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JUNE 1989

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IN THIS ISSUE

DX Listening
Sunspots, and DX'ing,
are on the upswing.

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THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

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MY FIRST RADIO PROJECT!

I remember putting together my first radio. The circuit used a type 37 vacuum tube whose filament was powered directly from the AC line in series with a 40-watt bulb. My Dad would kid me by saying: "That's not a radio. It's a lamp!"

The circuit included a plate-tickler coil loosely coupled to a tuning coil, which is typical of a basic regenerative receiver. A paralleled resistor and capacitor connected in series with the tube's control grid provide the biasing. That's the old *grid-leak* circuit, which has been the subject of a lot of cartoons in technical magazines over the years. The output was heard through a 2000-ohm "Cannon Ball" headset. I eventually purchased an output transformer and a permanent-magnet speaker so that more than one person could listen in. Besides, the headset leads were hot with AC.

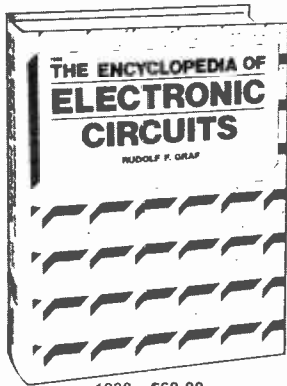
What started my reminiscing was reading the "Matchbox Crystal Radio," which begins on page 41 of this issue. I guess I was ahead of the crystal-set generation by a few years. Maybe that's why I enjoy projects like that so much. And, judging from our mail, many of you do, too. All of us seem to share a fascination for radio, especially when we can pull in local and distant stations with a hodgepodge of scrap parts and wire. The mystique is still there.

That's why we at **Popular Electronics** will always find room to include some of those simple but fun circuits. Those of us who have been around awhile still get a kick from producing a working project in an evening or two. And for those of you just starting out, maybe we can capture your imagination and inspire you to build your first radio project.

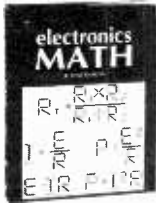
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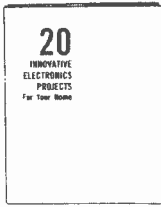
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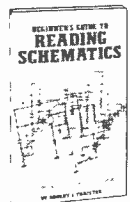
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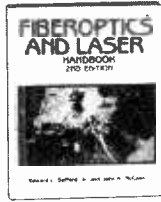
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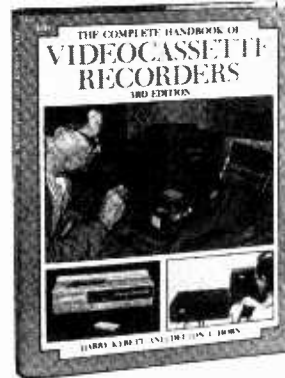
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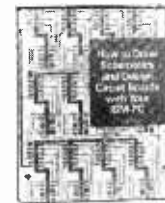
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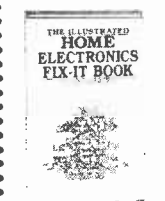
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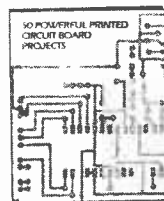
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Letters

ASSAULT ON THE BATTERY

Thank you for covering the new Duracell XL lithium batteries in "Gizmo" in the March issue of **Popular Electronics**.

In the interest of consumer safety, however, I must point out a mistake that was made when you ran the story. Duracell lithium batteries are *not* rechargeable; consumers should *never* attempt to recharge Duracell lithium batteries. The correct wording should have been "consumer changeable"—not "consumer chargeable."

James J. Donahue, Jr.
Director of Communications
Duracell Inc.

BRAKE-LIGHT ADJUSTMENT

Thank you for an excellent magazine. I spotted an error in the parts-placement diagram for the "Flashing Brake-Light" (**Popular Electronics**, March 1989): The anode and cathode leads of SCR1 are shown reversed.

Also, I'd like to suggest that R8 be a 20K potentiometer to slow flashing even more. I used a 2N6125 for Q1, and a 2N5061 for SCR1, which allowed me to get all parts from one inexpensive source (Circuit Specialists, Scottsdale, AZ; 1-800-528-1417). I found that diodes D4 and D5 are not needed if the vehicle has a third brake light; there's just a slight change in the hook up.

I built your "Musical Doorbell" from the November 1988 issue, and gave several of them for Christmas gifts. Wow! I've never gotten such thanks! The down side was that I had to install most of them, and had still more requests after Christmas. Thanks(?).

I increased the doorbell's volume by changing R7 to 33K, R8 to 68K, and R9 to 470. I also solved the problem of the bell sounding in rainstorms (if weather-proofing the button didn't work) by putting a 12K to 15K resistor between the doorbell and the button, mounted on the PC board. I got all those parts from Active Electronics (Westborough, MA; 1-800-228-4834.)

M.J.G.
Yale, MI

TESLA INFORMATION

Please inform S.S. of Chesnee, SC ("Letters," **Popular Electronics**, March 1989) that he may obtain a wealth of information on Nikola Tesla from Lindsay Publications, Inc.

(P.O. Box 12, Bradley, IL 60915-0012; Tel. 815-468-3668). Their new *Electrical Books Catalog* costs \$1.00; the diversity and thoroughness of the material it contains puts many libraries to shame.

S.S. might also want to know that, to the best of my knowledge, the doorknob capacitor (at least as far as TV sets are concerned) has gone the way of the dinosaur. If memory serves me anywhere near correctly, it disappeared back in the mid- to late-50's. However, they do still remain in the manufacturers' catalogs, though at a rather tidy sum (\$10.00 to \$15.00 apiece).

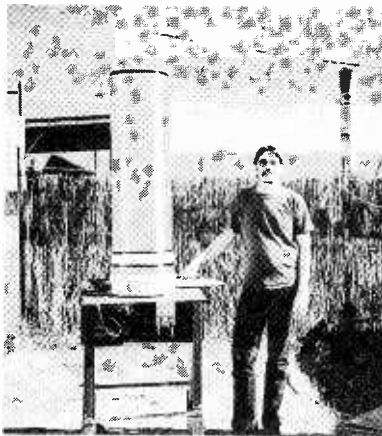
By the way, a couple of Lindsay's publications tell how to make high-voltage capacitors; there are several ways to get acceptable units. May not be as neat and nifty as a doorknob, but they work just as well, if not better.

L.E.S.
Hot Springs, SD

TESLA SOURCES

In your March issue, S.S. wrote that he couldn't find the 500-pF, 10K-WVDC capacitor for the Tesla Coil circuit. Hard-to-find parts like that are usually common stock at Fair Radio Sales Co. (P.O. Box 1105, Lima, OH 45802-1105; 419-223-2196/227-6573). On page 28 of their catalog is a bracket with two new 500-pF, 15K-VDC capacitors for \$2.25, or three for \$5.00 (#CAP500-15KV). I doubt that you will find them that cheap anywhere else. The cap will work fine; it just has a better voltage rating.

As for information on Nikola Tesla, I have a complete library myself, including a copy of his notes on his "Monster Machine" in Colorado Springs, and a copy of every patent he was granted. These can all be obtained from two sources—the Tesla Book Co. (P.O.



Box 1649, Greenville, TX 75401; 214-454-6819) and Angriff Press (P.O. Box 2726, Hollywood, CA 90028; 213-233-9848).

If he is looking for information on building Tesla coils, I'd suggest *Modern Resonance Transformer Design Theory* (\$29.50 plus \$1.50 shipping); for information on Tesla's life, *Prodigal Genius* (\$6.00 plus \$.75 shipping), both from Tesla Book Co.

Possibly someone could help me out. I need a source of spheres or torus rings of varying sizes for the top of the coils I build. I can't locate anything here in Phoenix, especially something around 2 feet in diameter for a 20-kW, 4-million volt machine I am building now. I'm also looking for sources or information on hard tube switchers or ignitrons that could handle something in the range of 30 kV at 2 amps, for a scaler wave interferometer I am currently building.

By the way, I thought your readers might be interested in a "moderate" sized machine I built, so I enclosed a photo. The lower part of the coil is not a primary; it is there for measurement purposes and has now been removed. The machine uses three .02- μ F, 120-K-VDC capacitors, although only one was installed on the day that the photo was taken.

Russell Clift
P.O. Box 2802
Glendale, AZ 85311

KEEPING TIME

In the "DX Listening" column in the January issue of **Popular Electronics**, Don Jensen's reply to Donald Callahan's question regarding EST/UTC conversion only hints at an important requirement for a clock that reads Universal Coordinated Time. Such a clock *must* tell time in the 24-hour mode (0000 to 2359 hours). There are mighty few such clocks available at a reasonable price these days.

Heath Company has one, their GC-1108. Some dealers who specialize in ham gear may still sell a 24-hour "digital" electromechanical clock or a large-diameter (about 12-inch) wall clock with 24 hours on its face. A nice little item, available from some mail-order electronics companies, is a 1-inch \times 4-inch battery-driven quartz clock that shows local time plus the time in any other time zone, simultaneously.

One problem in reading UTC is determining whether the time at Greenwich is "today" or "tomorrow." Tomorrow comes several hours earlier in Greenwich than in the U.S. (You can do a little arithmetic and discover why.) A clock showing UTC, or a conversion chart, should indicate the day.

J.N.J.
Skokie, IL

WHIZ KIDS

I got the February issue of **Popular Electronics** just in time for Christmas. I like the new title; it reminds me of those *Popular Mechanics* magazines that I used to get. As usual, I think your magazine has the best possible blend of theory, "tinker" projects, useful gadgets, test equipment, and letters from around the world.

The "E-Z Math" section could not have come at a better time. My wife's nephew, James, got a new computer game for his Apple IIc, which has you assemble robots

so that you can explore various tunnels in the game. To "program" those robots, he needed to use various AND, OR, NOR, XOR, 4-bit counters, etc.

Although he didn't understand the theory behind those gates, he did get the robots to explore the tunnels just fine. Bright kid that he is, James wanted to learn the theory. Luckily for me, I'd just read February's E-Z Math article on Boolean Algebra, and had a great time teaching him the facts. It is amazing how well the younger generation (James is 7 years old) can pick up concepts. Perhaps that is because their minds are not cluttered like ours. Anyway, we played away for hours and literally forgot about Christmas. Thanks for the article—my nephew thinks I am Einstein now!

By the way, James kept putting his feet (in socks, no shoes) on top of the computer, which was lying on the floor. When I asked him why, he said it kept his feet warm. Now that is what I call the maximum use of available energy.

E.M.
Vallejo, CA

HAVES AND NEEDS

I own a Sears AM/FM stereo amplifier that I bought second-hand. The amp is not fully operational due to a defect in an IC that encompasses the power output for both right

and left channels. Sears does sell the replacement IC, an STK 4151, but for an outrageous (in my opinion) \$45.00 plus. MCM used to offer it at a substantially lower price, but no longer stocks it. Can you give me a line on where to get this part at a more reasonable price?

John Keppel
8165 Scottdale Road
Berrien Springs, MI 49103

I read and enjoy your "Antique Radio" column regularly, as I have a love for the old sets. I would like to find a schematic for an old Marconi model 137 radio. It was manufactured in Canada, probably in the 1940's. Perhaps one of my fellow readers out there can help me?

James Carothers
7914 234th St. S.W.
Edmonds, WA 98020

DX ENTHUSIAST

Just this morning, I purchased the February 1989 issue of **Popular Electronics**. I read "DX Listening" with great enthusiasm. I didn't realize that there are so many SWL's around the globe. Here in Calgary and surrounding areas, printed information—particularly concerning station frequencies and schedules—are non-existent; there are no stores that will carry them.

Thank you for giving me the opportunity to read and enjoy many of your monthly articles in **Popular Electronics**. Keep up the good work!

E.F.
Calgary, Alberta, Canada

INDEX INQUIRY

I have been filing all the issues of the past year's **Hands-on Electronics** (and, lately, **Popular Electronics**). I would very much like a copy of your 1988 Editorial Index; it would allow me to quickly search for past articles and projects.

However, being an overseas reader, I am not sure how to comply with the instructions to send a self-addressed, stamped envelope. My country does not sell U.S. postage stamps.

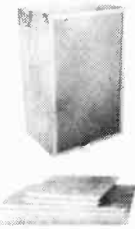
Could you advise me, and other overseas readers, how to place an order for an Editorial Index?

C.G.
Malaysia

Overseas readers should send a self-addressed envelope and two International Reply Coupons (IRC's), which can be purchased at their local post office, to 1988 Editorial Index, **Popular Electronics**, 500-B Bi-Country Blvd., Farmingdale, NY 11735, U.S.A. ■

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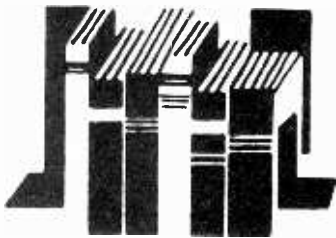
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This book details how to build an 80386 IBM-compatible microcomputer at a fraction of the full retail cost. The information it presents can also be used for updating existing PC's, XT's, AT's, and compatibles to powerful 80386 machines. Either way, the result is a computer that will accept the expanded abilities of MS-DOS 4.0 or OS/2.

No experience is necessary, and the only tools required are a pair of pliers and some screwdrivers. The project uses only readily available, off-the-shelf components. The book provides complete, step-by-step instructions and close-up photos to illustrate each stage of construction.

Besides assembly instructions, the book provides sources for buying components and parts, explanations of memory function and operation, descriptions of available peripherals (including floppy-, hard-

and optical-disk drives), and troubleshooting tips. Discussions of software and such applications as desktop publishing and network systems are also included, as well as reviews of 386 laptops.

Build Your Own 80386 IBM Compatible and Save a Bundle is available for \$16.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

MOBILE CELLULAR TELECOMMUNICATIONS SYSTEMS

by William C.Y. Lee

Written primarily for engineers and corporate planners who are involved in systems design and implementation, this book covers the practical concepts, design techniques, and operation of mobile cellular systems for telecommunications. It provides a convenient reference for consultants and technicians as well, describing how to solve common problems involving voice quality, switching capacity, and interference.

The author, a pioneer in mobile cellular telecommunications, followed a simple formula in preparing this textbook: He used mathematics to solve problems, physics to interpret the results, experiments to check the outcomes, and pictures to emphasize important points. The book includes different methods for maximizing the traffic capability of existing systems and describes



an accurate propagation model and how it might be affected by different environments. It shows how to reduce cochannel and non-cochannel interferences, how to operate with recent, additional 10-MHz allocations; and how performance depends on making the proper handoffs. The book details specifications in domestic and foreign cellular systems. It covers both analog and digital switching equipment and explains how digital systems improve spectrum accuracy. It also offers insights into what to expect in mobile cellular telecommunications in the 1990's.

Mobile Cellular Telecommunications Systems is available in hardcover for \$59.50 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

CIRCLE 96 ON FREE INFORMATION CARD

SUPERCONDUCTIVITY: EXPERIMENTS IN A NEW TECHNOLOGY

by Dave Prochnow

Despite some revolutionary progress in the past few years—and a lot of enthusiastic media coverage—superconductivity remains as much a scientific "curiosity" as a common, cost-effective technology. Research is speeding on, however, and progress is being made on several design fronts, and in many test applications. Research means experimentation, which requires extensive background information. This book is designed to present a definitive course on superconductivity—to provide that information.

The book progresses from elementary generalizations to complex theoretical topics, to allow the average electronics experimenter to follow it easily. But a familiarity with the basics of thermodynamics, inorganic chemistry, and quantum mechanics is needed for full understanding of the text.

Following a general overview of superconductivity, the book provides a time line of events in the research done to date, and explores the real world applications and their implications for the future. The book also includes working projects that comprise all the elements involved in demonstrating the Meissner Effect, including how to build a superconductivity oven and press, how to make and handle the superconductor, and how to levitate a magnet over the disk of superconducting material.

Superconductivity: Experimenting in a New Technology is available for \$14.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

ELECTRICAL ESTIMATING: WORK FOR A PROFIT

by Paul Rosenberg

When you own a small business, being busy isn't necessarily synonymous with making money, and the electrical-contracting field is no exception. This book shows how to run a profitable business by predicting trends, getting in on them at the start, and capitalizing on them.

The book details the basic practices to follow in selling, marketing, management, planning, and accounting. It explores how to develop smart purchasing techniques—

Electronics Library

such as magnet switches and foil-interrupt circuits, as well as high-tech components—including infrared and ultrasonic motion detectors, RF field-disturbance detectors, automatic telephone dialers, and wireless "panic" buttons. It also explains how to isolate and eliminate false alarms.

Handbook of Home Security Electronics is available for \$15.95 from Prentice Hall, Englewood Cliffs, NJ 07632.

CIRCLE 99 ON FREE INFORMATION CARD

DOS TIPS, TRICKS, AND TRAPS

by Chris DeVoney
with Norman Hale

The information in this book is intended to help readers make knowledgeable hardware and software purchase decisions, and to use and maintain their systems as efficiently as possible. The book provides background information, and offers shortcuts and alternatives to common operations. It also explores "safety vs. paranoia," in terms of deciding how much back-up and protection are actually practical.

Advanced beginners and intermediate users of MS-DOS and PC DOS (including Version 4) will find the information needed to become experienced, more productive users, as well as how to avoid or remedy common DOS problems. The book clarifies some of the confusing aspects about the CPU, memory, and the expansion bus, with an emphasis on expanded and external memory and advice on changing and expanding a system. It explains how to automate DOS with batch files and how to configure a system to meet specific needs. Various disk drives are described, including how to maximize performance. Practical advice is offered on formatting disks and diskettes, protecting diskettes (including tips for traveling with a laptop), establishing and using subdirectories effectively, file management, back-up procedures, and customizing the video display and keyboard.

DOS Tips, Tricks, and Traps is available for \$22.95 from Que Corporation, 11711 N. College Ave., Carmel, IN 46032.

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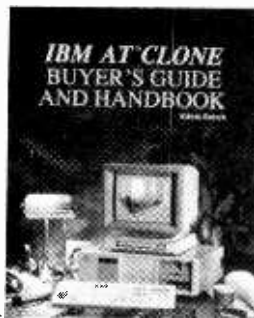
IBM AT CLONE BUYER'S GUIDE AND HANDBOOK

by Edwin Rutsch

There are so many IBM AT/286-type computers being sold today, and they vary so greatly in cost, quality, and performance, that making an informed purchase decision is no easy task. This book serves a dual

purpose: It is intended as a guide to help you choose the computer that best matches your needs and your budget, and as a reference tool to help you get the most out of the clone that you buy.

For readers who are completely unfamiliar with computers, there are several chapters devoted to the basics of computer his-



tory, components, and operation—including how you can determine what your current needs are, and predict what you'll need in the future. Various sources for buying computers are presented. Specific 286 models are reviewed and evaluated, and the separate parts of the computer—chassis, motherboards, disk drives, power supplies, monitors, modems, keyboards, etc.—are described, including buying recommendations and expansion tips. The book also offers assembly, expansion, and troubleshooting instructions. Helpful appendices include listings of computer manufacturers, magazines, show and swap-meet promoters; and IBM diagnostic error codes.

IBM AT Clone Buyer's Guide and Handbook is available for \$24.95 from Modular Information Systems, 431 Ashbury Street, San Francisco, CA 94117.

CIRCLE 89 ON FREE INFORMATION CARD

CUSTOMIZE YOUR PHONE: 15 Electronic Projects

by Steve Sokolowski

With the court-ordered break-up of AT&T's telephone monopoly, all sorts of multi-featured telephones and accessories appeared on the consumer-electronics market. This book offers more alternatives, with 15 do-it-yourself projects that even novice hobbyists can build.

The book provides a basic course in how to build electronics projects, including reading schematics, selecting components, and assembly and soldering techniques. The fundamentals of telephone theory and circuitry are also presented in the book, with topics covering everything from rotary and touch-tone dialing, wiring and installation, to how phones ring.

All the projects feature schematic dia-

grams, parts lists, and step-by-step instructions. They include a bug detector, an automatic recorder, an intercom, call indicators, a musical hold button, a speaker phone, an appliance controller, a line tester, and a conference caller.

Customize Your Phone: 15 Electronic Projects is available for \$12.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

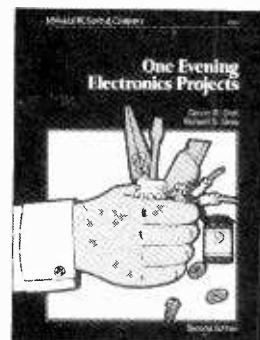
CIRCLE 98 ON FREE INFORMATION CARD

ONE EVENING ELECTRONICS PROJECTS Second Edition

by Calvin R. Graf
and Richard S. Gross

The 16 projects presented in this book are easy enough for junior-high students to handle, yet practical and interesting enough to appeal to engineers. Eliminating the frustration, expense, and time that complex construction projects often entail, these are designed using only tested circuitry, and can be assembled in a home shop using common tools and components that are easy to obtain from local electronics-supply stores.

An introductory chapter, which also contains background information on the projects, explains the electrical symbols found on circuit diagrams, and describes how to mount electronic components and how to



package the finished projects. Each project includes step-by-step instructions, circuit diagrams, illustrations, and a parts list. A sampling of the projects includes a line-voltage monitor, a voltage detector, a light-sensitive audio oscillator, a visual telephone ringer, a music-on-hold telephone addition, and how to design an audio amplifier using transistors.

One Evening Electronics Projects, Second Edition is available for \$8.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

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(Continued on page 12)

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BP84—DIGITAL IC PROJECTS . . . \$5.50. Both simple and more advanced projects to help the reader develop a knowledge of the workings of digital circuits. A number of board layouts are included.



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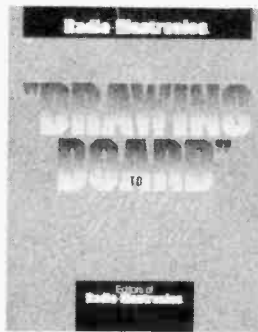
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Electronics Library (Continued from page 8)

FROM "DRAWING BOARD" TO FINISHED PROJECT

Editors of Radio-Electronics

The projects featured in this book were selected for their originality and practicality from the "New Ideas," "Drawing Board," "Designer's Notebook," and "State of Solid State" columns that are featured in *Radio-Electronics* magazine. The book combines instructive articles with hands-on experiments and projects, making it a valuable



reference tool for electronics enthusiasts.

Ranging from hobbyist contributions to the work of electronics professionals, every chapter includes unique ideas and helpful tips. Some of the projects and topics presented include audio overload-protection circuits, an automobile locator, a broadcast-band RF amplifier, how to design with the Schmitt Trigger, fiber-optic communications, a car-theft protection device, and an ultrasonic pest repeller. Clear illustrations accompany the text.

From "Drawing Board" to Finished Project is available for \$9.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

NEW HANDBOOK OF ELECTRONIC DATA

by Martin Clifford

If you're involved in electronics—whether as an engineer, a technician, or a hobbyist—an enormous amount of data is needed to keep up-to-date and to work effectively. This textbook is intended as a single, comprehensive source for the most commonly used formulas, and to minimize the time and energy spent on research.

