" or noise and with good color accuracy. Connecting the set to our local cable service also yielded excellent reception, limited only by the quality of signal delivered by our local cable company. (That quality varies from day to day and often from hour to hour and no amount of complaining to the cable company seems to result in any improvement in quality.)

If the idea of spending a day or so assembling a high-quality color TV set appeals to you, this TV model from the venerable Heath Company may be just what you want. You'll not only enjoy the feeling of having built something as complex as a TV set with "your own hands," but you're more than likely to enjoy the pictures delivered by this set for many years to come. And for those of you who are somewhat fearful of undertaking such a project, may we hasten to add that the first page of the owner's manual lists phone numbers you can call for technical assistance any time from 8:00 A.M. to 4:30 P.M. Eastern Time. Judging by the 48 pages devoted to assembly (the rest of the book is an operating manual), if you follow the step-by-step instructions carefully, you're not likely to need technical assistance at all.

For more information on the Heath GR-9009 9-inch TV Receiver Kit contact the manufacturer (Heath Company, Benton Harbor, MI 49022) directly, or you can circle 119 on the Free Information Card. ■

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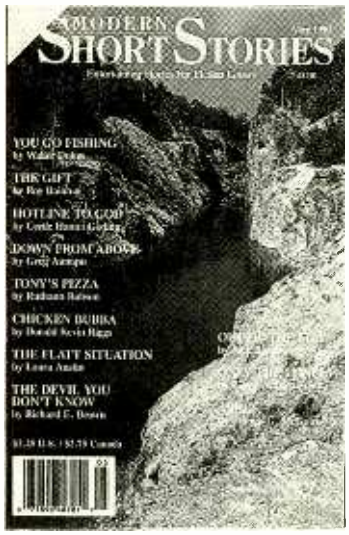

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SPELLCODE

(Continued from page 73)

for the same application takes only one minute and five seconds.

Further, when tested with three popular word-processing formats on a "slow-speed" XT, SpellCode was extremely fast in comparison to other spelling checkers.

You can customize SpellCode still further by building personal dictionaries for terms and jargon used in specific industries. SpellCode can even build those personal dictionaries automatically from user files.

Installation. SpellCode requires only 256K of memory and DOS 2.0 or higher on an IBM PC, XT, AT, OS/2, or a 100% compatible machine. A hard disk is recommended but not required, as SpellCode will work with even one-floppy-drive systems.

After quickly getting your feet wet by reading a little of the manual (just the installation section and a few of the pages that follow it) the only thing keeping you from using SpellCode is about five minutes of installation. During the installation procedure, an SCODE sub-directory is established to contain SpellCode's files, but an option built into SpellCode allows you to reach out into any sub-directory.

It will also be necessary to specify "SPELL" as an environment variable from the DOS command line or a batch file as shown in the instruction manual.

What You See! SpellCode uses windows and pop-up menus for user-friendly interaction. Dual windows display various aspects of program operation, including the context in which suspect words appear, suggested corrections based on advanced algorithms and heuristics, simple forms for setting program options, and context-sensitive help screens.

SpellCode uses a simple function-key command set, and the key assignments are always displayed, eliminating the need to memorize any key's function.

SpellCode sells for $99.95 and comes with all dictionaries and support utilities, plus an extensive, well-written user manual. It is available from Geller Software Laboratories, Inc., 35 Stephen Street, Montclair, New Jersey 07042; Tel. 1-201-746-7042. For more information you can circle No. 120 on the Free Information Card. ■

BATTERIES

(Continued from page 63)

"breathe" in order to vent the gasses that are generated as it operates. Never seal off or pot a battery in any sort of compound.

- Keep heat sources away from battery compartments. Excess heat will tend to drive moisture from the electrolyte and reduce battery life, so allow for heat venting where possible.
- Always connect batteries in series. A parallel battery with an output voltage lower than any others will be in a charge state. That will load any other cells and reduce the service life of the whole battery assembly. It can also cause a leak or rupture in the weaker battery.
- Try to use an AC adaptor in addition to the battery whenever possible. That can go a long way to extending battery life.

Conclusion. Conventional batteries come in many shapes and sizes. Carbon-zinc, zinc-chloride, and alkaline cells can be found in 1.5-volt D, C, AA, AAA, N; 6-volt lantern; and 9-volt rectangular sizes. Mercury cells are usually found in 1.35 to 1.4 volt button packages. Lithium cells can take many shapes and generate a consistent 3.0 volts for almost their entire life. Lead-acid and nickel-cadmium batteries are secondary cells and will accept repeated chargings. Lead-acid cells generate about 2 volts and are used in high current applications. NiCd cells source about 1.5 volts, and can be found in just about all common sizes.

Two new types of primary cells have recently been introduced. A lithium sulfur dioxide cell can offer up to 19Ah of service at 3.0 volts with a shelf life up to 10 years. Those cells are used in some military and industrial process control applications requiring high capacity and operation at extreme temperatures. A zinc air cell is found in a button package that can provide 8.5Ah of service at 1.4 volts when activated by exposure to air. The shelf life in an inactivated zinc air cell can approach 10 years. Zinc air cells are found in hearing aids, emergency lighting, and pagers among others.

Batteries have found uses in almost every aspect of military, industrial, and commercial electronics. New designs and capacities will certainly be developed in the future to suit the needs of new products and technology. ■

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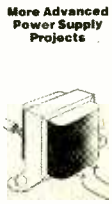

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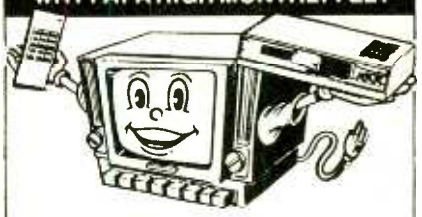

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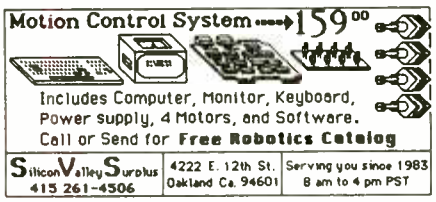

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