The book presents hundreds of formulas in an easily accessible manner; explanatory text is provided only to clarify the use of a formula or its derivation. Formulas are used because they are precise—a shorthand way of presenting information—and

they can be manipulated to supply new information. Solving an electrical problem often requires the use of several formulas. To use the information presented in this book, the reader must have a sufficient background in elementary algebra and trigonometry, and some familiarity with algebraic functions; that will enable him to solve electronic problems by selecting the right formulas and using them in the proper sequence.

The *New Handbook of Electronic Data* is available in hardcover for \$32.00 from Prentice Hall, Englewood Cliffs, NJ 07632.

CIRCLE 99 ON FREE INFORMATION CARD

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

by R. Jesse Phagan and Bill Spaulding

If you're more adept with your Apple computer than with electronics theory or mathematics, this is the book for you. It presents basic theory, background math, and lab and practice exercises, all with corresponding computer programs, so that you can use your Apple to teach yourself about electronics. (A diskette that contains all the programs is available separately.)

The self-study format is designed to provide beginners with a thorough introduction to electronics. The theory and mathematics that support each concept are explained, and the computer programs graphically illustrate the concepts and the mathematical relationships. Complete instructions for experiments and projects, which offer hands-on experience with the principles being taught, are also provided.

The book covers terminology, engineering notation, basic math, soldering techniques, tools and test equipment, magnetism, and many other subjects. Each chapter includes sample problems, lab exercises, and quizzes; two major exams are also included.

Learning Electronics: Theory and Experiments with Computer-Aided Instruction for the Apple is available for \$16.95 (the diskette costs \$24.95) from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

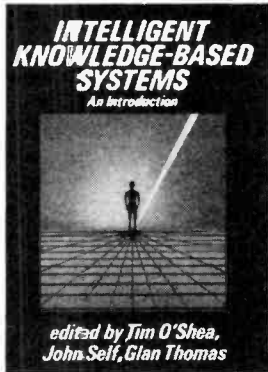
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INTELLIGENT KNOWLEDGE-BASED SYSTEMS

edited by Tim O'Shea, John Self, and Glan Thomas

This book is a textual version of a highly acclaimed BBC series of lectures on vari-

ous aspects of intelligent knowledge-based systems. It is a collection of articles written by the lecturers—American and British experts in Artificial Intelligence (AI). The 12 articles have an informal but informative



style, with an emphasis on the applications of AI research in industry and commerce. Aimed at a broad technical audience, no specific prior knowledge of AI is assumed. The book contains descriptions of the tools used in constructing intelligent knowledge-based systems, and details important applications and problems that are currently being addressed by AI researchers.

Intelligent Knowledge-Based Systems: An Introduction is available for \$29.50 from Hemisphere Publishing Corporation, 79 Madison Avenue, New York, NY 10016-7892.

CIRCLE 91 ON FREE INFORMATION CARD

DIGITAL VIDEO IN THE PC ENVIRONMENT: Featuring DVI Technology

by Arch C. Luther

There's no doubt that television is an integral part of our lives, and personal computers have been gaining in acceptance and popularity. In digital-video systems, both real and computer-display images are represented in computer-data (digital) form, and can be displayed or manipulated by a computer. Digital Video Interactive (DVI) technology merges the accessibility of television with the storage capacity of computer and provides a high degree of interaction between the user and the system—especially useful for teaching, training, and sales applications.

The exciting new medium combines interactive, full-motion video, stereo digital audio, and powerful computer graphics. The author, one of the developers of DVI technology, presents a step-by-step explanation of video, audio, and optical-storage media before examining how they can work together. For those who are interested in working in the field, or who are simply curi-

ous, he offers a complete picture of DVI capabilities and applications, including the skills and technology needed to make the system a success.

The book examines still-video imaging systems, image-compression technology, digital motion-video systems, video manipulation, and special effects. Other issues critical to the development of DVI technology—including video digitizing, the selection of video material, video production considerations, real-time operations, and multi-

tasking—are also discussed. Using the DVI development system as a model, the book looks at development software in the C language, including examples of application techniques.

Digital Video in the PC Environment is available in hardcover for \$39.95 and in softcover for \$27.95 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

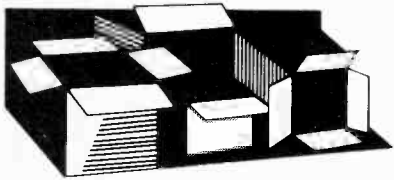
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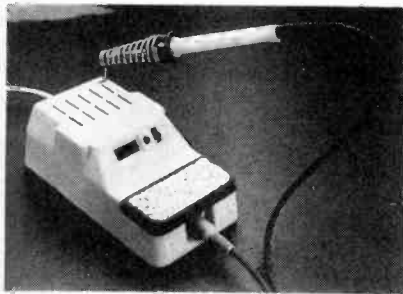
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DIGITAL SOLDERING STATION

M.M. Newman's Antex TCSU-D2 is a compact, digital temperature-control soldering station that features dial-selectable settings, a 50-watt soldering iron, a spring holder, and a removable sponge tray.

The temperature settings range from ambient to 450°C, with $\pm 5^\circ\text{C}$ accuracy and 1°C display resolution. The self-contained soldering station measures just 8 by 4 $\frac{3}{8}$ by 2 $\frac{3}{4}$ inches.

Designed for soldering heat-sensitive components, the soldering iron uses interchange-



able slide-on tips. The TCSU-D2 provides a continuous temperature readout. A thermocouple in the heating element ensures positive feedback from the tip at all times.

The Antex TCSU-D2 Digital Temperature-Control Soldering Station costs \$184.50. For further information, contact M.M. Newman Corporation, 24 Tioga Way, P.O. Box 615, Marblehead, MA 01945.

CIRCLE 101 ON FREE INFORMATION CARD

CAR CD PLAYER

Blaupunkt's New York SCD 08 can recognize 18 CD's and play the songs on each of them in any order that suits the user. That Track Program Memory (TPM) feature gives the user the listening options in the car that a high-end home CD player would provide. Other CD features include Auto Restart, which automatically returns

to the beginning of the track being played when the unit was turned off; a 10-second automatic track scan; fast-forward/reverse; a CD/Tuner switch that allows the radio to be played without ejecting the CD; and Blaupunkt's CD-cartridge loading system, in which a CD is placed in a protective cartridge before driving, making it easier and safer to handle.

The New York SCD 08's FM tuner also provides the sound quality of a home tuner, even in difficult mobile-reception conditions. It offers dynamic noise reduction, ASU impulse-noise quieting, and other FM signal-processing circuits. The tuner has 18 FM and 12 AM presets, plus 6 more FM travel-store presets that seek and store the 6 best available stations. For theft deterrence, the unit features optional pull-out mounting and built-in security codes; the unit won't func-



tion until it is reprogrammed with the owner-selected 4-digit code.

The New York SCD 08 automotive CD player has a suggested retail price of \$899.95. For further information, contact Robert Bosch Corporation, Blaupunkt Division, P.O. Box 4601, North Suburban, IL 60198; Tel. 1-800-872-6788.

CIRCLE 102 ON FREE INFORMATION CARD

IBM XT COMPATIBLE

Vendex Technologies' HeadStart II, an enhanced XT-compatible computer, is one of a line of PC's aimed at the home and business marketplace. The computer includes a 640K RAM 8088-1 microprocessor that operates at 9.54 MHz (switchable to 4.77 MHz). The system includes a power supply; a three-in-one (CGA-color, Hercules-, and monochrome-compatible) graphics card; clock/calendar circuitry with battery back up; and built-in parallel, game, and mouse ports.

HeadStart II also comes with bundled software that includes MS-DOS 3.3, GW Basic, the HeadStart Operating Environment, a floppy driver, typing and computer-use tutorials, and the HeadStart Office Manager, which features a word processor, database manager, and spreadsheet. All of the bundled software is completely menu driven by simple on-screen instructions. Special software allows the user to select either the 3 $\frac{1}{2}$ -inch or 5 $\frac{1}{4}$ -inch floppy-disk drive as the bootable A drive. With four available empty slots, there is room to accommodate any half-height hard-disk drive.



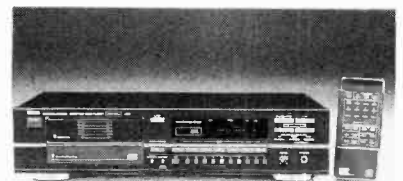
The HeadStart II computer system has a suggested retail price of \$1,195.00. Three monitors are available: A 12-inch TTL amber monochrome costs \$109.00; a 14-inch, flat-screen, amber dual-mode TTL monochrome that can display CGA graphics costs \$199.00; and a 14-inch high-resolution CGA color monitor costs \$395.00. For more information contact Vendex Technologies Inc., 40 Cutter Mill Road, Suite 438, Great Neck, NY 11021.

CIRCLE 103 ON FREE INFORMATION CARD

CD CHANGER

Yamaha's CDC-500 compact-disc changer offers the convenience of multiple- or single-disc operation. It accepts Yamaha's 6-disc magazine, and gives a wide array of program-selection options. For playing single discs, the CDC-500's "Plus One" tray provides simple operation.

Any track on a loaded disc can be selected using a 10-key direct-access system; a supplementary set of 6 keys provides instant access to any disc in the magazine. The CDC-500's memory will hold up



to 32 programmed tracks, which can be played in any order selected. The player can repeat a single disc, or all of the discs in the magazine. Other features include selectable analog or digital output, 4-times oversampling, 3-beam optical head, and a dedicated infrared remote control.

The CDC-500 6-disc CD-changer has a suggested retail price of \$499.00. For further information, contact Yamaha Electronics Corporation, USA, 6722 Orangethorpe Avenue, Buena Park, CA 90620.

CIRCLE 104 ON FREE INFORMATION CARD

POCKET DIRECTORY/DIALER

Texas Instruments' TI-3100 stores up to 125 names and telephone numbers, and dials at the touch of a button. The portable unit, which is designed for one-handed dialing, functions as a directory, a dialer, an appointment schedule, a clock/alarm, and a calculator.

For ease of use, all keyboard symbols are color-coded by function. Phone directory entries are automatically stored in alphabetical order, and can be recalled by scrolling, by typing the first letter and then scrolling, or by typing the first word and scrolling. Confidential numbers can be pro-



ected with a password. The dialer works by holding it against the receiver and pushing one button. Appointments are stored in chronological order; the alarm can be set as a reminder. The 10-digit calculator adds, subtracts, multiplies, divides, and calculates percentages.

The compact unit runs on one lithium battery (included). Memory is saved for several minutes during battery changes. Instructions and a protective case are included.

The TI-3100 Pocket Dialer has a suggested retail price of \$65.00. For more information, contact Texas Instruments, Consumer Relations, P.O. Box 53, Lubbock, TX 79408.

CIRCLE 105 ON FREE INFORMATION CARD

BARKING-DOG ALARM

This dog's bark is definitely worse than its bite. Featuring a deep, lifelike bark, Heath's Barking Dog Security Alarm System is intended to frighten off burglars by convincing them that a guard dog is on the premises. The barking can be adjusted to two volume levels, and when the family is home, the alarm can be switched to sound a less disturbing chime.

A passive infrared sensor activates the

alarm when motion is detected. A multi-zone lens provides overlapping detection zones, for downward and outward coverage up to 60 feet away. The system's "pulse-count technology" prevents pets from falsely triggering the alarm. The sensor also fea-



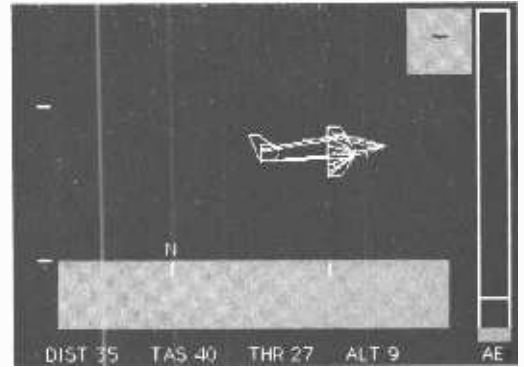
tures adjustable sensitivity, swivel-mounting hardware, and a weather-tight case. The system can be used in cars, boats, and campers, as well as homes.

Master the skies with the RC Flight Simulator

Learn the ups and downs of RC aircraft and helicopter flight right on your computer screen. Exciting new software designed expressly for Heath Co. by Dave Brown Products lets you take the time you need to become a master pilot. You'll save on heartache and save on dollars when you perfect your skills *before* you ever put your plane in the air.

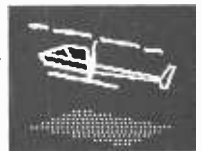
Menu-driven software gives you a constant read-out of plane distance, true air speed, throttle setting and altitude. Even a dollar estimate of damage flashes on screen each time you crash.

Use with Heath/Zenith and IBM PC, XT, AT and compatibles.



Comes with dual joystick controller. Order required gameport adapter separately.

To order your Flight Simulator for only \$129.95 call **1-800-253-0570** 24 hours a day.



Includes flight simulation for helicopters, too!

Heath Company

Benton Harbor, MI 49022

A subsidiary of Zenith Electronics Corporation.

Prices, product availability and specifications are subject to change without notice. © 1989, Heath Company.

CIRCLE 14 ON FREE INFORMATION CARD

The Barking Dog Security Alarm System (model DS-6000) has a suggested retail price of \$59.95. For more information, contact Heath Company, Heath/Zenith Consumer Products Group, Hilltop Road, St. Joseph, MI 49085.

CIRCLE 106 ON FREE INFORMATION CARD

A/D STORAGE SCOPES

Philips' PM 3365 is the top model in their new line of analog/digital storage oscilloscopes. The 100-MHz scope features 100-MS/s single-shot sampling on both channels, and an additional repetitive-sampling mode ensures high-resolution acquisition of recurrent signals up to 100 MHz. The DSO has a 4K memory, 150-MHz triggering bandwidth, and dual-timebase referencing for simultaneous display of basic waveform and signal detail.

For ease of operation, the instrument offers instant on-screen measurements and an informative LCD panel located next to the display. An AUTOSAVE feature provides automatic channel selection and setting of amplitude, timebase, and triggering for any input signal. Optional GPIB/IEEE-488 or RS-

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 AVOID PHONE MISUSE,
 CHECK ON PHONE COSTS



TAM
 Model 88-U

Only
 \$ 156.00

Sample Printout

Time	Explanation
18:00:55 (1) 12:1	(1) Tel Number Dialed
18:01:00 (2) 10:34	(2) Call Start Time
18:01:05 (3) 10:34	(3) Call End Time
18:01:10 (4) 10:34	(4) Duration of Call
18:01:15 (5) 12:54	(5) Incoming Call Time
18:01:20 (6) 11:01	(6) Call End Time
18:01:25 (7) 00:06	(7) Duration of Call
18:01:30 (8) 20:30	(8) Modification, Tel Line
18:01:35 (9) 22:40	(9) Tel Line Repaired
18:01:40 (10) 07:09	(10) Record of Sept 23, 1987
18:01:45 (11) 09:00	(11) Tel Number Dialed
18:01:50 (12) 09:30	(12) Start Time
18:01:55 (13) 09:10	(13) End Time
18:02:00 (14) 00:10	(14) Call Duration

Prints all space for your notes and markings on 58 mm (2 1/4 inch) wide printer paper available commonly.

- * Record of all "Outgoing" phone numbers.
- * Record of "Start," "End" timings of Outgoing & Incoming Calls.
- * Record of "Date" & "Duration" of all Calls.
- * Restrict "Long Distance" Calls of more than 8 digits.
- * Restrict all "Outgoing" Calls.
- * Display of Phone Number being dialed.
- * Display Year, Month, Date, Hour, Minute, Seconds.
- * Memory Capability approximately 800 Calls.
- * Usable on Pulse & Tone systems.
- * Use on batteries only or on power 110 Volts AC, 60 Hz.
- * With adaptor provided.
- * Usable World-Wide, F.C.C. Approved.
- * Records all phone line failures.
- * Easily connected to your telephone.
- * Uses inexpensive calculator paper.

TAM model 88-U, suggested list Price \$ 195.00. Special Introductory price direct from manufacturer US\$ 156.00 (Valid till June 1989). Internationally despatched by Air Mail, add US\$ 15.00. Despatched by UPS in USA, add \$ 6.00. N.J. residents 6% Sales Tax.

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 Lawrenceville, N.J. 08648
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CIRCLE 17 ON FREE INFORMATION CARD

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 and well
 in Indiana



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THIS MONTH'S GIANT ELECTRONICS CATALOG

The Dick Smith Electronics Catalog is the fun way to find the electronic things you need. Our new monthly Catalog is bigger - 192 pages crammed full of the things the other guys don't offer - and better - with more of our exclusive data pages including the new "feed back" section that invites your participation. The ever-growing DSE Catalog is as dynamic as Dick himself with a brand new issue each month to keep you up-to-date. Join the fun! Send us your name, address, and \$2 for this month's Dick Smith Electronics Catalog today!

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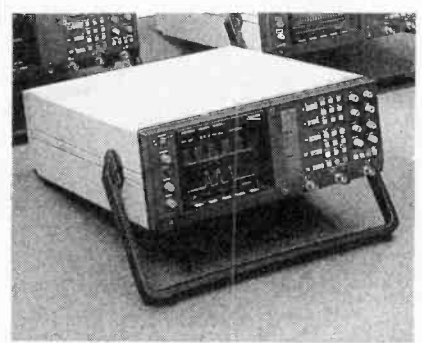
DICK SMITH ELECTRONICS

CIRCLE 15 ON FREE INFORMATION CARD

New Products

232 interfaces allow the scope to be used in automatic-measuring systems, or under computer control—measurements can be downloaded to a computer for storage or processing.

The PM 3365 analog/digital storage oscilloscope has a suggested retail price of



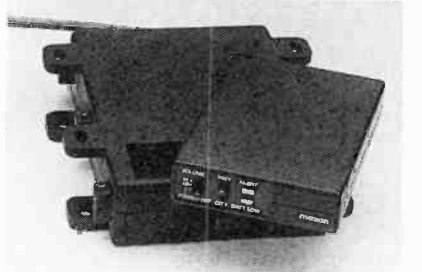
\$4,990.00. The optional GPIB/IEEE-488 or RS-232 interfaces, factory installed, cost \$500.00 each. For further information, contact John Fluke Mfg. Co., P.O. Box C-9090, Everett, WA 98206; Tel. 800-443-5853, ext. 77.

CIRCLE 107 ON FREE INFORMATION CARD

"WIRELESS" RADAR DETECTOR

While conventional remote radar detectors rely on a "hard-wire" connection, with Maxon's RD-30, radar-detection signals are transmitted via 49-MHz radio waves to the driver's control module. That makes the Maxon system—which consists of a remote-mounted receiver unit and a portable control module—much easier to install and more convenient to use. The control module is small enough to fit on the visor or dash, in the glove box, or in the driver's pocket.

The RD-30 detects X- and K-band radar surveillance (including instant-on radar-pulse signals), apprising the driver



within 1/8 of a second of radar-signal strength with a pulsing audio alarm and a flashing LED. The unit features anti-false alarm circuitry, and automatically turns on and off

with the vehicle's ignition switch. Included are hook-and-loop fastening materials, an earphone, a spring visor clip, installation hardware, and a power/recharge cord for the control module.

The RD-30 Wireless Remote Radar-Detector System has a suggested retail price of \$199.95.

CIRCLE 108 ON FREE INFORMATION CARD

MOBILE FACSIMILE

The Nissei FAX-305 provides facsimile service anywhere you find a telephone—including cellular car phones. The G3-compatible fax machine provides an acoustic coupler (as well as the standard RJ-11 phone jacks) that allows facsimile links to be established from cars, boats, and airplanes that are equipped with telephones; and from hotel rooms, public phone booths, and your home or office.

The FAX-305 runs on 120 VAC or the built-in NiCd batteries. A battery charger is standard, as is a special adapter that connects to a car cigarette lighter, allowing the recharger to be used in a car. The ma-



chine can process about 25 standard-size pages before requiring recharging. It offers normal and fine print modes, and can function as a photocopier. Measuring just 12 x 7 x 3 inches, and featuring a convenient carrying handle, the unit is easily portable.

The FAX-305 mobile facsimile has a suggested retail price of \$1399.00. For additional information, contact Nissei Electric U.S.A., Inc., 3 Reuten Drive, Closter, NJ 07624.

CIRCLE 109 ON FREE INFORMATION CARD

CORDLESS TELEPHONE

AT&T's Model 5500 allows users to make and receive calls at the phone's base as well as at its handset. It features a keypad and a speakerphone in the base, 9-number speed dialing, and a portable handset cradle. Because the handset can go for up to a week between recharges, it can

POPULAR ELECTRONICS

be kept at a separate location from the base—in effect, giving the user two phones in one.

Offering sound quality comparable to corded phones, the 5500 allows users to



the base and the handset. If there is interference on one channel, the user can instantly switch to another.

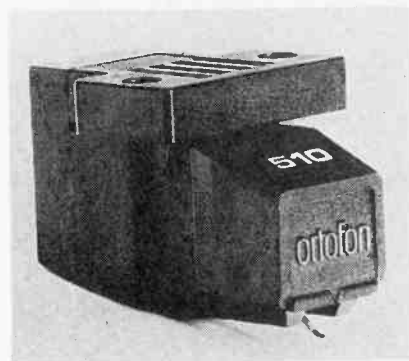
The Model 5500 cordless telephone has a suggested retail price of \$249.00. For more information, contact AT&T, 5 Wood Hollow Road, Parsippany, NJ 07054.

CIRCLE 110 ON FREE INFORMATION CARD

MAGNETIC PHONO CARTRIDGE

Ortofon's Model 510 phonograph cartridge uses a lightweight moving-magnet transducer system and a bonded elliptical stylus. Its body is extremely rigid, to deliver improved linearity and reduced distortion. Using sophisticated CAD/CAM technology, the designers were able to accurately define the natural pivot point of the cantilever system. A unique, patented stylus guard functions as a 3-position stylus lock. One position is for normal play, one locks the stylus to protect it during shipping and installation, and the third is used when removing the stylus from the cartridge.

The Model 510 phonograph cartridge has



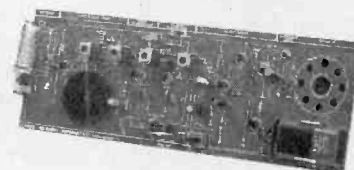
a suggested retail price of \$75.00. For further information, contact Ortofon Inc., 122 Dupont St., Plainview, NY 11803.

CIRCLE 112 ON FREE INFORMATION CARD

SUPERHET AM RADIO KIT

Elenco's Superhet 550 AM-radio kit is a do-it-yourself superheterodyne AM-broadcast receiver that uses 7 transistors.

It is designed to maximize the learning process inherent in kit-building, while mini-



mizing the chances for assembly error. During assembly, the builder can place each part over its corresponding symbol in the schematic drawing that is printed on the circuit board.

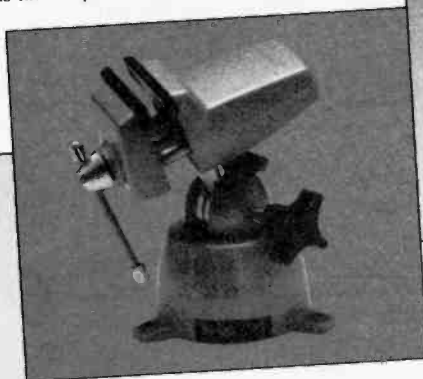
The Superhet 550 kit includes an assembly and instruction manual that also explains theory of operation. The actual as-

HOLD IT ANYWHERE YOU WANT IT!

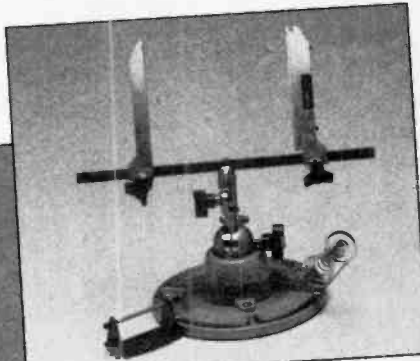
PanaVise electronic work holding systems allow you to position, tilt and rotate your projects without removing them from their holding devices! With over 30 years experience and made-in-USA quality, PanaVise ensures reliable, long-lasting service.



MULTI-PURPOSE WORK CENTER: Self-Centering Extra Wide Opening Head (opens to 9"), famous "split ball" Standard Base (moves in three planes), and convenient Tray Base Mount (with parts wells) handle difficult to hold items with ease! Model #350. \$52.95.



STANDARD PANAVISE: Our most popular vise, the Standard PanaVise is an extremely versatile, useful workbench tool. Jaws open a full 2.25", and the patented "split ball" base tilts, turns and rotates through three planes. One convenient control knob locks work into any position! This durable, all-purpose mini-vise stands about 6" tall and will deliver years of rugged service. Model #301. \$33.95.



ELECTRONIC WORK CENTER: A complete combination to make work areas more efficient and manageable! Circuit Board Holder gently, but firmly, holds PCB's up to 12" wide. Add our Standard Base (moves in three planes), Tray Base Mount (with parts wells), and Solder Station (self-centers wire and holds iron at perfect angle) for a great combo! Model #324. \$54.95.

PANAVISE

See your local electronics supplier or contact PanaVise for the source nearest you:
PanaVise Products, Inc.; 2850 E. 29th Street;
Long Beach, CA 90806; (213) 595-7621

CIRCLE 12 ON FREE INFORMATION CARD

New Products

sembly process is divided into five simple sections; each section should be tested before moving on. That method, along with the circuit board's design, reduces difficult troubleshooting.

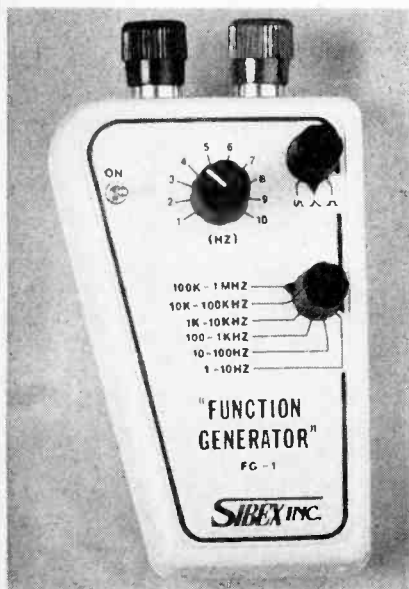
The Superhet 550 AM-radio kit costs \$19.95. For more information, contact Elenco Electronics Inc., 150 West Carpenter Ave., Wheeling, IL 60090.

CIRCLE 113 ON FREE INFORMATION CARD

FUNCTION GENERATOR

The model *FG-1* from *Sibex* is a handheld, 9-volt battery-powered function generator that is small enough to be carried in a shirt pocket or tool box. It is designed to replace bulky, expensive equipment for field-service and site-calibration work.

The *FG-1* provides sine, square, and triangular signals from 1 Hz to 1 MHz. It of-



fers 6 frequency ranges that are switch-selectable from the front panel. With output levels of 0V and +5V DC, the unit provides a TTL-compatible signal source.

The *FG-1* function generator costs \$96.95. For further information, contact Sibex, Inc., 1040 Harbor Lake Drive, Safety Harbor, FL 34695.

CIRCLE 114 ON FREE INFORMATION CARD

PORTABLE COLOR TV

CBM's Model T-126 is a cube-shaped, handheld color LCD TV set. Weighing less than 2 pounds, the set features an easy-to-see 2²/₃ inch screen. Less than 4 inches high,

just over 3¹/₂ inches wide, and 2¹/₂ inches deep, the television fits almost anywhere. Its AV-in jack lets it be used as a video monitor or camcorder accessory.

The set features sleek styling and Citizen Super Matrix technology to ensure a vibrant, high-resolution (94,608 pixels per square inch) picture. Controls are easily accessible; the tuning control and speaker are located on top of the set, and all other controls are on the sides. A provision for



mounting the *T-126* on a tripod is built-in to the bottom. The set is powered by 5 "AA" batteries, or the included AC adapter can be used. Also included are earphones and a case.

The Model *T-125* portable color TV has a suggested retail price of \$369.95. For additional information, contact CBM America Corp., Division of Citizen Watch Co. Ltd, TV/Video Division, 2999 Overland Avenue, Los Angeles, CA 90064.

CIRCLE 115 ON FREE INFORMATION CARD

ANTI-THEFT CAR STEREO

Proton's CR-560 automotive AM/FM receiver/cassette player features an anti-theft slide mount. Its design allows easy installation, removal, and fuse changes, and a pull-out handle fits flush below the faceplate so that a clear view of the display is maintained.

The 16-watt-per-channel *CR-560* incorporates the Schotz II tuner, a unique type of RF amplifier that offers enhanced selectivity, better overload handling, and a 3-dB increase in sensitivity. The unit features 12 FM- and 6 AM-station presets and a seek/scan function. A built-in clock, FM muting, and a local/distance button are standard.

The unit's auto-reverse cassette player is metal-tape compatible and includes Dolby B noise reduction and separate controls for bass, treble, balance, and loudness. The *CR-560* is equipped with two sets of pre-amp outputs with a fader control for multiple-



speaker installations. For system flexibility, there is a front-panel CD input. Speaker impedance is 4 ohms, and maximum power output is 25 watts.

The *CR-560* has a suggested retail price of \$369.00. For more information, contact Proton Corporation, 5630 Cerritos Avenue, Cypress, CA 90630.

CIRCLE 116 ON FREE INFORMATION CARD

REPLICA BURGLAR ALARM

The *Protector* provides an alternative to expensive home-security systems. Comprising a replica "remote-sensor" box, complete with a flashing red light and a green light, as well as a bright red warning label, the *Protector* is designed to intimidate—and scare off—potential intruders.

The product is designed to be placed next to the front door or any window where a break-in might occur. The realistic appearance is said to deter thieves from burglarizing the home, apartment, trailer, or



RV where it is used. The lightweight and weather-resistant unit is easy to mount using the self-stick adhesive backing, and runs on a long-lasting alkaline battery.

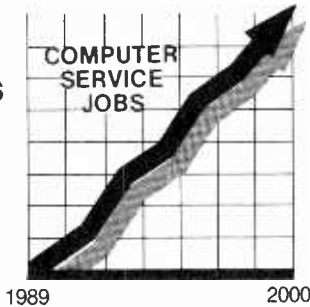
The *Protector* costs \$19.95; additional warning labels cost \$1.00 each. For more information, contact *Homeguard Products*, Dept. PE, P.O. Box 245, Kingsville, MD 21087.

CIRCLE 117 ON FREE INFORMATION CARD

5 sure steps to a fast start as a high-paid computer service technician

1. Choose training that's right for today's good jobs

Jobs for computer service technicians will almost double in the next 10 years, according to the latest Department of Labor projections. For you, that means unlimited opportunities for advancement, a new career, or even a computer service business of your own.



But to succeed in computer service today, you need training—complete, practical training that gives you the confidence to service any brand of computer. You need NRI training.

Only NRI—the leader in career-building, at-home electronics training for 75 years—gives you practical knowledge, hands-on skill, and real-world experience with a powerful XT-compatible computer you keep. Only NRI starts you with the basics, then builds your knowledge step by step until you have everything you need for a fast start as a high-paid computer service technician.



2. Go beyond "book learning" to get true hands-on experience

NRI knows you learn better by doing. So NRI training works overtime to give you that invaluable practical experience. You first read about the subject,

studying diagrams, schematics, and photos that make the subject even clearer. Then you do. You build, examine, remove, test, repair, replace. You discover for yourself the feel of the real thing, the confidence gained only with experience.

3. Get inside a powerful computer system

If you really want to get ahead in computer service, you have to get inside a state-of-the-art computer system. That's why NRI includes the powerful new Packard Bell VX88 computer as the centerpiece of your hands-on training.

As you build this fully IBM PC XT-compatible micro from the keyboard up, performing key tests and demonstrations at each stage of assembly, you actually see for yourself how every section of your computer works.

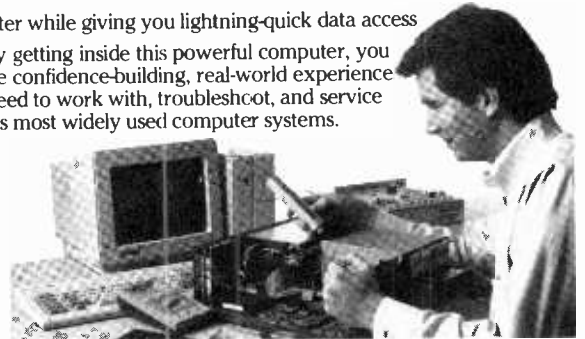
You assemble and test your computer's "intelligent" keyboard, install the power supply and 5¼" floppy disk drive, then interface the high-resolution monitor. But that's not all.

You go on to install a powerful 20 megabyte hard disk drive—today's most-wanted computer peripheral—included in your training to dramatically increase the data storage capacity of your



computer while giving you lightning-quick data access

By getting inside this powerful computer, you get the confidence-building, real-world experience you need to work with, troubleshoot, and service today's most widely used computer systems.



4. Make sure you've always got someone to turn to for help



one, giving you as much time and personal attention as you need.

Throughout your NRI training, you've got the full support of your personal NRI instructor and the entire NRI technical staff. Always ready to answer your questions and help you if you should hit a snag, your instructors will make you feel as if you're in a classroom of

5. Step into a bright new future in computer service—start by sending for your FREE catalog today!

Discover for yourself how easy NRI makes it to succeed in computer service. Send today for NRI's big, 100-page, full-color catalog describing every aspect of NRI's one-of-a-kind computer training, as well as training in robotics, TV/video/audio servicing, electronic music technology, security electronics, and other growing high-tech career fields.

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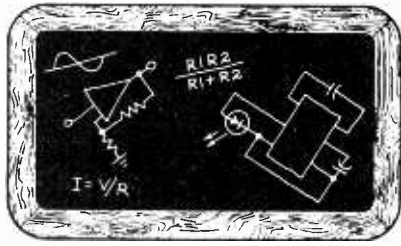
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18-069



Think Tank

By Byron G. Wels

SIMPLE BUT USEFUL CIRCUITS

According to the mail and the tone of some telephone calls we've received, there's a great deal of interest in "throw-together" circuits that do not require a great deal of involvement. One writer said, "I don't have a shop as such, and do all my work on the kitchen table between dinner and bedtime, while the rest of the family turns into "prime-time" couch potatoes. They call it "daddy's playtime." He went on to explain that he really appreciates the quick-and-dirty path. If it is necessary to quit before finishing the project, it's easy to remember where you left off the night before. Even better, are what are called *one-evening projects*, which are those that can be begun and finished in a couple of well-spent hours.

There's a lot to be said for that. In this issue, we're going to concentrate on projects that can be quickly completed and, in most cases, do not even require a soldering iron. We used to call such projects "breadboards," for they really were laid out on a slab of wood that looked like a breadboard. (Hey! Do you remember Fahnestock clips?) Today you can assemble small projects on simple perfboard, using flea clips to hold the component leads.

Naturally, there's nothing to stop you from soldering the components to the board if you like. But for those of our readers who prefer the simple way of life, this is for you. We've carefully and assiduously ferreted out the projects that the mail has brought in, and hope you enjoy them.

Once you've got them wired and working however, it would be a good idea to devote a second evening to making the unit more permanent by soldering everything in place, putting it all in a nice cabinet, and adding the decals for a professional touch. So let's see what we've got for this month.

Flicker Light. This simple conversation piece is quick and easy-to-

build, and, because of its novelty, kids will especially love it. The circuit (see Fig. 1.) is built around three relaxation oscillators formed of unijunction transistors, so you don't need an adjustment potentiometer. A common resistor is used in the base 1 of each transistor, thereby eliminating the possibility of a coincidental firing point of any two of the transistors. I used a transformer power supply which produces less heat and requires a good-deal lower power.

You can use just about any incandescent lamp that is rated at less than the SCR you select, but make sure you heat sink the SCR. Diode D3 is used to conduct during half of the 60-Hz AC cycle; the other half cycle is "modulated" by the SCR and the relaxation oscillators. —*Juan J. Martinez, Mexico, D.F.*

Good circuit, Juan! Just make certain that all the components are properly rated to handle the current requirements, especially that power transformer. I know you'll enjoy that Fips book that I sent out today.

Analog Meter. Expanded-scale analog meters are a handy way to monitor voltages that don't vary too much, such as a car battery. Unfortunately, such meters can come with considerable cost and they are hard to find. The ridiculously simple circuit shown in Fig. 2 has worked very well for me, however, and can be permanently mounted (on a car's dashboard, for example).

The circuit consists of a 0-1 mA meter (M1), a 6.2-volt Zener diode (D1) and a 12K, 1% resistor (R1). Note R2 is included in the circuit as a load resistor for the Zener diode; its value isn't at all critical. A value of 1000 to 1500 ohms works well. The meter reads 6- to 18-volts at center scale, which is perfect for checking the car's charging system. And since the circuit draws less than 10 mA, there's no reason not to just let it remain in the circuit. —*Michael Kolenich, Lakewood, OH*

Okay Mike, good circuit, and very useful, too. Now here's an added tip for our readers. If you work very carefully,

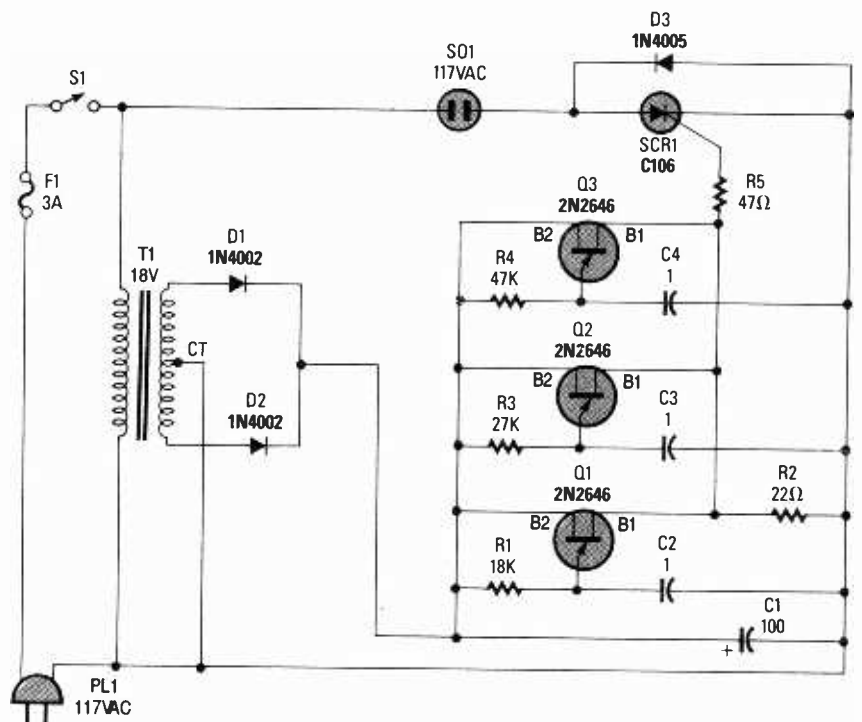


Fig. 1. This simple conversation piece is quick and easy-to-build and, because of its novelty, the kids will especially love it.

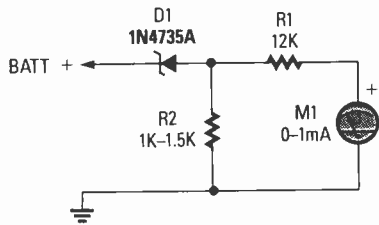


Fig. 2. This simple metering circuit can be used to keep constant tabs on the status of your auto's battery.

you can disassemble the meter, remove the printed scale using a small jeweler's screwdriver, then reverse the scale, spray the back of it with flat-white enamel and then use black indian ink to mark in your own voltage indications. Use assorted batteries to indicate the voltage demarcations, then reassemble the meter.

Transistor Checker. Lowell Picklyk writes, "I'm just an amateur in the field of electronics,...." and then comes up with a doozy! His problem was how to determine if a transistor was NPN or PNP. The cross-reference books probably could have helped, except that he didn't always have one, and wasn't sure if the desired transistor would be listed anyway! Besides, it's a lot less trouble to pop the transistor into a tester and press the switch than to start searching through all that fine print.

"For the life of me," he writes, "I couldn't find a tester like this anywhere, not even in Russia or Greenland. I did look hard." The Transistor Checker I came up with does the job. (See Fig. 3.) To use the unit, connect the transistor into the circuit (EBC or BCE) and press switch S1. If LED1 lights, it's a NPN unit; if LED2 lights, it's a PNP unit.

According to the symbol of a transistor, if you apply the positive probe of a continuity tester to the base of a PNP, touching either the emitter or collector will give continuity. The idea works exactly the opposite in an NPN.

Two comparators and two LED's display the results of the test. If the transistor is an NPN, a small current flows from the base to the emitter, giving a high input to inverting comparator U1-a. That forces a low output, lighting LED1. In the case of a PNP transistor, the input of inverting comparator U1-b is low, forcing a low output, which lights LED2.

Lowell also asks "What if I've already received a Fips book and send in another piece that's accepted? Can I get a copy of the *Think Tank* book in-

stead?" He also wanted to know if he can get a copy of the Fips book for this submission. —Lowell Picklyk, Kelowna, BC, Canada

No Lowell. Since you sent in two ideas, we're sending you a copy of the hilarious Fips book, along with a copy of the *Think Tank* book. And, of course, you get my thanks!

Third Brakelight. There are still a lot of cars on the roads that were produced before 1985—a period when a

third brakelight (sitting in the rear window) was an accessory, rather than standard equipment, on many domestic and foreign-make cars. And many owners of such vehicles would like to connect a highly visible third brakelight to the car. Here's an easy way to do it.

Most cars use a standard 1157 lamp that contains two filaments. The brightest is used for both stop indications and flashes for turn signals. The question is, what lamps should we tap to

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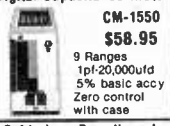

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THINK TANK
(Continued from page 23)

draw power for the new third light? When braking while turning, one lamp comes steadily on while the other flashes.

The input to the circuit shown in Fig. 4 is fed from both brake-lamp wires. If one of the lamps is in the flashing mode, we send it through an R/C time-constant circuit to the gate of a two-input NAND gate. The RC time constant of the circuit as established by R1/C1 and R2/C2 (connected to the left and right signal lamps, respectively) is suitable for most flash rates.

The output of the first NAND gate (U1-a) must be inverted to the proper polarity to turn on transistor Q1, which, when activated, is used to trigger a small 12-volt relay. When the relay is triggered, the relay contacts pull in, applying power to I1 (which represents the third brakelight).

Fuse the entire circuit by using a ¾ inch length of a single wire strand taken from ordinary lamp cord. A convenient source of 12 volts would be the lead that goes to the trunk-interior light socket. Make sure that all exposed wire connections are carefully insulated with tape. I hope that this circuit qualifies for a copy of that Fips book! —Roger W. Hamel, Lake Orion, MI

Nice Rog. If the readers will stop in at any local auto supply house, they can get a suitable third brakelight assembly, and chances are that your circuit will fit comfortably in that housing. Or, if they prefer, they can house the circuit in a small plastic box, which should be hidden from sight, and connect the circuit the auto's electrical system using hook-up wire. Anyway, your Fips book is on the way and I hope that you'll enjoy reading it!

Power MOSFET Inverter. Here's an

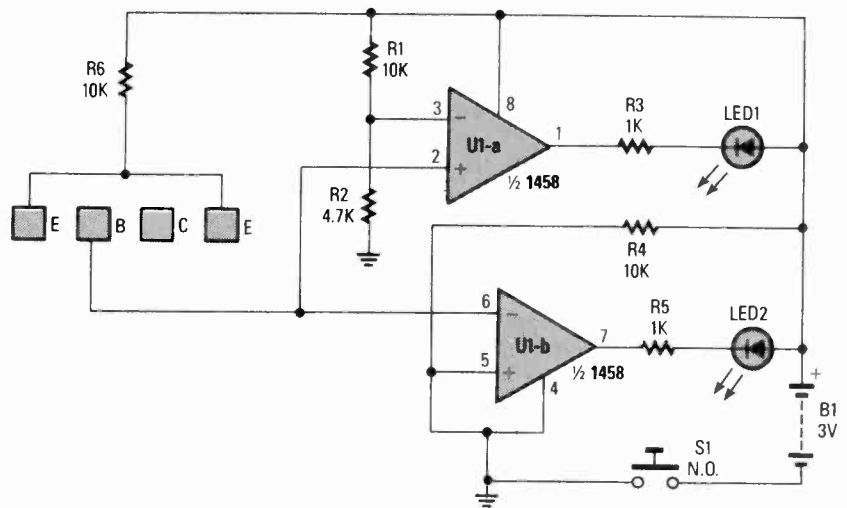


Fig. 3. Although the transistor checker shown here is built around a 1458 dual op-amp, almost any op-amp can be used; for example, two 741 op-amps or similar devices can be substituted for U1.

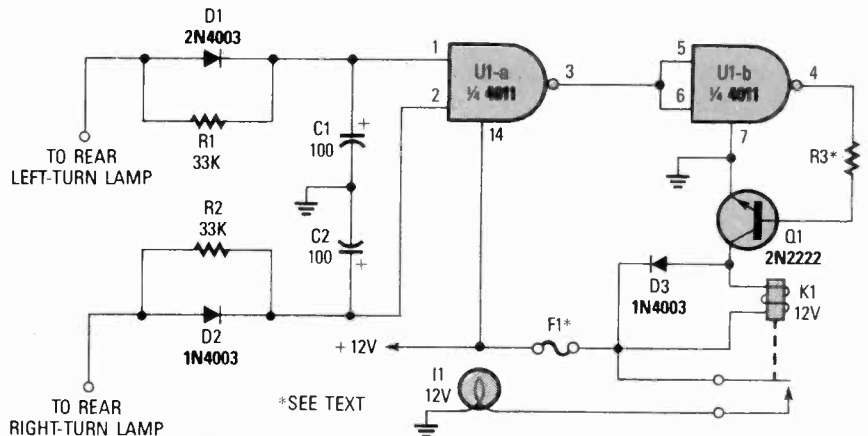


Fig. 4. The third brakelight is fed from both the left- and right-brakelight (or turn-signal) lamp wires.

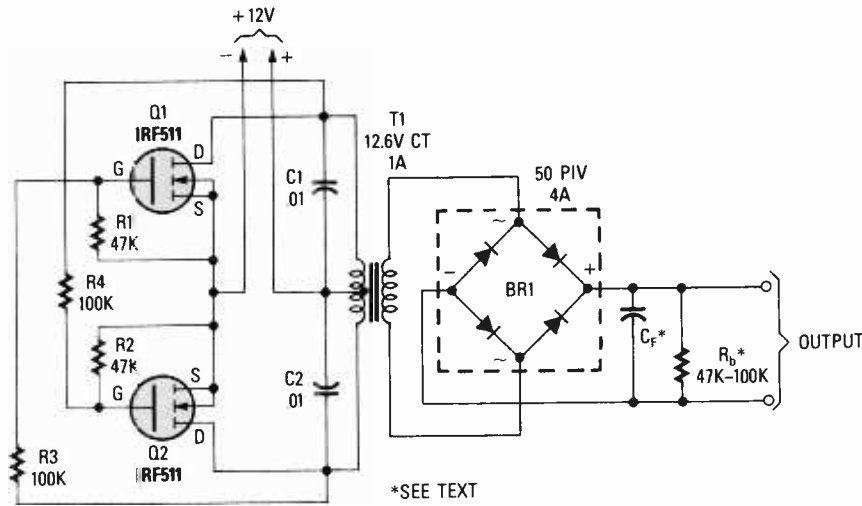


Fig. 5. This inverter, using two power MOSFET's, can deliver AC or DC (with a rectifier and filter) of several hundred volts.

inverter that can deliver high-voltage AC or DC (with a rectifier and filter) that's capable of supplying several hundred volts. See Fig. 5. The circuit is a simple inverter that will raise 12 or 14 volts to a thousand volts or more.

In that circuit, the primary and secondary of T1—a 12.6- to 440-volt power transformer (the 440 volts being the primary, of course)—are reversed; e.g., the primary becomes the secondary and the secondary becomes the primary.

Transistors Q1 and Q2 can be any power FET. I used International Rectifier's IRF511 hexFET's simply because I had them on hand, but there are other similar devices that would do equally well. In any event, be sure to heat sink Q1 and Q2. Capacitors C1 and C2 are used as spike suppressors. Resistors R1-R4 can be any value within $\pm 20\%$ of the values specified.

The circuit is ideal to power a tube circuit, or it might be combined with a

step-up transformer to build a spark gap, a Jacob's Ladder, or, by modifying the frequency, it might be used to power a Tesla coil. —Gerald A. Fortier, Torrance, CA

A novel circuit with novel applications Gerry, but readers are cautioned that high voltages are present, so be careful not to get burned! We're sending out your Fips book today. Hope you enjoy it.

Audible Transistor Checker. If you're just an electronics experimenter and don't care about various transistor specifications, but just want to know if a transistor is "good" or "bad," this circuit might just be what the doctor ordered. All you have to do is plug the transistor into the circuit, flip switch S2 (see Fig. 6) to either PNP or NPN, and if you hear a shrill "beep" from the loudspeaker (SPKR1), the transistor is good.

In actual operation, simply rotate R3 to the maximum resistance position

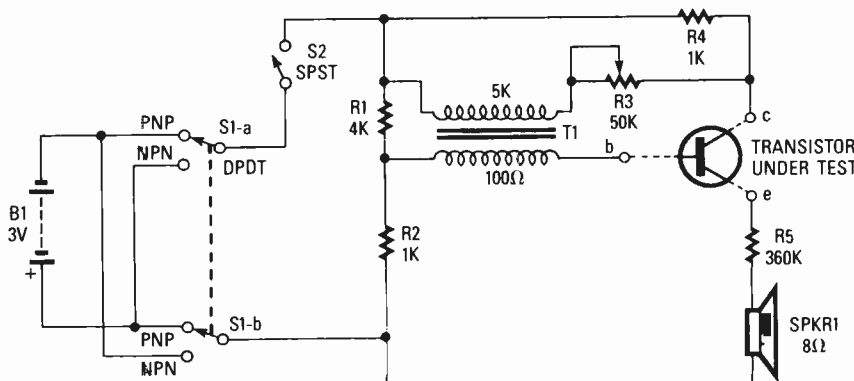
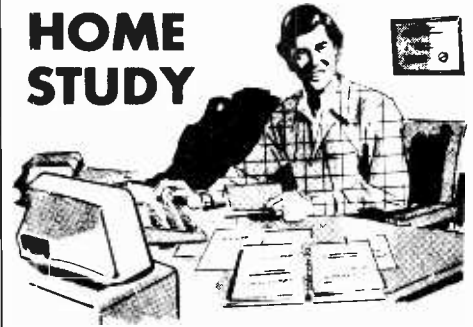


Fig. 6. Unlike the previous transistor checker (see Fig. 3), this one provides an audio indication, rather than a visual one.

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and then slowly start backing off to zero resistance, while listening for the beep. No beep? Throw the transistor away.

There are no secrets or cautions regarding the circuit assembly, just make certain that S1 is wired according to the schematic diagram. The circuit fits comfortably into an enclosure measuring 2 × 4 × 7-inches.

The circuit is essentially an audio oscillator with R3 adjusting the bias for the transistor under test. Hope you like it By, and that it earns me a copy of the Fips book. —*Luke Cummings, Austin, TX*

Good job, Luke. But I'd also suggest that a small TO-92 type transistor socket (which will also accommodate TO-220 packages) be connected to the circuit at the points reserved for the connection of the transistor under test. And if you want to make it really convenient, permanently solder alligator-clip leads to c, b, and e terminals of the circuit to handle the larger power transistors (those that come in TO-3, TO-66, etc. style packages).

Circuit Breaker Blower. Why would anybody want a circuit-breaker blower? With today's fast-acting semiconductors, you could easily develop a damaging short and the damage could be done before the breaker opens. The circuit in Fig. 7 provides a rush of power to the breaker when

duce the value of R3 accordingly, and use a heftier SCR. That ensures that R3 and SCR1 will operate the breaker. For smaller currents, under one ampere, you can use a one-amp SCR and increase the value of R3.

Resistors R1 and R2 limit the current through the diode D1 (a 9.1-volt, 400-mW Zener). Current through D1, R1, R2, and SCR1 will be momentary, as the breaker removes the voltage.

—*Stuart L. Page, LaCrosse, WI*

Nice going Stu. Hope you like the Fips book (I know you will) as much as we liked your circuit!

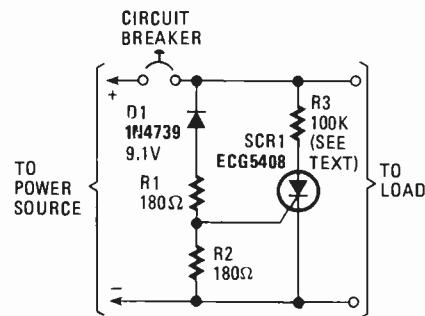


Fig. 7. The Circuit-Breaker Blower is designed to trip a circuit breaker before damage to the load can occur.

something goes wrong, and the breaker pops before anything can happen.

We use a silicon controlled rectifier (SCR1) and a voltage-sensing circuit so the SCR provides a heavy load when the voltage rises above a predetermined level. That by-passes the current through the SCR and causes the breaker (or a fuse) to operate. The circuit is designed for nine-volt use.

With normal voltage present, diode D1 doesn't conduct, and the SCR gets no gate current, putting no load on the circuit. When the supply rises beyond the Zener's rating, the Zener conducts and gate current through R1 triggers SCR1. It conducts and the circuit loads to an amount determined by the value of R3. If the breaker operates at 2 amps, you can make R3 about 4.7 ohms. If a larger current-handling capacity is needed, you'll have to re-

Novel Metronome. All musicians need a way to keep the beat while they practice. I'm no exception. I could have purchased a metronome at the music store, but the high prices of those things, along with my knowledge of hobby electronics dissuaded me. I started scrounging through my parts box, but didn't have a handy 555. I did have an LM3909 LED flasher/oscillator. All I had to do was couple the 3909 output to an LM386.

The LM3909 is configured, so that the frequency of oscillation is dependent on a single R/C timing circuit, consisting of C1 and R1 (see Fig. 8). Since the frequency of oscillation changes with variations in the supply voltage, I provided a regulated 5-volt source (consisting of R1 and D1) to power the LM3909.

LED1 discharges capacitor C1 and the resultant pulse is directed into pin 3 as well as pin 1 of the LM386 audio amplifier to externally control of that unit, thereby providing adequate volume. The circuit, as it is configured, provides frequency ranges from 57 to 204 beats per minute, and plenty of volume. Maybe this rates a Fips book? —*Steven Petrovic, Lafayette, IN*

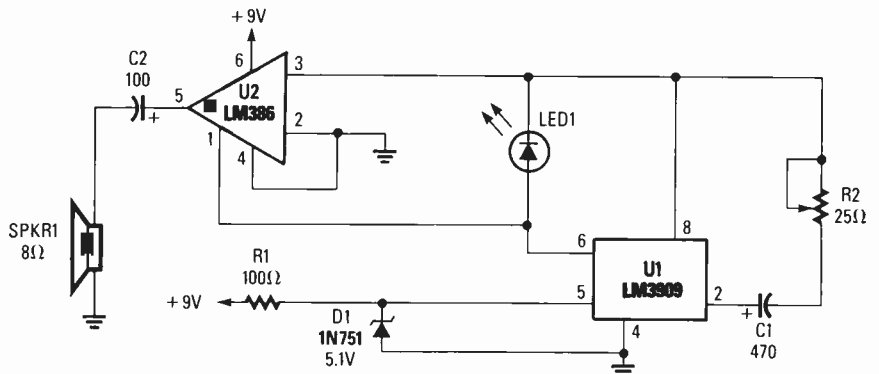


Fig. 8. In this metronome circuit, an LM3909 flasher/oscillator—whose frequency is dependent on a R/C timing circuit, consisting of C1 and R1—is used as a timing device.

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Great circuit, Steve. But, I'd suggest that a SPST switch be connected between the positive voltage source and the circuit to conserve power. Otherwise, it will be necessary to disconnect the power source, or (if the circuit is powered from dry cells) have a large supply of batteries on hand. And no maybe about it...your Fips book is on the way.

"...and the Winner is..." My family is almost addicted to one of those trivia quiz games on TV, and I found a box-game version of it at a local toy shop. I brought it home, thinking it would (a) keep the family from spending too much time watching TV, and (b) make me a real hero.

What it actually did, was to start world war III! It began with simply raising our hands to see who would be first to answer the question. Arguments began about who put his hand up first. Something had to be done, and Fig. 9 was the answer!

Indicator lamp I1 is controlled by SCR1. The operator simply presses switch S1. Lamp I2 is similarly controlled by S2 and SCR2. With both switches open, neither of the lamps is lit. The

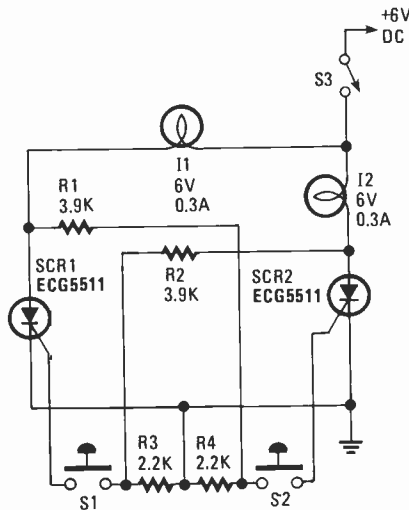


Fig. 9. Using two SCR's this control circuit is designed to lock out the other SCR when one has been triggered so only one lamp will light.

anodes of the SCRs are at full positive potential. Closing S1 causes current to pass through I2 and R2 to the gate of SCR1, causing the SCR to conduct and light up I1.

If S2 is now pressed, current to the gate of SCR2 is through R1, but the anode of SCR1 has gone negative and

the result is that there is insufficient gate current to trigger SCR2 into conduction, so lamp I2 does not light. If S2 is pressed first, the reverse situation occurs. Once one of the SCR's is activated, it is necessary to open S3 to turn the light off.

I used colored bulbs, and mounted the pushbutton switches at the ends of flexible wires attached to a small plastic box with the lamps mounted on the top. Small plastic insulators from alligator clips were used to insulate the switches. If you like this circuit, could you send along a spare Fips book?

—Ron Mabijs, Portland, RI

Right Ron. Keep an eye open for it. It's on the way!

That should cover all our blank pages with ink for this month, and remember please, that the circuit you've been playing around with can get you a Fips book and make you a member of a pretty-exclusive club, too! Remember this is your column; without your submissions, there'd be no *Think Tank*. Send your circuit, along with a short explanation of its operation to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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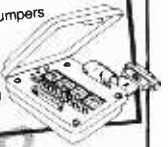
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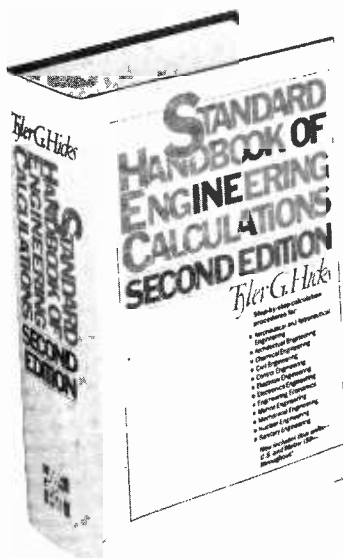
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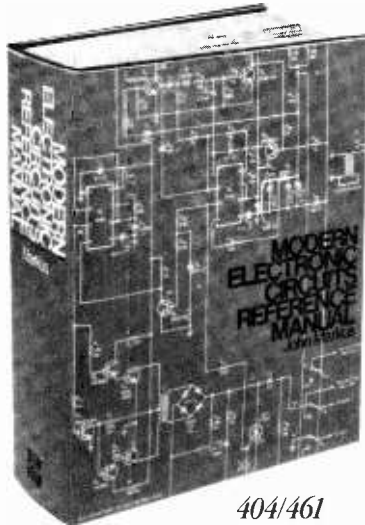
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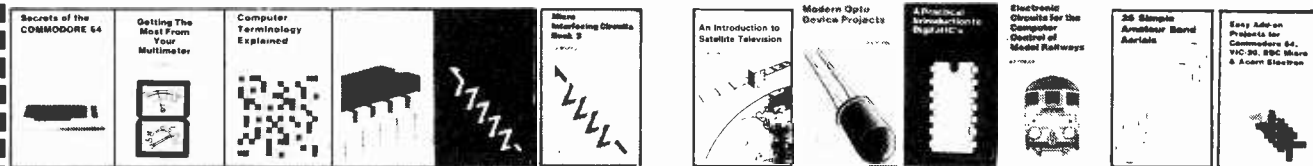
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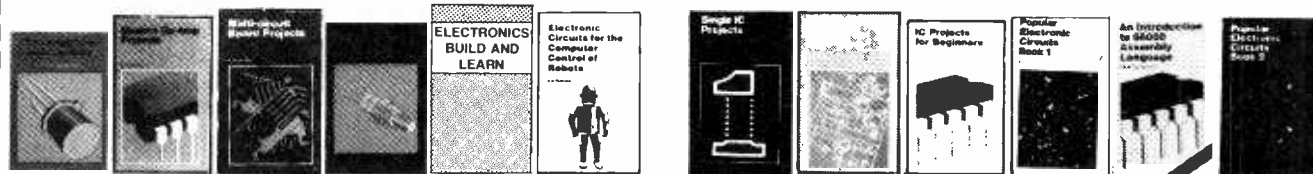
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THE TELE MONITOR

BY CHARLES R. BALL, JR.
AND W.K. BALL

Now you can keep an audible record of your telephone conversations with the aid of this simple circuit.

Remember when your sister called to tell you about this year's family reunion, but in the excitement of hearing from her, you forgot to write down the date, time, or even the city? How often have you talked on the phone with a client for an extended period and after hanging up, remembered that you hadn't taken any notes?

Well, such memory lapses need not be a problem if you build the *Tele Monitor* described in this article. The Tele Monitor automatically activates a recorder to keep a perpetual log (within the limits of the tape's capacity) of all calls, incoming or outgoing. Best of all, it can be built for less than \$25, excluding the recorder.

How it Works. Figure 1 is the schematic diagram of the Tele Monitor. The circuit is connected between the telephone line and the tape recorder. The telephone line—the conductors are designated *tip* and *ring*—normally has -48 volts across it when the telephone is on hook. When the telephone is taken off hook, that voltage changes to about -10 volts, depending on the subscriber loop resistance (see information in Table 1).

A full-wave bridge rectifier (consisting of D1 through D4) connected across TIP and RING allows the circuit to

Parameter	Value	Condition
Central Office voltage, tip to ring	-48 VDC	On-hook
Central Office voltage, tip to ring	-10 VDC	Off-hook
Central Office voltage, tip to ring	105 VAC, 20/30 Hz	On-hook, Ringing
Subscriber loop current, tip to ring	-20 to -80 mA	Off-hook, CO Seizure
Subscriber loop resistance, tip to ring	0 to 1200 ohms	Off-hook

NOTE: Telephone C. O. is positive ground.

be tied to the telephone line without regard to polarity. The voltage applied across TIP and RING appears, polarity corrected, at the + and - ends of the diode bridge. When the phone is on hook, the voltage through D5 keeps Q1 on and Q2 off, so the recorder is in an idle state.

When any telephone tied to the circuit is picked up (goes off-hook), the voltage across TIP and RING drops to about -10 volts, causing Q1 to turn off

and Q2 to turn on, activating the recorder through J2. Incoming calls also activate the recorder with each ringing cycle.

When the phone is off hook and the recorder is running, voice is coupled through R1 and the C1/C2 combination. Because the central-office ringing voltage is 105-volts AC, C1 and C2—which must have a voltage rating of 150 volts or better—are connected back-to-back to simulate a non-polar-

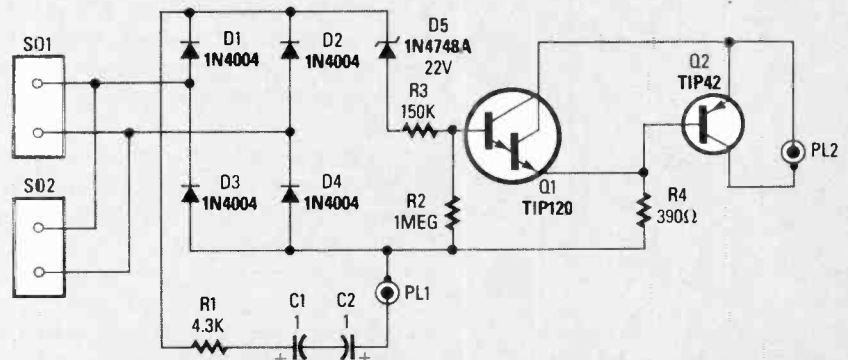


Fig. 1. Schematic Diagram of the Tele Monitor. Note that no relays are used.

WARNING: The use of the Tele Monitor and the parts therein is governed by Federal and State law. Federal law prohibits the taping of telephone conversation by one party without the knowledge and/or consent of the other party. Many states have adopted identical or similar provisions. Prospective users are advised to obtain independent advice as to the propriety of the purchase and use of the parts and use of the Tele Monitor, including (but not limited to) taping conversations therewith. We make no representations concerning the parts referred to in this article or their use or the legality of the use of the Tele Monitor or any other such equipment referred to in this article. Readers are advised to obtain independent advice as to the propriety of their use of the parts, the Tele Monitor, or similar equipment based on their individual circumstances and jurisdiction.

ized capacitor. The diodes, D1 through D4, should have a peak inverse-voltage (PIV) rating of 200 volts or better.

Power for Tele Monitor is derived from the telephone line. A very small current (less than 80 μ A) is derived from the telephone line through the diode bridge when the phone is on-hook, so that Q1 remains off, keeping the recorder in an idle state. **(CAUTION:** For use in this application, the recorder must be battery operated or powered with a UL/CSA/FCC approved adaptor. Neither the telephone company or the FCC take kindly to having 120-volts AC suddenly appear on the telephone line. See box copy for additional warnings.)

It is recommended that the Tele Monitor circuit be coupled to a recorder with automatic volume control to compensate for varying signal levels on different calls and varying speech characteristics. The recorder mentioned in the Parts List is one such recorder. Other recorders can be used, but you must be sure that the internal remote-jack connections

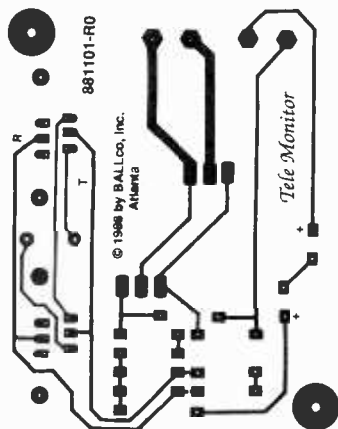


Fig. 2. Here's a full size template of the foil pattern for the Tele Monitor.

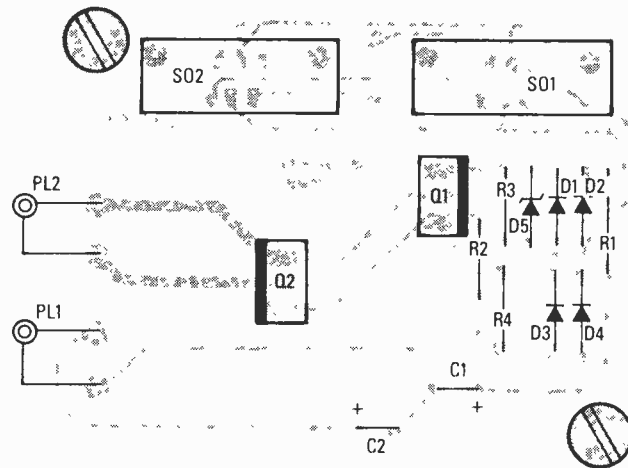


Fig. 3. This parts-placement diagram, like the schematic diagram (Fig. 1), shows two modular telephone sockets. If the second socket (S02) is not needed, it can be eliminated without consequence.

PARTS LIST FOR THE TELE MONITOR

SEMICONDUCTORS

Q1—TIP120, NPN Darlington transistor
 Q2—TIP42, PNP silicon power transistor
 D1—D4—1N4004 1-amp, 400-PIV rectifier diode
 D5—1N4748A, 22-volt, 1-watt Zener diode

RESISTORS

(All resistors are 1/4-watt, 5% units.)
 R1—4300-ohm, 1/2-watt, 5%
 R2—1-megohm, metal film
 R3—150,000-ohm
 R4—390-ohm

ADDITIONAL PARTS AND MATERIALS

C1, C2—1- μ F, 200-WVDC, electrolytic
 S01, S02—Modular telephone socket
 PL1—See text
 PL2—See text

Printed circuit, enclosure (Radio Shack 270-283 or equivalent), IC socket (optional), heat sink (AAVID 5741B or equivalent), modular telephone plug with cable (Radio Shack 279-397, 279-374, or similar) recorder (Radio Shack CTR 70 or equivalent), wire, solder, hardware, etc.

Note: The following items are available from BALLCO, Inc., PO Box 1078, Snellville, GA 30278-1078: 404/979-5900; Etched, drilled, plated, and silk screened printed-circuit board (#881101-R0), \$9.95 post paid in the USA; a complete kit (#TM88) less case and recorder plugs for \$19.95 + 2.50 shipping and handling. Florida and Georgia residents please add appropriate sales tax. Please allow 6 to 8 weeks for delivery.

have the proper polarity for Q2 to turn on the recorder.

Assembly. The author's prototype of the Tele-Monitor was assembled on a printed-circuit board measuring about 2 3/4 x 2 1/4 inches. A template for the printed-circuit board—which is available from the source given in the Parts List—is shown in Fig. 2. The layout provides for two modular connectors that allow you to connect your phone and the Tele Monitor to the same wall jack.

Once you have obtained or etched the board and are in possession of all the components, begin assembling the project using Fig. 3 as a guide. When stuffing the board, be careful of component orientations, particularly the diodes, capacitors, and transistors. Mount Q1 and Q2 as shown in Fig. 3.

Transistor Q2 should be heat sunk because the combination of the saturation drop in Q2 and motor current in the recorder may exceed the transistor's ambient thermal rating. Usually a small clip-on heat sink is adequate.

Next, prepare a cable for connection to the remote jack of the recorder. Select a plug that's suitable for mating with the remote jack of your recorder. Almost any wire will do, but for ease of soldering to the plug, 24- to 26-gauge stranded wire is recommended. Make sure that the circuit-board pad marked "T" is connected to the "tip" of the remote plug and "R" to the other lug of the plug.

After soldering the wires to the plug, twisting the wires about 2 turns per inch will prevent the cable from tangling. If you are using a recorder other than the

(Continued on page 100)

Are you tired of using the manual switch located in the maze of wires behind your TV set at the start and end of each videogame session? Does your VCR fail to record as programmed because someone in the family leaves the switch in the "Game" position after they've played? Put an end to those troublesome events by modifying your present switch at a cost of about \$10 so that it functions automatically whenever the power switch on your game console is used.

Switch Modification. The project, which is little more than a DPDT relay that replaces a part of the game's TV/Game switch, is simple enough to permit even starting hobbyists to build. Figure 1 shows the interior of a typical TV/Game switch case, which consists of a DPDT slide switch, a matching coil (L) at the game input, and terminals for connection to the antenna, game, and TV.

You must begin by removing the existing DPDT switch. To start, remove the snap-on back of the case and desolder the six connections to the DPDT switch. Remove the twinlead cable that goes to the TV, and bend the antenna solder-lugs upward to provide clearance to install the relay PC board. Secure the case to a stable surface and use a drill to remove the flared ends of the two rivets indicated in Fig. 1. Pop the rivets off the case, lift the slide switch out, and discard it as it is not needed.

To finish up, place a piece of insulation (perf-board, etc.) inside the case to prevent the new PC board and components from shorting out on the metal case.

Relay Circuit-Board. The circuit that replaces the switch is shown in Fig. 2. The circuit gets its power from the game itself. Note the polarity of diode D1, which protects the relay from damage by inductive voltage spikes when it is turned on and off. The diode is turned off when the power is applied to the relay. But when power is removed, whatever EMF develops in the relay coil forward biases the diode, which then acts like a short and keeps the spike from reaching the game's power supply.

The value of resistor R1 must be large enough to limit the current drawn from the game supply, but small enough to

permit the relay contacts to audibly snap closed when +5 volts is applied to the circuit.

If you use a relay other than that specified in the Parts List, you will have to select the proper current-limiting resistor by experimenting with some different values. To do that, mount the three components on a solderless breadboard and use a low value potentiometer (like 500 ohms) in place of R1. Connect the circuit to the computer power supply (see the section entitled "System Hookup" for instructions) and adjust the potentiometer for best relay operation. Use an ohmmeter to read its resistance and select the closest standard resistor value to use in the circuit.

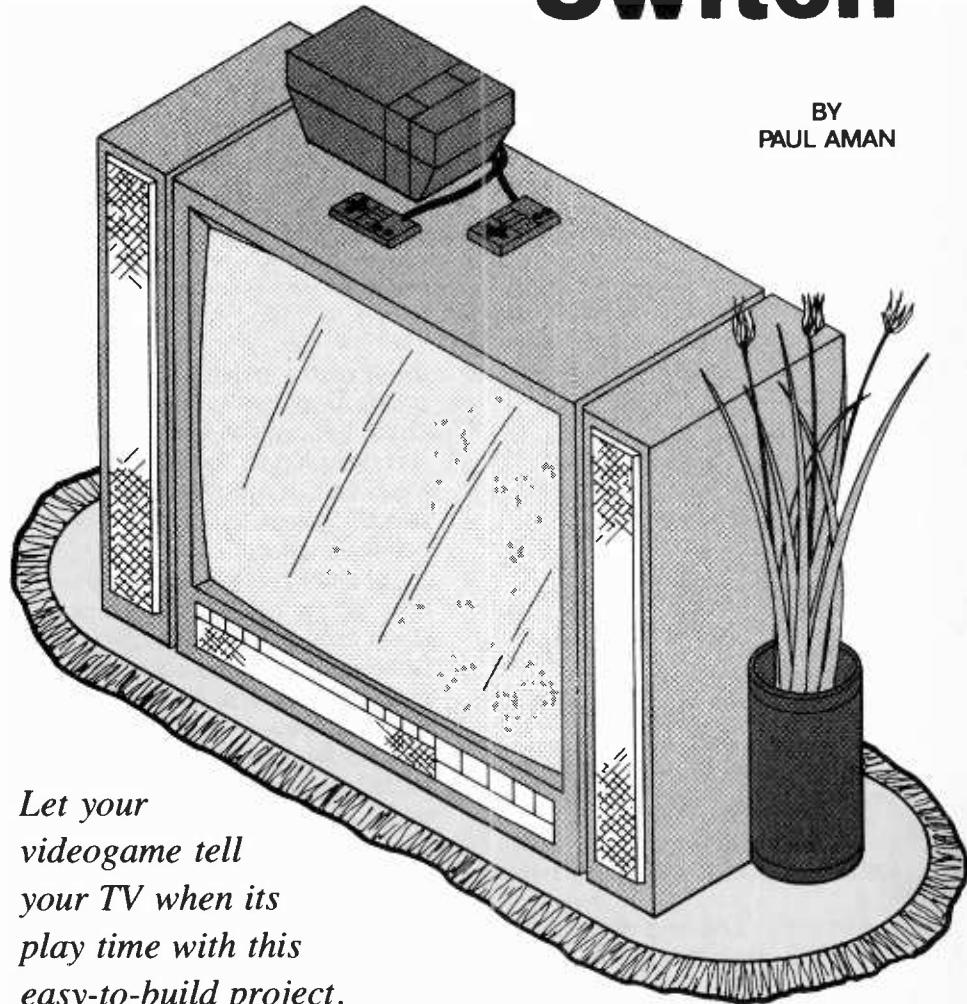
Try sticking to values in the 20- to 200-ohm range.

It is recommended that the printed-circuit board shown in Fig. 3 be used, however, a carefully wired perfboard may be substituted for it. Figure 4 shows the placement of the three board-mounted components. Stuff the board noting the orientation of K1, which comes in a dual in-line package, and D1. If you use the relay specified in the Parts List, the card that accompanies the relay will help you identify each of the eight pins.

With the board complete, solder the twinlead cable for the TV to the appropriate points on the board. Solder two short hook-up wires to the board for

Automatic Videogame Switch

BY
PAUL AMAN



*Let your
videogame tell
your TV when its
play time with this
easy-to-build project.*

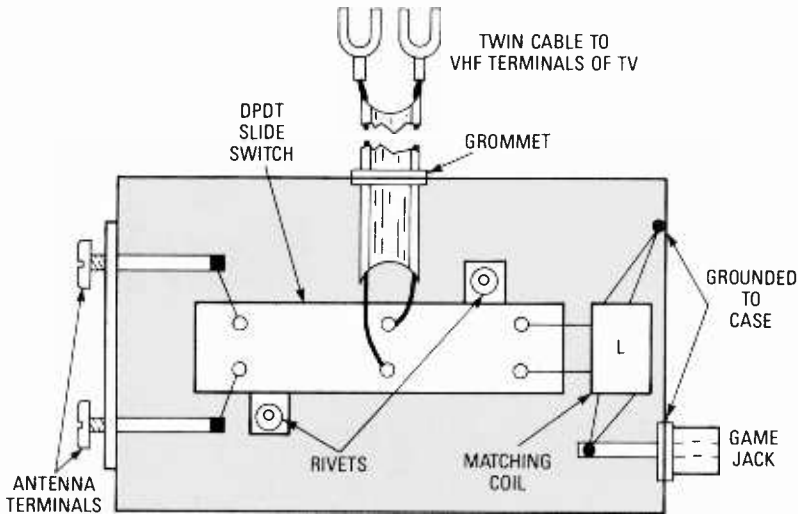


Fig. 1. The standard videogame switch is very simple. Beside jacks and terminals, it only contains a DPDT switch and a matching coil.

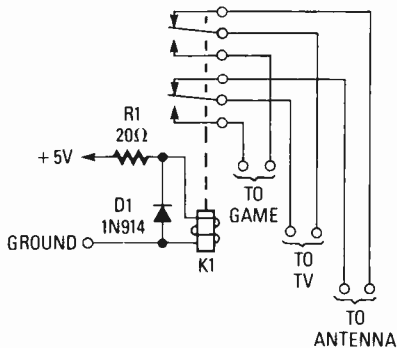


Fig. 2. Resistor R1 limits current to the relay's coil, while D1 shorts any EMF kickback from the relay's coil.

later connection to the antenna solder lugs.

Also solder one end of a length of two-conductor cable to the +5-volt and ground pads as shown in Fig. 4. Be sure to use enough cable to conveniently span the distance between the TV and the game console, and if the cable you use has a braided shield,

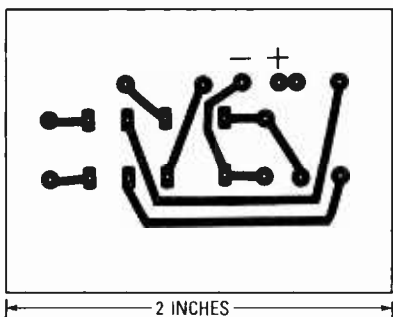


Fig. 3. This PC trace, although not mandatory, can be used to neat-up the Automatic Videogame Switch circuit.

use it as the ground wire. Attach a phone plug to the other end of the cable. If your videogame already uses a phone plug for something else, you may wish to use a different plug for the switch to preclude confusion and incorrect hook-up.

Cut a notch in the side of the switch case for the power cable, making it deep enough that the snap-on back panel will not cut the cable. With normal usage, the cable need not be further anchored.

Carefully solder the leads from the matching coil to the appropriate points on the board. Insert the board, foil side

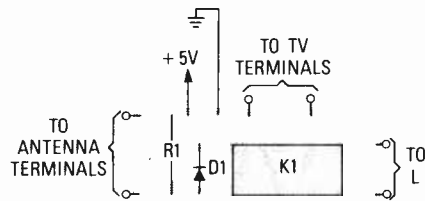


Fig. 4. This overlay should be used to stuff the printed-circuit board.

down, into the case on top of the insulation previously installed. Bend the antenna lugs back to their original positions and solder the short jumper wires from the board to them. Finally replace the snap-on back panel.

Game Console Modification. The prototype was used with a Gemini videogame by Coleco. Other videogames may be used with the switch, but it is up to the reader to locate the ground and supply-voltage points on the unit. (Note: opening your

unit's case will probably void the manufacturer's warranty—Editor.)

Disconnect the power and game cords, controllers, and cartridges. Remove the screws from the console bottom. Place the console right-side up and remove the cover and any plastic washers used around the switches. There is probably a metal shield covering the circuit board, so twist a flat-blade screwdriver behind its spring clips to release the shield.

PARTS LIST FOR THE AUTOMATIC VIDEOGAME SWITCH

- D1—1N914 diode, or similar
 - R1—20–200-ohm, ¼-watt, 5% resistor (see text)
 - K1—DPDT 6-volt, 60-ohm, relay (Digi-Key order No. Z439-ND)
 - Subminiature phone jack (see text)
 - Subminiature phone plug (see text)
 - Wire, solder, insulating material, PC-board or perfboard materials.
- An etched and drilled PC board may be purchased for \$5.00, plus return postage in the USA, from Paul Aman, 1552 Daffodil Dr. NE, Marietta, GA 30062. Allow 10 to 14 days for delivery.

Now you must find the 5-volt supply trace and the ground. Remember the positive-supply point you choose should provide power only when the unit is turned on, not just plugged in. An AC adaptor on the author's unit provides about 14 volts DC to the game, where it is regulated to 5 volts. The 5 volts is what is needed to drive the relay to switch the TV from the antenna to the game, so be sure you pick up the voltage at the proper point.

Solder color-coded wires to the +5-volt and ground points you select. Attach an open-circuit jack that matches the plug on the cable to those wires. Double check your connections and check for shorts.

Drill a hole in the side of the console cover closest to the power-supply points and securely mount the jack. Use a nibbler or other tool and notch the shield to provide a passage for the power wires to the jack. Install the shield and secure it as it was before. Return the plastic washers (if any) to the switches, and re-install the cover.

System Hook-Up. With the exception of the new power cord running be-
(Continued on page 105)

BUILD A METAL-LEAF ELECTROSCOPE

Detect static charge before it lays waste to some of your expensive CMOS chips.

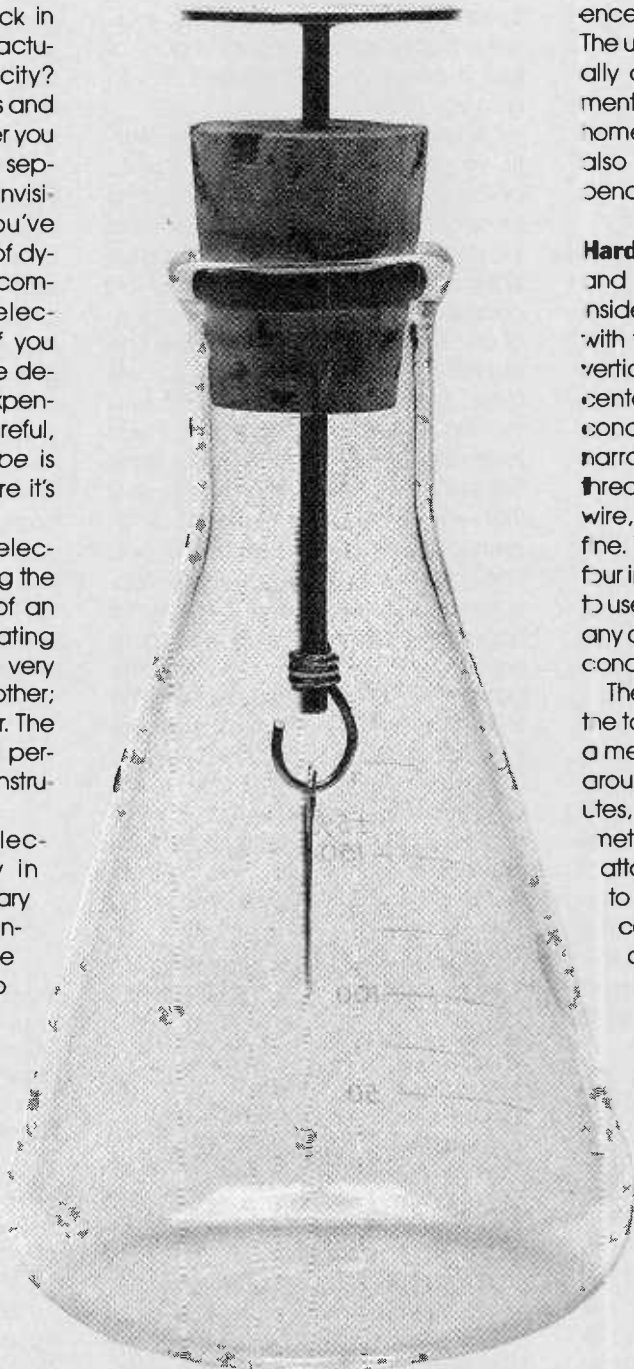
BY STAN CZARNIK

Remember those days back in the school lab when you actually *studied* static electricity? Brush away some of the cobwebs and recall with me the sense of wonder you felt as you watched pieces of foil separate under the influence of an invisible force. Since those days you've advanced far into the mysteries of dynamic electricity, but can you completely ignore the effects of electrostatic discharge? You can't if you experiment with high impedance devices. Static can ruin your most expensive components if you are not careful, and our *Metal-Leaf Electroscope* is perfect for detecting static before it's too late.

As you may remember, an electroscope is a device for indicating the presence and relative strength of an electrostatic charge. The operating principles of the device are very simple: like charges repel each other; unlike charges attract each other. The electroscope, or electrometer, is perhaps the oldest known electrical instrument.

Plans for building various electroscopes appear frequently in books and articles on elementary physics and electricity. All such instructions are very clear on how the metal leaves must be allowed to swing freely from the hanger inside the container. The problem is that many designs do not, in fact, permit the leaves to move as they should. The result is an electroscope that responds poorly, and sometimes just barely, to electrostatic charges.

The electroscope described here requires more time to complete than others, but the extra sensitivity is worth the effort. Build the device carefully, and it will indicate the pres-



ence of a fairly subtle electric charge. The unit described in this article is actually a very sensitive electronic instrument and a welcome addition to any home laboratory. As we'll see later, it is also useful on the electronic's work bench.

Hardware. Look at the photographs and Fig. 1. Note that the metal leaves inside the electroscope communicate with the outside world by means of a vertical conductor running through the center of a small cork. The vertical conductor can be almost any long narrow piece of metal. A screw, a threaded rod, a length of coat-hanger wire, or even a large nail will work just fine. The rod should be about three or four inches long. Whatever you choose to use, it must be clean, dry, and free of any coating or insulation that might not conduct an electric charge.

The receiver, which is the probe on the top of the electroscope, should be a metallic sphere or disc. After poking around in my junk box for a few minutes, I was lucky enough to locate a metal rod with a metal disc already attached. Many of you may be able to find something similar. If you become desperate, just use a piece of aluminum foil rolled tightly into a ball.

The purpose of the bottle is to insulate the leaves electrically and shield them from currents of air. It is essential that the bottle be made of transparent glass. Any clean dry bottle of sufficient size will make a good electroscope.

I used a 200-milliliter laboratory flask—an Erlenmeyer flask to be exact. The cone shape permits the leaves to move apart without hitting the inside surface of the glass. Such flasks are

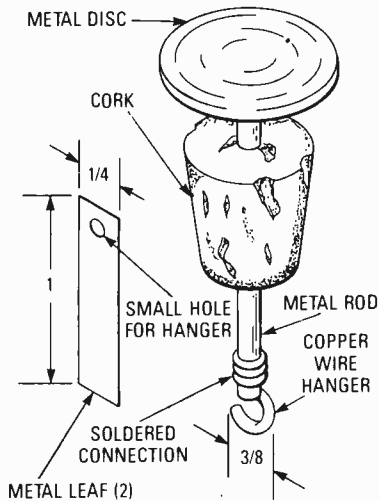


Fig. 1. The Metal-Leaf Electroscope can be made from ordinary household materials. Make sure all metal parts are clean, dry, and free of any coating or insulation that might not conduct an electric charge.

available from the supplier given in the Materials List.

You'll need a cork to fit the bottle. Cork is a good insulator and preferable to rubber stoppers or plastic caps. A small assortment of corks can be found in the housewares section of many large supermarkets.

Assembly. With all the parts collected, you're ready to build the electroscope. Drill a small hole down through the center of the cork and push the metal rod through the hole. Now, take a short piece of bare copper hook-up or magnet wire. Make absolutely certain that all insulation is scraped from the wire before you start bending it. Wind one end of the copper wire around the lower portion of the metal rod. To insure a good electrical connection, solder the wire to the rod. Heat the contact area thoroughly with your soldering iron before applying any solder. A tiny drop of solder will be enough.

Curl the other end of the wire carefully around the shaft of a screwdriver. The loop should be about $\frac{3}{8}$ inch in diameter. Do not permit any kinks or other irregularities to develop in the loop. It should be as round and as smooth as possible.

Locate a small piece of household aluminum foil. The thinner the foil, the more sensitive your electroscope will be. Cut two strips about 1-inch long and $\frac{1}{4}$ -inch wide. Punch a tiny hole, about $\frac{1}{16}$ inch in diameter, near one

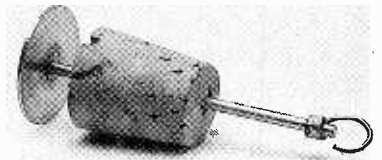
end of each of the strips. If you experience too much trouble try again, but make the holes *before* you cut out the strips.

Now, gently place the leaves on the copper wire hanger. The leaves should hang together and swing freely. If they do not swing freely, remove the leaves and make the holes slightly larger. Put the entire assembly into the bottle, press the cork down, and your electroscope is complete.

Static Charge. There are a great many ways to charge an electroscope. Discovering those for yourself is highly educational and a lot of fun! The following is intended only to give you a start.

Obtain a piece of soft flexible plastic (a plastic grocery bag is ideal), and a glass rod, a glass test tube, or a small drinking glass. Rub the glass with the plastic. That puts a strong positive charge on the glass. Now bring the charged glass object close to the metal disc on top of the electroscope. The aluminum leaves inside the flask will move apart. Pull the glass away, and the leaves will come together. If you touch the disc with the charged glass, the leaves will move apart and stay that way. To bring the leaves back together, touch the disc with your finger.

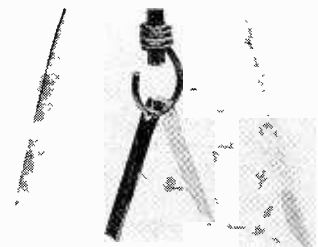
Initially, the net charge on the electroscope leaves is neither positive nor negative; it is neutral, and the leaves hang together. When you bring the positively charged glass close to the electroscope, the negative electrons in the electroscope are drawn upward toward it. That means the electroscope leaves are left with a positive charge. Since like charges repel each other, and since the charge on both leaves of the electroscope is the same,



The metal disc, metal rod, cork, and copper-wire hanger will look something like this before you attach the aluminum foil leaves. Note that the connection between the wire hanger and the metal rod has been secured with a drop of solder.

the leaves are forced apart. When you touch the electroscope with your finger after touching it with the glass rod, you add electrons (or neutralize the positive charge) and the leaves fall back together. You are now back where you started.

Putting it to Work. Your new electroscope can be used to detect static charge before it damages your more sensitive devices. To use it in that fashion, start by removing any charge on the electroscope by momentarily grounding it. Touching the probe on a metal household water pipe is a good way of grounding the electroscope. Now touch the electroscope's probe with each metal object that may come into contact with the device you're concerned about. Of course, if the leaves separate after touching one of the objects, it indicates the presence of charge and the object and the probe will have to be momen-



A static charge on the electroscope will cause the aluminum leaves to move apart. The stronger the charge, the wider the angle between the leaves. The electroscope, cannot tell you whether a charge is positive or negative.

tarily grounded before proceeding. When running this test, be sure to check the workbench itself for charge if it is made out of metal.

For more information on electroscopes and electrostatics, see *Nature's Electricity*, by Charles K. Adams (Tab Books, Blue Ridge Summit, PA).

MATERIALS LIST FOR THE METAL-LEAF ELECTROSCOPE

- Aluminum foil strips
- Copper hook-up wire or magnet wire
- Cork
- Metal disc or sphere (see text)
- Metal rod
- Transparent glass bottle or flask

ADDITIONAL MATERIALS

- Solder, glass rod or test tube, and a flexible plastic sheet or grocery bag.
- Pyrex glass flasks and glass stirring rods are available from Hagenow Laboratories, Inc., 1302 Washington Street, Manitowoc, WI 54220. The Hagenow catalog is \$1.00.

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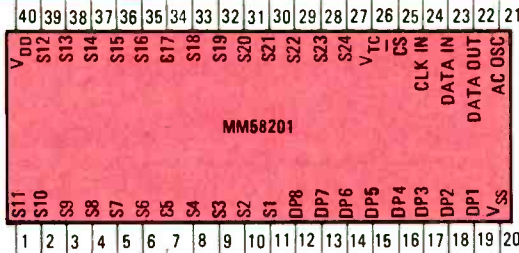
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Operating	$V_{DD} + 7.0V$ to $V_{SS} + 18.0V$
Lead Temperature (Soldering, 10 seconds)	$300^{\circ}C$

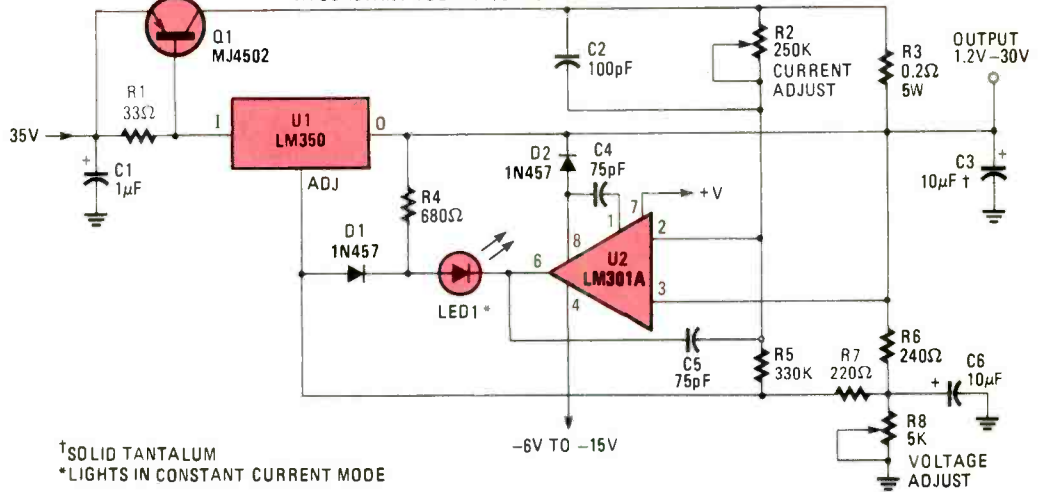
GENERAL DESCRIPTION

The MM58201 is a monolithic CMOS LCD driver capable of driving up to 8 backplanes and 24 segments. A 192-bit RAM stores the data for the display. Serial input and output pins are provided to interface with a controller. An RC oscillator generates the timing necessary to refresh the display. The magnitude of the driving waveforms can be adjusted with the V_{TC} input to optimize display contrast. Four additional bits of RAM allow the user to program the number of backplanes being driven, and to designate the driver as either a master or slave for cascading purposes. When two or more drivers are cascaded, the master chip drives the backplane lines, and the master and each slave chip drive 24 segment lines. Synchronizing the cascaded drivers is accomplished by tying the RC OSC pins together and the BPI pins together. The MM58201 is packaged in a 40-lead dual-in-line package.

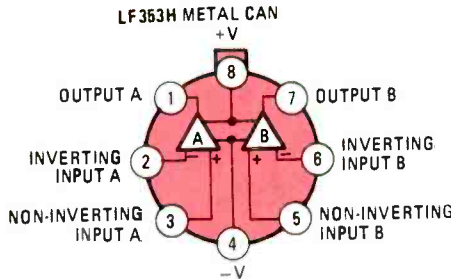
FEATURES

- Drives up to 8 backplanes and 24 segment lines
- Stores data for display
- Cascadable
- Low power
- Fully static operation

5A CONSTANT VOLTAGE/CONSTANT CURRENT REGULATOR



†SOLID TANTALUM
*LIGHTS IN CONSTANT CURRENT MODE



GENERAL DESCRIPTION

These devices are low cost, high speed, dual JFET input operational amplifiers with an internally trimmed input offset voltage (BI-FET II™ technology). They require low supply current yet maintain a large gain bandwidth product and fast slew rate. In addition, well matched high voltage JFET input devices provide very low input bias and offset current. The LF353 is pin compatible with the standard LM1558 allowing designers to immediately upgrade the overall performance of existing LM1558 and LM358 designs.

FEATURES

- Internally trimmed offset voltage
 - Low input bias current
 - Low input noise voltage
 - Low input noise current
 - Wide gain bandwidth
 - High slew rate
 - Low supply current
 - High input impedance
 - Low total harmonic distortion $A_V = 10$, $R_L = 10k, V_O = 20 V_{p-p}, BW = 20 Hz - 20 kHz$
 - Low 1/f noise corner
 - Fast settling time to 0.01%
- | |
|------------------|
| 10 mV |
| 50 pA |
| 16nV/√Hz |
| 0.01pA/√Hz |
| 4 MHz |
| 13 V/μs |
| 3.6 mA |
| $10^{12} \Omega$ |
| <0.02% |
| 50 Hz |
| 2 μs |

DC ELECTRICAL CHARACTERISTICS

Parameter	Conditions	Typ	Units
Quiescent Supply Current		0.3**	mA
Logical "1" Input Voltage		.45*	V
Logical "0" Input Voltage		1**	V
Logical "0" Output Voltage	$I_{BINK} = 0.6 \text{ mA}$.4**	V
Logical "1" Output Leakage Current	$V_{OUT} = V_{DD}$		μA
Logical "1" Input Leakage Current	$V_{IN} = V_{DD}$.1**	μA
Logical "0" Input Leakage Current	$V_{IN} = V_{SS}$		μA
Input Voltage			V
Input Impedance		10*	k Ω
Output Impedance	Backplane and Segment Outputs		k Ω

AC ELECTRICAL CHARACTERISTICS

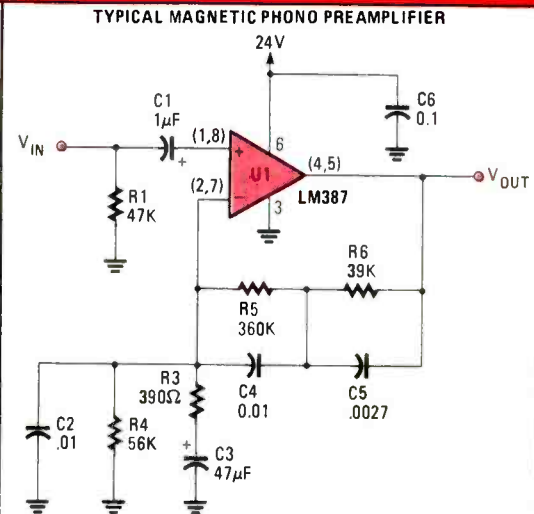
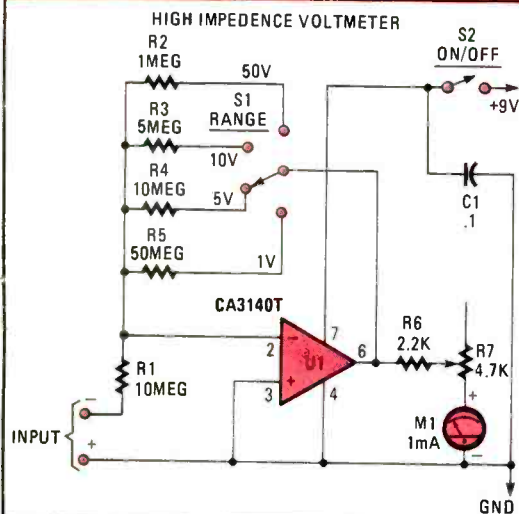
Parameter	Conditions	Typ	Units
Oscillator Frequency*		400**	Hz
Clock Frequency		100**	kHz
Clock Pulse Width			μS
Clock OFF Time			μS
Clock Pulse Width			μS
Input Data Set-Up Time			μS
Input Data Hold Time			μS
Access Time			μS
Rise Time	Backplane, $C_L = 2000 \text{ pF}$	60**	μS
Fall Time	Backplane, Segment Outputs $C_L = 2000 \text{ pF}$	60**	μS

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 - experimenter circuits
 - exceptional construction projects

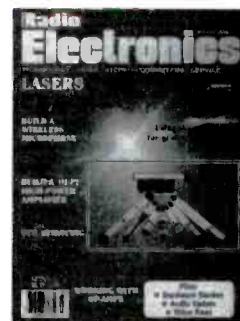
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DC ELECTRICAL CHARACTERISTICS

PARAMETER	CONDITIONS	LF353, LF354	UNITS
Input Offset Voltage	$R_S = 10 \text{ k}\Omega$, $T_A = 25^\circ\text{C}$ Over Temperature	5	mv mv
Average TC of Input Offset Voltage	$R_S = 10 \text{ k}\Omega$	10	$\mu\text{V}/^\circ\text{C}$
Input Offset Current	$T_I = 25^\circ\text{C}$, $T_I \leq 70^\circ\text{C}$	25	pA nA
Input Bias Current	$T_I = 25^\circ\text{C}$, $T_I \leq 70^\circ\text{C}$	50	pA nA

PARAMETER	CONDITIONS	LF353, LF354	UNITS
Input Resistance	$T_I = 25^\circ\text{C}$	10^{12}	Ω
Large Signal Voltage Gain	$V_S = \pm 15\text{V}$, $T_A = 25^\circ\text{C}$, $V_O = \pm 10\text{V}$, $R_L = 2 \text{ k}\Omega$ Over Temperature	100	V/mV
Output Voltage Swing	$V_S = \pm 15\text{V}$, $R_L = 10 \text{ k}\Omega$	± 13.5	V
Input Common-Mode Voltage Range	$V_S = \pm 15\text{V}$	+ 15 - 12	V V
Common-Mode Rejection Ratio	$R_S \leq 10 \text{ k}\Omega$	100	dB
Supply Voltage Rejection Ratio		100	dB
Supply Current		3.6	mA



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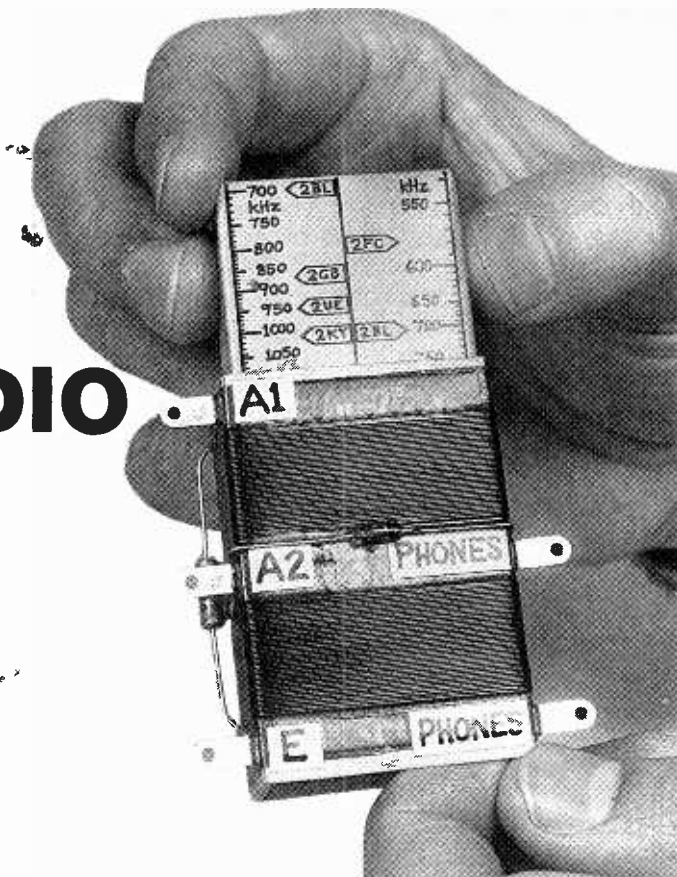
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Build a MATCHBOX CRYSTAL RADIO

BY STEVE PAYOR

If you've never built a crystal set before, this is the one to have a go at. You'll be surprised at how well it performs.



This interesting little project is easy on the budget, but big on satisfaction. And it won't cost you a cent to run after it's finished, even if you let it play forever. Make no mistake about it, the *Matchbox Crystal Set* is a real working AM receiver, not just a nostalgic novelty.

Until the invention of electronic amplification, the humble crystal set was the only form of wireless reception in use. During the 1920's, simple crystal sets, using only a single tuned circuit, were used for listening to domestic broadcasts; the crystal set described in this article is in the same category. It's cheap, easy to use, and capable of receiving local broadcast stations at a reasonable volume.

There is a small price to pay for free entertainment however. First, you have to string up an antenna and provide a fairly good ground. Second, you will have to find a pair of sensitive, high-impedance headphones, which we'll talk about in greater detail later.

Indoor Antenna. This crystal set has been designed to work with 15 meters (49.2 feet) of hookup wire as an indoor antenna. In most cases just draping it

This story first appeared in *Silicon Chip, Australia* (October, 1988); reprinted with permission.

around a skirting board will do the trick, but if you live in a poor-signal area, it may be necessary to run the wire out the window and up and away from the building. In any case, stick to a length of 15 meters to start with, because the antenna's impedance is an integral part of the tuned circuit.

As you can see from the photos, the tuned circuit consists of an inductor wound on the outside of a matchbox. In parallel with the inductor is a fixed capacitor and the antenna/ground capacitance, as you can see in Fig. 1. The inductance is varied over a wide range by sliding two pieces of ferrite rod in and out of the matchbox.

The ratio of minimum to maximum inductance that can be achieved by tuning that way is about 4:1, which is not quite enough to cover the entire broadcast band. The broadcast band extends from 531 kHz to 1602 kHz (i.e. a 3:1 frequency ratio), and so requires a 9:1 inductance ratio.

That problem is resolved with an antenna tap, A2, at the center of the coil. The tap is used when tuning the top half of the band, and the antenna capacitance is transformed to an equivalent capacitance of only 32 pF, or thereabouts. When the antenna is connected to A1, the full antenna capacitance (approximately 135 pF) is in

parallel with the tuned circuit. That effectively doubles the tuning capacitance and shifts the tuning range down to cover the bottom half of the band.

The two antenna taps also perform another vital function—they enable us to optimize the antenna coupling for each tuning range.

The subject of antenna impedance, and its loading effect on the tuned circuit, is perhaps the most important consideration in the design and operation of a crystal set. So let's start by looking at the antenna.

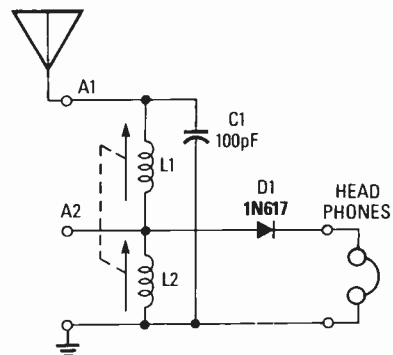


Fig. 1. This is the complete circuit for our Matchbox Crystal Set. Unlike most crystal sets, it uses variable-inductor tuning to give constant bandwidth and volume over the entire tuning range. The headphones should be high-impedance types.

Equivalent Antenna Circuit. Figure 2 shows the equivalent circuit of our 15 meters of hookup wire at broadcast-band frequencies. The wire is too short for its inductance to be significant at such frequencies. Thus, the antenna can be effectively represented by a capacitance of 135 pF in series with a small voltage source (the received signal) and a certain amount of resistance.

The resistance can be broken down into two parts. The major component is just the high-frequency resistance of the antenna wire itself. The other component is the "radiation resistance," which represents the coupling of the antenna to the surrounding space. The

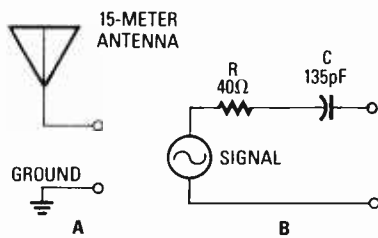


Fig. 2. This is an equivalent circuit for a 15-meter long antenna. It can be represented by a 135-pF capacitor in series with a 40-ohm resistor and an AC-voltage source.

radiation resistance is not to be confused with inductive or capacitive coupling; it is actually due to the fact that work must be done to propagate a signal into space, and since receiving antennas retransmit any received signal, they also have a radiation resistance.

The total series resistance of our 15-meter indoor antenna (including the ground connection) is about 40-ohms at 1 MHz, of which only a few ohms is the actual radiation resistance. Thus the antenna's efficiency is quite low.

One way to increase the antenna's efficiency is to make it longer and higher. The wire resistance increases in proportion to the length, whereas the radiation resistance goes up with the square of the effective height above ground. That should answer the old question "why is a longer antenna better than a short one?"

If we could run a very thick wire straight up to a height of a quarter-wavelength (75 meters at 1 MHz), we would find that the series inductance would exactly cancel out the capacitive reactance. Thus, the only impedance left would be the radiation

resistance, about 37-ohms. To achieve such ideal performance, the antenna would also require a perfectly conductive ground plane—a copper disc 492 feet in diameter would be near enough!

Believe it or not, at a distance of 12 miles from a typical broadcast station, such an ideal antenna would receive more than 20 mW of power. That is enough to give quite a respectable volume to a loudspeaker! Obviously, such an antenna system is not practical, but one should bear in mind that a crystal set needs the best possible antenna and ground system to function effectively.

A microwatt of received power will provide good volume with a sensitive pair of headphones, a nanowatt is perfectly listenable, and a signal of around 50 picowatts is just audible. For the record, this crystal set will receive stations at a listenable volume with less than a yard of antenna. However, it won't work at all without a ground connection, for the simple reason that the antenna current has nowhere to flow.

One can get away with a large metal object buried in damp soil, but since dirt is not as conductive as metal, the best ground connection would be a large metal grid, laid on or under the ground, and stretching as far as possible in all directions. Water pipes fit that description admirably, so they make an effective ground.

Selectivity and Coil Taps. Sharpness of tuning is always a problem with simple crystal sets—the resistive component of the antenna impedance and loading by the diode circuit both tend to reduce the selectivity of the tuned circuit. One solution to the problem is to provide several taps on the inductor, as in the typical "textbook" crystal set

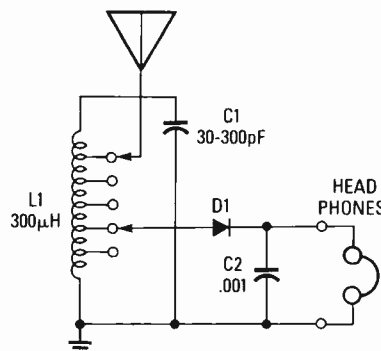


Fig. 3. The traditional "textbook" crystal set. The need for tap-changing as the set is tuned makes operation awkward.

of Fig. 3. If we connect the antenna and diode to the coil a few turns from the grounded end, the tuning will be very sharp because the loading will be negligible. However, the signal coupling will be correspondingly small.

The optimum tapping points can be found by experiment, but (and here's the catch) they vary with each frequency setting. For example, at the low-frequency end of the band, one might obtain best results with the antenna tapping at 100% (i.e., at the top of the coil) and the diode at about 60% of the way up the coil. At the high-frequency end of the band, the optimum antenna tapping may be only 10%, and the diode tapping about 25%.

There are three reasons why the taps change so much. First, the RF resistance of the antenna wire increases

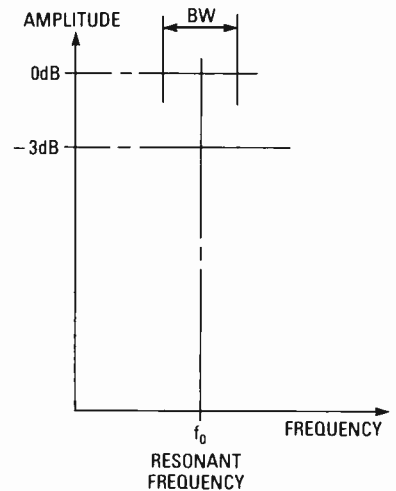


Fig. 4. The Q of a tuned circuit is the ratio of its center frequency to its $+3\text{dB}$ bandwidth.

with the square root of the frequency (due to the "skin effect"). Worse than that, the radiation resistance goes up with the square of the frequency. Thus, the damping effect from the antenna resistance is considerably greater at the top end of the band than it is at the bottom end.

Second, to obtain the same selectivity at the top end, the tuned circuit needs to have a "Q" (which we discuss in the next section) three times higher than at the bottom end. Finally, to make matters worse, the impedance of the inductive and capacitive elements is three times higher at the top end of the band. The result is that we need to reduce the effective antenna

and diode loading by more than a factor of nine as we tune up the band.

For that reason the fixed-inductor/variable-capacitor approach is just about the worst arrangement possible. The only reason why that circuit is so popular is that variable capacitors are (or were) readily available. Variable inductors, on the other hand, were something you had to make yourself.

Selectivity and the Q Factor. Since we've mentioned that the Q factor of our circuit is important, it's a good idea to discuss what it is and why it is important. The Q, or Quality factor, of a tuned circuit is the ratio of its center frequency to its -3dB bandwidth (see Fig. 4). For example, a tuned circuit with a center frequency of 1 MHz, and a -3dB bandwidth of 10 kHz, has a Q of 100. Normally, a Q of that magnitude is barely achievable with a well-designed low-loss inductor in the tank circuit. The unloaded Q of the Matchbox Crystal Set at 1 MHz was measured at around 95 to 98.

Conveniently, Q is also equal to the ratio of the impedance of either the inductor or capacitor (since they are equal at resonance) to the resistance causing the energy loss in the tuned circuit.

For example, consider again a circuit with a Q of 100 at 1 MHz. If the tuning capacitance is 100 pF, it has a reactance of -1600 ohms at 1 MHz and the inductor has a reactance of +1600 ohms when adjusted to 253 μH. For a Q of 100, the equivalent series resistance of the tuned circuit is:

$$1600/100 = 16 \text{ ohms}$$

as shown in Fig. 5A. The equivalent parallel resistive load would be:

$$1600 \times 100 = 160,000 \text{ ohms}$$

as shown in Fig. 5B.

Thus a high-Q tuned circuit must have a very little series resistance (in the coil for example), and a very high parallel-load resistance.

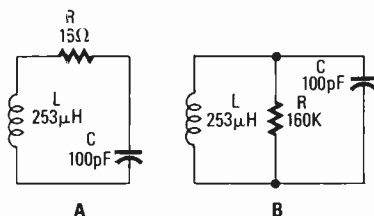


Fig. 5. Equivalent series (A) and parallel (B) high-Q tuned circuits (Q = 100 at 1 MHz) for our crystal set.

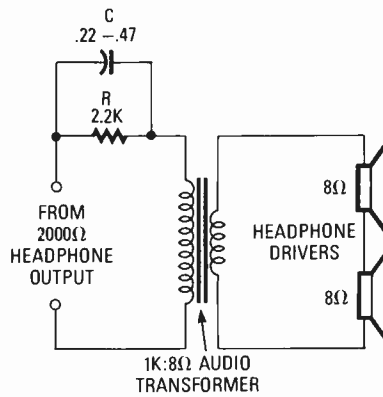


Fig. 6. This diagram shows how to convert a pair of low impedance headphones into 2000-ohm high-impedance headphones. All you need is a small audio transformer, a resistor and a capacitor.

The unloaded Q of the Matchbox Crystal Set is almost entirely determined by the coil resistance, which, as we have just calculated, is about 16 ohms at 1 MHz. Compare that with the DC resistance, which is only about 1.3 ohms!

When the crystal set is in use, the Q factor of the circuit is considerably lower, because of the combined loading of the antenna resistance and the diode circuit.

With a 5000-ohm headphone load and a 15-meter antenna connected to A2, the Q of the Matchbox Crystal Set was measured at around 50 at 1 MHz, giving a bandwidth of 20 kHz. Since the typical minimum frequency separation between local broadcast stations is about 50 kHz, that would put any interference from an adjacent carrier at +14dB. Unless the wanted signal is very weak, the major component of the interference will be ultrasonic, and therefore inaudible, so you will find that the Matchbox Crystal Set has adequate selectivity for most applications.

Variable Inductance is Best. If we want a tuned circuit that maintains constant selectivity with the antenna and diode connected to a fixed tap point, the first thing we must do is use a variable inductor instead of a variable capacitor. Oddly enough, all of the earliest crystal sets used variable inductors. They were cumbersome affairs, using either a sliding-contact arrangement or a pair of coils that slid or rotated inside one another. Nowadays, making a variable inductor is almost too easy, thanks to the availability of low-loss RF ferrites.

With a fixed tuning capacitor and a variable inductor, the impedance of the active components is three times lower at the top end of the band. That means for a given loading, the tuned-circuit Q will automatically be three times higher. In practice however, the effect is not too good, since we have ignored the resistive losses in the coil itself.

Another problem is that the loading is not constant. Remember that the antenna resistance increases with frequency, so the optimum tap point still needs to be moved, although over a much smaller range.

Our design solves the problem by electrically "moving" the A2 tapping as the tuning inductance is adjusted. Although that tap is nominally half-way up the coil, the effective coupling varies depending on how far the ferrite rods are inserted into the top of the coil. When the rods are only partially inserted, the inductance of the top half of the coil is greater than the inductance of the bottom half. Also, not all of the magnetic flux from the bottom half of



This old telephone earpiece was converted to high impedance operation using the circuit shown in Fig. 6. The parts all fit in the plastic housing.

the coil passes through both halves—some of it "leaks out" of the sides of the matchbox. Thus, the effective tapping is less than half-way up the coil.

When the ferrite rods are fully inserted, all of the flux flows through both halves of the coil and the effective tapping point is exactly half-way. So the fixed antenna tap is actually being adjusted while one tunes from station to station.

There is an obvious advantage to the tuning system: it's easy to use. As a bonus, the Matchbox Crystal Set auto-

matically maintains a constant bandwidth and volume over its entire tuning range.

There is a second and not-so-obvious bonus: we can accurately mark a tuning scale on the sliding part of the matchbox. That's not normally possible with an "ordinary" crystal set, since a slightly different tuning scale is required for each antenna tapping.

Actually, the Matchbox Crystal Set has two tuning scales, one for the top end of the band (with the antenna connected to A2), and one for the bottom end (with the antenna connected to A1). Both scales are almost linear, and all of the local stations are spread out quite nicely across each range. The same will apply for most locations.

Once your crystal set has been calibrated, the tuning scales will always be right on the money as long as you maintain a fixed antenna length.

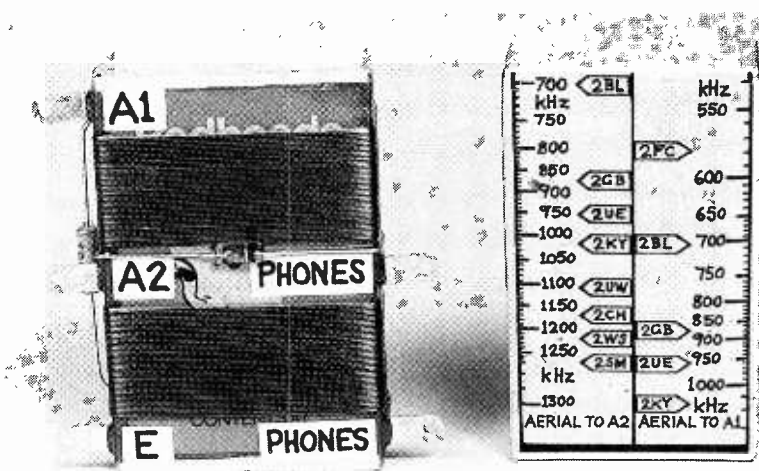
Headphone Impedance. At this point we should explain why the headphone impedance required for crystal sets is always very high (hundreds of ohms), compared with the impedance of modern high-fidelity headphones (usually 8 to 32 ohms). Why can't we just move the diode tap way down towards the bottom of the coil and use low impedance headphones? The answer is we could, if we could find a diode with resistance of about 10 ohms at a forward voltage drop of say 10 mV.

The best all-around diode for crystal-set use is the gold-bonded germanium type. In our tests, with 10-mV applied voltage, a typical device of that kind had a forward static resistance of 26,000 ohms, and a reverse resistance of 31,000 ohms. So, for signal voltages of ± 10 mV, no effective rectification takes place.

When the voltage was increased to 100 mV, the forward resistance dropped to 7000 ohms and the reverse resistance increased to 73,000 ohms. Rectification now takes place, but for reasonable efficiency a load in excess of 10,000 ohm is necessary to prevent undue loading.

There are two possibilities for improved rectification with low impedance loads. One is the so-called "backward diode," which is really a Zener diode with a reverse breakdown voltage of 0 volts. They are normally used only in microwave detectors and are hard to come by.

Another approach is to use a bat-



The tuning scale was carefully hand-drawn on the inner part of the matchbox. Note the diode running across the center and the polystyrene capacitor to the left.

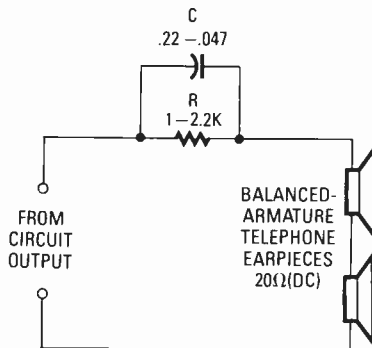


Fig. 7. This circuit will give good results with 20-ohm telephone earpieces.

tery and potentiometer to bias a diode into forward conduction. By adjusting the bias, you can select the best compromise between forward and reverse resistance for a given load. That approach was often used in the past, especially when using a *carborundum detector*. That was a diode made from a crystal of silicon carbide with a sharpened steel point sticking into it. It needed a forward bias of about a volt for best results.

However, high impedance headphones and an ordinary germanium diode are still the most convenient arrangement. If you want to, you can make a suitable pair of phones using currently available parts, as you will see.

Headphones for the Matchbox Crystal Set.

Owning a good pair of high-impedance headphones is a must for any crystal-set enthusiast. You may get lucky poking around at ham-fests, but most of the headphones you are likely to find will have a fairly low impedance. Don't let that worry you

too much. If you find a sensitive pair in good condition, then a small audio transformer with the appropriate turns ratio is all you will need to turn them into a first-class pair of crystal-set headphones.

The most sensitive type to look for are those with a "balanced armature" mechanism and a light-aluminum diaphragm. Old telephone earpieces of that type are excellent and, even allowing for the losses in the impedance-matching transformer, they are just about the most sensitive transducers ever made.

The even older style of headphones that have sheet-iron diaphragms come second in order of decreasing sensitivity. They are still being manufactured with a 2000-ohm impedance, but the sensitivity is not as good as it was in the old days.

Next come the older style of "modern" headphones, the ones with small 8-ohm speakers in them. A good scheme for using them is to connect both 8-ohm drivers in series (get the phasing right) and use a 1000-ohm:8-ohm transistor-radio type audio transformer. You may lose a little bass response, but you will have a pair of 200-ohm headphones.

Note that the DC resistance looking into the matching transformer will be a lot less than 200 ohms, so the transformer looks like a short circuit to the DC voltage from the rectified carrier. Actually, it is not quite that bad because the diode still has a few thousand ohms of forward resistance. Nevertheless, it is worth taking some steps to avoid excessive damping of the tuned circuit. Figure 6 shows how a

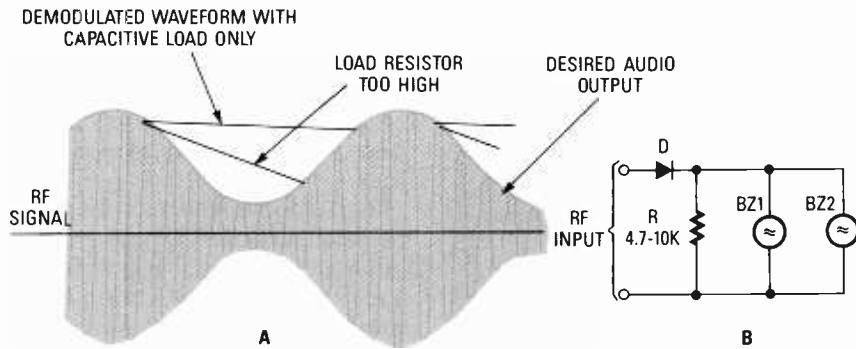


Fig. 8. Improper load impedance (A) will cause audio distortion in piezoelectric transducers. A resistor between 4700 and 10,000 ohms connected in parallel (B), will prevent distortion due to insufficient shunt resistance.

series resistor can be added to bring the DC resistance up to 2000 ohms. A bypass capacitor prevents any attenuation of the audio signal.

The same technique can also be used to make a pair of medium impedance headphones from a couple of old telephone earpieces. Those have an AC impedance of a few hundred ohms each, but a DC resistance of only 20 ohms. Connected as shown in Fig. 7, they perform well, although with a proper matching transformer the results are phenomenal.

If you don't want to go to all that trouble, and you've got a pair of piezoelectric transducers you can make use of them. However, unlike electromagnetic transducers, piezoelectric transducers have an infinite DC resistance, and a fairly low AC impedance. Electrically, a typical pair of piezoelectric transducers in parallel looks like a 9.1- μ F capacitor. If you connect them to the diode without a load resistor, all you will hear is a faint, distorted cracking.

Figure 8A shows the demodulated signal envelope as delivered by the diode into a load that has too much capacitance and not enough shunt resistance. Severe audio distortion results because the capacitor can't discharge rapidly enough to follow the audio-frequency variations. Adding a 4.7k to 10k resistor in parallel with the transducers will fix that problem.

Last, but not least, you might like to try a pair of "crystal" earpieces. They use tiny crystals of a naturally-occurring piezoelectric salt and their impedance is very high. A pair connected in parallel will only need a shunt resistance of between 100k and 1 megohm for best audio quality. Often, the reverse leakage of the germanium diode alone will be sufficient.

The tap you use for the diode will depend on the audio transducer you decide to use. We show the A2 tap being used for the diodes as well as the antenna. Loads of between 2,000 and 10,000 ohms are about right for that tap. If you intend to use a very high impedance load, such as a pair of piezoelectric earpieces, then connect the diode to the top of the tuned circuit (i.e. to A1). The load resistance with crystal earpieces will be between 100k ohms and 1 megohm.

The Case of the Missing Capacitor.

Conspicuous by its absence from the circuit diagram is the usual .001- μ F capacitor across the headphones. It is included in all the "textbook" circuits to provide RF filtering for the audio output, but its presence is usually undesirable. The impedance looking into a rectifier with a capacitive filter is close to half that of the load resistance, so with our headphones al-

ready lower than the optimum load resistance, the capacitor would only make things worse.

By contrast, an inductive filter can increase the effective load resistance to slightly more than the headphone resistance. A 1 or 2.5-mH RF choke in series with the diode may well improve the performance with low impedance headphones (typically 1,000-600 ohms), at least in theory. In practice, the choke can be left out as there will be sufficient inductance in the headphone windings and/or the matching transformer.

Construction. Let's begin construction by locating a suitable matchbox. Try looking for one at your local hardware or grocery store. While the size is not critical, try to select a box of about 2 x 1½ x ½ inches. If you cannot find a suitable matchbox, you can make one out of cardboard taken from a gift box. In any case, you will need to make up a wooden support to prevent the box from being crushed during the winding. Carefully plane a block of wood so that it just fits tightly inside the outer portion of the matchbox, then glue a short piece of broom handle to it and put the assembly aside for now.

Next, give the insides and outsides of both parts of the matchbox a coat of polyurethane finish. That strengthens the assembly considerably. Allow it to dry overnight, then lightly sand all over with 600-grade paper to smooth any "furry" bits. A top coat of polyurethane will be added later, when the coil windings, etc. are in place.

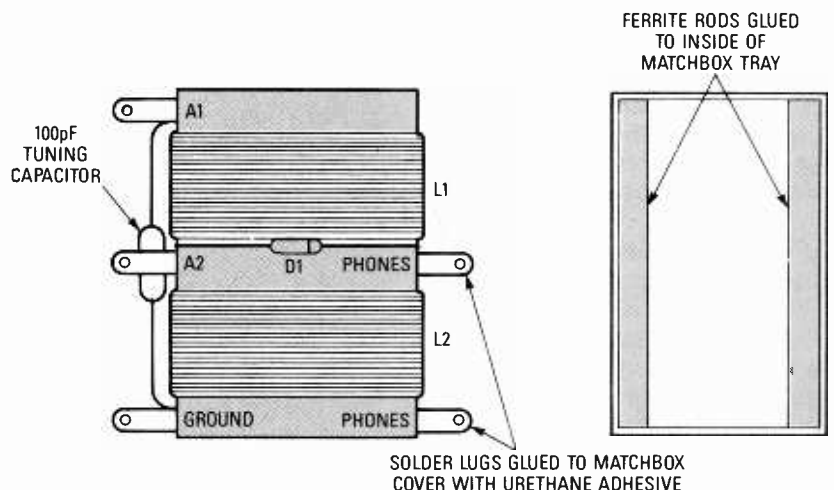
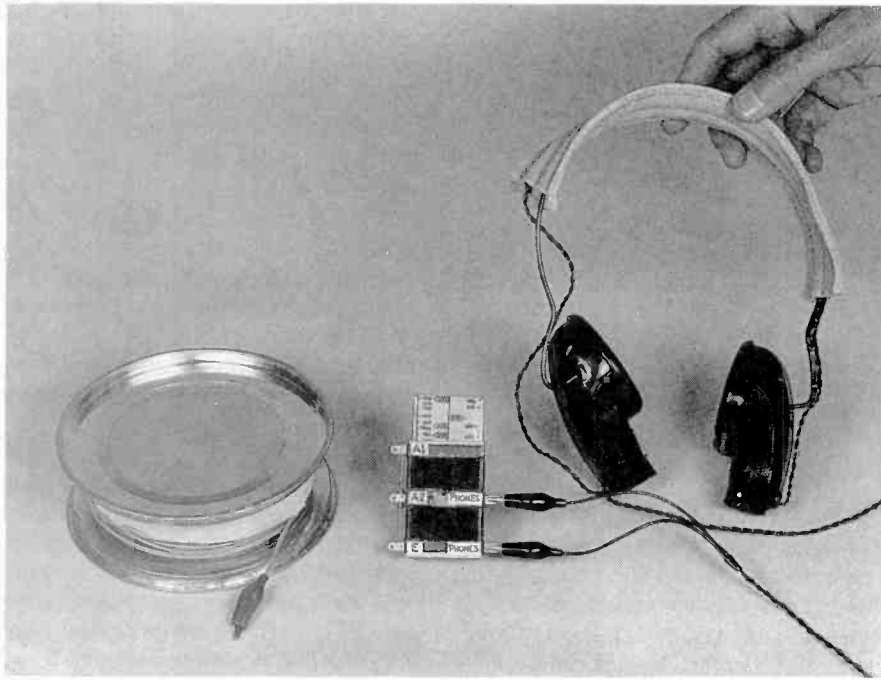


Fig. 9. Here's the layout for your Matchbox Crystal Set. Each of the coils consists of 37 turns of No. 27 gauge wire, but other wire gauges can also be used; see text.



To make setting up and taking down the antenna easier, we made up an antenna reel from a tin can and a couple of car-wax can lids. The headset was made of a pair of discarded telephone headsets and a small audio transformer.

Meanwhile, prepare the five solder lugs by first tinning them—that will minimize the amount of soldering heat needed later on. Once tinned, thoroughly scrub away all traces of the flux resin with a tissue and methylated spirits, then bend the lugs 90° as shown in the photos.

Gluing the Lugs. Start with the three lugs on the antenna side of the matchbox. Spread an ultra-thin smear of Duco or similar epoxy on the matchbox, and a little more on the solder lugs. Position one lug at each end, and one exactly in the middle. Leave the box standing on its side for several hours until the glue hardens.

Next turn the box over and glue the two headphone lugs exactly opposite the A2 and E lugs, checking the location with a ruler. Stand the box between two heavy objects to keep it erect until the glue sets.

Winding the Coils. The recommended wire is No. 27 gauge, but don't worry if you don't have the exact size—good performance can be obtained with any gauge from 25 to 28. Of course, the number of turns that will fit in the available space will vary, but the appropriate choice of tuning capacitor will compensate for any variation in inductance.

For example, on one prototype, wound with No. 27 gauge wire, two

coils of 37 turns each just fit between the lugs. That set required a tuning capacitor of 100 pF. A second prototype was wound with No. 25 gauge wire. The two coils ended up having only 23 turns each, and a 270-pF tuning capacitor was required.

Performance wise, there was little difference between the two versions, although the second set had a slightly restricted tuning range, and it preferred a lower headphone impedance.

Before winding the coil, mount the outer portion of the matchbox on the wooden support you've made. You will use the broom handle portion as a handle while you are winding the coils. When it comes to winding the coil, you

PARTS LIST FOR THE MATCHBOX CRYSTAL SET

- C1—100-pF polystyrene or mica capacitor (see text)
- D1—Germanium small-signal diode, 1N617, 1N87A or equivalent.
- L1, L2—Hand-wound coil (see text)

ADDITIONAL PARTS AND MATERIALS

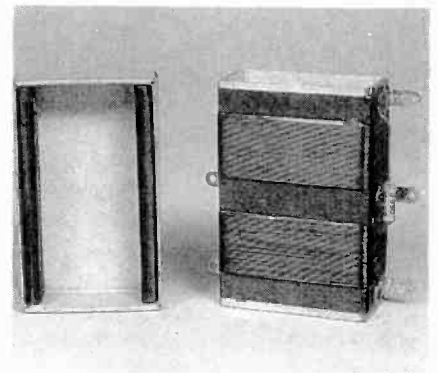
Matchbox, 9 yards of No. 27 enamelled copper wire for coils, 5 solder lugs, 4 miniature alligator clips, jumper-cable clip, over 15 meters of insulated hookup wire (depending on the ground-wire length), high-impedance headphones (see text)

can use one of two methods. Either wind each half of the coil separately, terminating the wire on the solder lugs as you go, or wind the whole thing at once, with a few extra turns across the central gap that can be snipped out later.

Keep a heavy tension on the wire all the time, and don't let go or you will find yourself having to start all over again. In fact, it's a good idea to have on hand several short pieces of masking tape, for holding the wire in place should you need to stop for any reason.

It isn't necessary to count the turns, just fill up the available space between the lugs with a neat, close-wound layer of wire. However, be aware that there should be between 23 and 38 turns per coil depending on the gauge you use.

When the time comes to solder the wire to the lugs, you can temporarily anchor the turns in place with more masking tape, or secure the windings



This view shows how the two ferrite rods are glued to the inside of the matchbox tray. Any type of round or flat ferrite rod can be used, providing it is antenna-grade ferrite.

with "Super Glue." Thoroughly scrape and tin the ends of the wire, and solder them to the lugs with a minimum of heat.

Mounting the Components. The diode should run from the middle A2 lug, across the front of the matchbox, to the headphone lug on the other side. Bend the leads neatly to follow the shape of the box.

The tuning capacitor runs down the side of the matchbox, between the A1 and E lugs, but its exact value needs to be determined experimentally, so you can't solder one in place at this stage.

The only other components are the two pieces of ferrite rod, but first they
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GIZMO

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NUMBER 6

A CHRONICLE OF CONSUMER ELECTRONICS

Child Prodigy

TALKING WHIZ-KID. Distributed by: Video Technology Industries Inc., Northbrook, IL 60062-2536. Price: \$60.

Children love to learn, and the best toys are often those that gently challenge a youngster's mind, either by encouraging imagination through the plaything's simplicity, by demonstrating cause and effect, or by stimulating problem solving.

Schools have the institutional responsibility for our children's education, but educators have long realized that the reinforcement the child receives at home is important in making classroom instruction effective. Unfortunately, many parents' hectic schedules make quality time with children difficult to arrange. But there are some educational toys currently on the market that can teach and entertain the little tykes on evenings when all you want to do is put your feet up and stare at the wall for awhile.

Talking Whiz-Kid, a pre-computer toy from *Video Technology*, has been one of the toy industry's top-selling electronic teaching aids. It provides an arsenal of learning material for children 5 years old and up, and requires no particular parental supervision. Everything about the Talking Whiz-Kid is designed with the child in mind. Simple to use, it resembles a portable personal computer. It is light enough for a child to carry, yet sturdy enough to take some bumps. Power is supplied via an included adapter (80-0877) or by six "C" batteries. Adapter operation is recommended in rather small type on the last page of the instruction booklet.

The 50 brightly colored software study cards offer a curriculum of math, spelling, reading, colors, geography, astronomy, history, logic, and music at basic and advanced levels. Each card offers eight questions. The cards are numbered by study lesson, and a lesson description is included on the back of each card. An answer symbol on the front of the card indicates if the answers will be numbers, words, or musical notes. The child's score for correct answers is displayed at the end



CIRCLE 50 ON FREE INFORMATION CARD

of the exercise. A 20-point bonus is given if all questions on the card are answered on the first try.

The child simply inserts one of the cards into the unit's mock disk-drive port and the Whiz-Kid asks a question. The youngster enters an answer using a 46-key alpha/numeric keyboard that is arranged alphabetically, rather than typewriter-style. When a child answers correctly, Whiz-Kid plays a musical salute and an animated bear waves a flag. If the answer entered is wrong, the bear bows his head and the unit asks the youngster to try again. The CLEAR key allows the user to erase an answer and enter another one. On most program cards, after three unsuccessful attempts, the correct answer will appear. (The other sets of questions either do not require a "correct" response or the player is allowed unlimited tries.) If the question proves to be too difficult, the child can ask Talking Whiz-Kid for the answer.

An item worth noting is the CODE key, which allows the Whiz-Kid to display a card program when the study card itself has been lost or destroyed. The unit stores all the questions and answers for each card in its internal memory. All the cards are listed by number and title in the back of the user's manual. The user simply presses CODE, the number of the card, and the ENTER key and the missing questions appear on the screen.

Study cards 1 through 14 provide lessons in math, including addition, subtraction, multiplication and division. Talking Whiz-Kid displays and speaks the problem simultaneously, reinforcing the child's learning. Two lessons offer review quizzes; another allows the child to use the unit as a calculator by entering their own equations and requesting the answer. A problem may have up to three digits and an answer of up to four digits.

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CIRCLE 51 ON FREE INFORMATION CARD

Backgammon to the Future

GAKKEN LCD BACKGAMMON. Available through: The Sharper Image, 650 Davis St., San Francisco, CA. Price: \$89.

The best endorsement we could give an electronic game is to 'fess up to having spent over 500 hours playing it. We've done just that with *Gakken LCD Backgammon*, over the span of a couple of years. This backgammon game is obviously a best-seller for *Sharper Image*, as it keeps reappearing in the mail-order firm's catalog (albeit with steadily increasing price tags).

The unit is advertised as the "backgammon board with a brain," referring to its onboard 4K microcomputer. Although it can be used in person-to-person play, the game is most intriguing when one player competes against the computer. (In play against another individual, the contestants have to pass the game back and forth between players, which becomes a tiresome interruption in the action; users might just as well play on one of those small magnetized travel boards available at airports and bus terminals.) There's something deeply appealing about vying with an artificial brain, electronic or otherwise.

Unfortunately, we had been keenly disappointed with other hand-held computerized backgammon games. Their simplistic programs offered no challenges to any but the most novice backgammon player. But we can testify that the Gakken has given us many hours of enjoyment and challenge.

It's relatively easy to master the electronics of the game. A dice mode is set to either "manual" or "automatic." Manual allows players to roll tiny, non-electronic

dice that come tucked into a storage compartment. Then the numbers are entered via the unit's "dice" buttons. We found that method too cumbersome to bother with; in any case, gizmo buffs *like* automatic features.

When playing against the computer, the player selects either an "A" or "B" game. The distinction between the two is not in their respective levels of difficulty. Rather, in the "A" mode the computer pursues an aggressive strategy of play, and in the "B" mode it is more defense oriented. We found that a nice touch, since it simulates the kinds of real-life players one might encounter.

The unit measures 4½ inches by 8½ inches—it's rather like holding a very long paperback book. The unit can be used with the sound switch off, if you don't enjoy the loud beeps that signal play.

When a player pushes "ENTER," LCD representations of dice "roll" on the playing field. Then markers are put into motion by pressing position buttons found on either long side of the unit. Moves aren't registered until the ENTER key is pressed again. A player can change his mind about either of the moves that follow the dice roll. Press CLEAR and both moves are aborted, press REJECT and only the second of the two moves is erased. We appreciated both options and the flexibility they bring to the game.

If you're familiar with backgammon, you know that the "doubling cube," which doubles the points (or wager) riding on a dice roll, is an integral part of the game. By pressing the game's doubling button, the human player can double the computer; the computer signals its intention to double the player by flashing a display on the LCD. The computer also keeps a running score for those contestants with a serious interest in points and outcome.

If you tire of the progress of a particular

game, simply press "reset" to start anew. We also use the reset button when it's clear we've beaten the computer. Human opponents can agree to end the game then and there, but the computer, sans reset, would have to play out the entire game.

One feature that might interest novice players is the "problem" button. By using the manual dice mode, a player can reenact a particular situation faced during a game. The player can then ascertain what strategy the computer would have followed in that situation. We have seldom used that option, mainly because we've spent dozens of hours poring over backgammon-strategy books. Basically, in the problem mode the computer is programmed to make the highest percentage move—that is, the one

that, by the numbers, will most often succeed. Those are the moves that an experienced backgammon aficionado would already know.

That's what makes playing against this unit so endlessly enjoyable. At some point in a backgammon game a human player will usually make a risky move. (At least we do.) If the high-risk strategy pays off, the player lucks-out and gets that win. If it doesn't... well, that's why backgammon is sometimes tagged "the cruelest game." It's a game of strategy, but the element of chance always plays a role. The computer, however, does not take big risks, always preferring the highest percentage selection. It's like playing against the most careful, conservative player in a high-

school chess club.

After two years and 500 accumulated hours of play, the Gakken game still provides us with a stimulating, interesting diversion. We like the fact that although we often beat the computer, there are the occasional games that it wins, because it's been programmed at an impressive level of backgammon skill.

The plastic casing around the game is solid and has stood up to more than its share of bangings around both at home and in various travels. It's calmed and distracted us during turbulent jet flights. The game uses four "AA" batteries, which seem to have a long service life—a characteristic they share with the electronic backgammon game that they power. ■

Pigskin Protagonist

HEAD TO HEAD TALKING FOOTBALL (7-760). Manufactured by: Tiger Electronic Toys, 980 Woodlands Parkway, Vernon Hills, IL 60061. Price: \$30.

Frankly, it was the packaging that induced us to purchase *Head to Head Talking Football*. Nowadays, most consumer electronics might be fabricated in Asia (China, in this case) as is the packaging (Hong Kong), but we would bet even money that Head to Head's package design came from some office in the good old U.S.A. There's something about American design that the Asian advertising industry just hasn't managed to duplicate.

Cruising the aisles of a large toy retailer, our attention was immediately drawn to Head to Head's packaging, with its colorful renditions of football players in orange, yellow, and blue uniforms. The box flap, when open, showed two youngsters deeply engrossed in Head to Head Talking Football.

The gimmick of this electronic game is that it provides "all the thrills and excitement of real football, complete with an electronic voice announcer." Still, we should say, we're dubious about such electronic sports games. In the past they have often turned out to be monotonous. Sure, they contain a "microcomputer"—but apparently one of such microscopic skill that the average player can quickly figure out its programmed strategies. It's not much fun playing a dumb computer.

But this unit—with which a player can square off against either its computer or another person—seemed to promise a little more sophistication. We splurged.

Opening the box, we were slightly taken aback by the actual size of the LCD playing field. Maybe this is Pee-Wee Football? Although the entire unit measures 9½ by 5½ inches, the LCD itself is much smaller,



2¼ by about 1½ inches, roughly the same dimensions as an open matchbook.

When we turned it on after inserting four "AA" batteries (not included), there was a second design surprise. Initially, it's a bit difficult differentiating between the Sharks and Tigers. The two teams have three players each (sorry, sports-authenticity fans); one trio is shaded and the other outlined. But their diminutive size makes it tough, at first, to figure out which team is which. If the unit is tilted at just the right angle, a user can see the dozens of tiny figures set into the LCD football field. By highlighting the right figures, the computer creates the illusion of movement.

The unit has the same control panel on each side of the LCD. The player can choose to play against another human or the computer. The user can "kick" or "pass" the ball while the computer can be prompted to remind players of the score.

Central to each control pad is a large green button. Depending on which side of the button is depressed, an LCD player is directed left, right, up, or down. Only a single player on each side—the player that's flashing—can be directed to move. The other players' responses are determined by the computer's program.

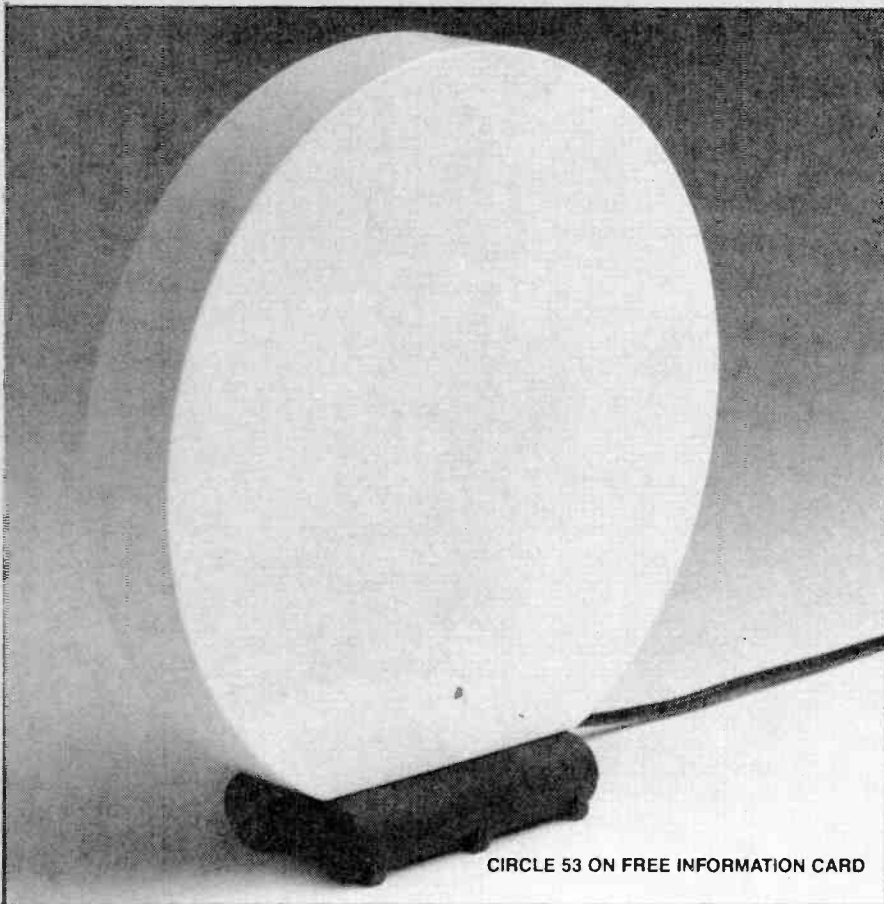
The offensive-team player presses "down" on the over-sized green button to have the ball hiked. Then the flashing quarterback can either attempt to outmaneuver the defense by running, or pass to a teammate.

After a few tries, we could stop the computer's offense dead in its tracks. Four downs and it had to punt. When we went on the offensive, we were also able to beat the computer easily. To make things more interesting, we devised a rule variation. In two of the four downs, we had to pass. That resulted in a few computer-team interceptions.

We wish that some of the technological acumen that went into the electronically produced humanoid voice, which provides verbal commentary like "First and ten, ball on the 35," had been applied to a more sophisticated program for the game strategy. (In our household, we are forced to turn the sound off much of the time. Non-fans are not exactly enthusiastic about hearing a loud computer-generated voice piercing a quiet afternoon with "The defense held tight.")

Playing against another person is more enjoyable because two good players essen-

(Continued on page 4)



CIRCLE 53 ON FREE INFORMATION CARD

Reception in the Round

TERK FM (Pi) INDOOR STEREO FM ANTENNA. Manufactured by: Terk Technologies Corp. 56 Harrison St., New Rochelle, N.Y. 10801. Price: \$85.

If we were asked to replace "mousetrap" in the adage, "Build a better mousetrap, and the world will beat a path to your door," with a more contemporary product, our substitution would be "FM antenna." Although not the most glamorous of audio gear, antennas rank near the top of products **GIZMO** editors and writers are most often asked about.

That's not surprising, perhaps, given the near-universality of tuners and FM receivers—and of interference and static on the FM bands. In our experience (see **GIZMO**'s report on the *LS-4 Parsec Indoor FM Antenna*, *Popular Electronics*, January 1989), FM antennas all work to some extent—even that college-dormitory staple, the straightened coat hanger, will improve reception marginally. So, as with other audio gear, the question comes down to what's best for the consumer's particular FM-reception situation.

One candidate to keep in mind when antenna hunting is *Terk Technologies Corporation's "Pi"* FM antenna. The com-

pact, unobtrusive, omnidirectional unit was granted a patent a year ago. According to the company, it was "the first such patent granted for a product of its type." The instructions state that the Terk Pi "amplifies received signals by up to 30 dB before the signals reach the tuner or receiver." The patented aspects of its design include the unit's "Gamma loop," a development that allows the electronic circuitry to fit into a much smaller space, eliminating the need for an elongated structure to house the unit. In fact, one of the most striking aspects of the Terk Pi is its compact size. Disc-shaped, it measures only 5 inches in diameter. There's a hard rubber base, for when the unit is used vertically (which makes it a directional antenna) and a converter to plug into a standard wall outlet.

Directions suggest that the Pi works within the "practical limit to FM reception of 50 to 70 miles." In its vertical position, the unit is said to be particularly efficient in pulling in weak signals, as it "rejects interfering signals and multipath (signal reflections)." That was **GIZMO**'s experience in our use of the Pi. In either vertical or horizontal position, however, we had to move the unit around a good deal to find the most advantageous place for it. But vertically situated and placed at a height of about six feet, the Pi performed admirably in pulling in a number of signals from lower-powered stations in the area.

In fact, the Pi is a mite too good at

pulling in signals. As we moved and maneuvered the antenna for optimum performance, a cacophony of conflicting signals assaulted our ears. Included with the unit is a 6-dB attenuator which is used between the antenna's F-connector and the tuner's antenna input. Connectors, for use with tuners having a either screw-style or 75-ohm direct connection (F-type), are included.

One annoying feature, common to all antennas, is the slightly comic effect of the human body on the antenna. With the Pi situated for perfect reception, as we stepped back static would suddenly well-up. Picking the antenna up would instantly quiet the irritating noise (rather like calming a squalling infant). The first engineer who figures out a way to overcome that will be something of a magician.

Using the Terk Pi antenna also taught us something about our beat-up receiver: Its tuning dial no longer corresponds very closely to the actual frequencies of the signals. Our ears and the signal-strength meter were a better guide to where we were at on the dial than the dial itself.

We would unconditionally endorse the Terk Pi indoor stereo FM antenna—but thus far we've never met an FM antenna we didn't like. In other words, any improvement is an improvement. This particular antenna improves reception a great deal. It may not be the ultimate "mousetrap" (like all gadget fans, we retain the faith that the ultimate is right around the corner), but it's certainly a better one. ■

PIGSKIN PROTAGONIST

(Continued from page 3)

tially stop their opponent's offense most of the time. That results in low-scoring games, which dismayed our 6-year-old daughter somewhat, until we explained that it was like "real life" football as played between teams with good defense. The youngster's favorite aspect of play was hearing the computer voice. Although she mastered much of this electronic version of football, passing proved to be somewhat difficult to execute; she had a hard time manipulating the controls.

One problem in playing Head to Head is its size. The game is so small that two players end up crouched side-by-side. Players have to make sure that the game is held just so, otherwise they will be unable to clearly see the LCD field of play.

The game itself is divided into four quarters of play, just like the full-sized, flesh-and-blood contest, although playing time is obviously much abbreviated.

After a few dozen hours of play (at least a hundred games), we would give the unit a barely passing grade. We're still waiting for the electronic sports game that will consistently present a challenge to us in the long run. ■

Reasonable Facsimile

RICOH PORTABLE COMPACT FACSIMILE (RF 800). Manufactured by: Ricoh Corp., 5 Dedrick Place, West Caldwell, NJ 07006. Price: \$800.

Not wanting to be the last on the block without a fax, we rushed out in pursuit of today's hottest communications toy. We'd heard horror stories about the quirkiness of some equipment, and had been warned that it would be difficult to find a decent unit for under \$900. There were ads presenting machines for less, but caution kept us away from the bargain basement. The Ricoh RF 800 "ultra-compact facsimile with a full-featured telephone" was our choice, for its range of features, brand name, and high-tech design.

The sales pitch began by touting Ricoh's push buttons, which would last longer than the touch-activated control mechanisms on some machines. Then the unit's other features were enumerated, including its telephone with on- and off-line capabilities, copier functions, speed dial, automatic redial, and usage reports. No, the RF 800 didn't function as an answering machine; but then, we already had an answering machine. The only features we might have wanted that were lacking were an automatic paper feed and a tray to hold documents after they've been fed through. The unit comes with a 90-day warranty, but an additional continuing warranty is available for a charge of \$89 a year.

Bringing the RF 800 home, we were prepared for glitches of all kinds. The concept of fax machines was still mind-boggling, and we feared that the results of our experiment might turn out to be as twisted as Jeff Goldblum's in the remake of *The Fly*. Years of fitful experience with computer modems did little to increase our optimism.

When the product came out of the box with several parts to assemble, we experienced even more trepidation. But much to our relief, the clear, simple instruction manual made the job easy.

The facsimile unit itself is a rectangular white box, weighing about 10 pounds with dimensions of 10.4 inches × 11.8 inches × 3.1 inches, with two slots on the face, one through which paper is fed and another where faxed documents come out. Above those slots is a large telephone keypad, along with FUNCTION, HOLD, SPEED-DIAL, START, STOP, and COPY buttons. Warning lights flash green or red to indicate system status.

The only tool necessary for installation is a screwdriver, which is included. After assembling the telephone holder and telephone support plate, all that remained was

to plug the AC-power cord into a grounded, 115-volt, 60-Hz wall outlet and the phone cord into the wall jack. The final step in the set-up procedure is to set the unit to pulse or touch-tone dialing, depending on the type of telephone service used. Even if the user has only one phone line, all that one must do is to let the machine know whether the transmission is in fax or telephone mode.

The entire system, including speed dial, transmission and activity reports, date, and time, works on a function-programming system that controls the unit's features. That might be daunting, but each function is clearly explained in the manual. Programming it is, quite literally, just a matter of following the instructions. So far, its documentation has proven to be idiot proof. But a warning—don't lose the manual. There is no way to know the functions or figure them out without it. They involve code numbers between 1 and 100 that cue the processor inside.

The most intimidating part is setting the RTI, TTI, and CSI codes that identify the machine to another fax terminal. The truth is, Ricoh could limit panic potential by labeling the settings, "your name" and "phone number." After getting the hang of the function keys, operating the speed-dial function was no problem, and we keyed in everybody we knew who had a fax.

Ricoh even provides a test document for the machine. After sending it through in "Copy" mode—and getting a clear reproduction on the thermal paper, even with standard resolution (98 × 203 dpi), which stands for "dots per inch." The unit also offers a "detail" setting, 196 × 203 dpi—we were ready for our first official facsimile call. Sending a greeting to a fax acquaintance, we slipped in the paper, felt the pull of the feeder, heard the "ready" beep, dialed the number, listened to the connection, pushed the "start" button,

and watched as the paper went through. After waiting five seconds in case another page was to be sent through, the machine broke the connection and then pumped out an activity report indicating that the message had been successfully transmitted. It was so easy, we wondered if that's all there was to it. Transmission time is less than 20-seconds a page, and for international calls, the RF 800 is both Group-2 and Group-3 compatible.

Sending 10- and 15-page documents proved to be a little tedious, as we hovered over the machine with papers poised and ready, to make sure that the 5-second lag time didn't pass and disconnect us. For multi-page documents, some coordination is required. Pulling paper from the back while loading paper in the front can cause a tangle. Users who frequently send long documents, should seriously think of getting a unit with a sheet feeder and paper tray.

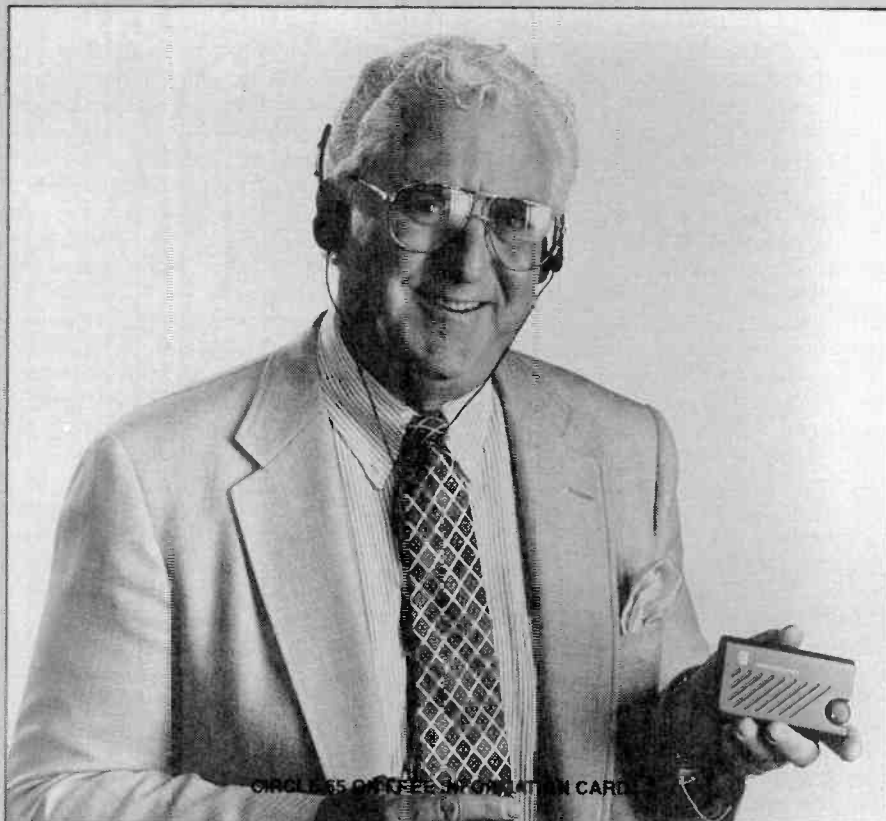
Receiving messages is as easy as sending them, although, again, larger documents may cause sheets to jam if not monitored. Due to the nature of our phone lines, we have fax senders call us before they transmit, so we are always aware when a fax is coming in and can keep an eye on the machine.

The unit serves competently as an extra phone, but talking into the receiver is like talking into a tunnel, and the handset is not built for comfort. The phone is most valuable when establishing fax communication, as the unit can switch from fax to telephone mode during a single call. The ringer chirps at 3 volume levels.

As a first fax, the Ricoh RF 800 is reasonably priced and simple to operate. It even helps users to be cost-conscious: To keep track of costs, the unit provides usage reports after thirty calls, so fax abusers can be duly spotted. In daily use, this Ricoh RF 800 has performed admirably. ■



CIRCLE 54 ON FREE INFORMATION CARD



CIRCLE 65 ON READER INFORMATION CARD

Listening to the Waves

PRIVATE WAVES WIRELESS HEADPHONES (WH 100). Manufactured by: **Datawave, Inc., 19611 Ventura Blvd. (Second Floor), Tarzana, CA 91356.** Price: \$99.95.

Private Waves Wireless Headphones allow the user to enjoy music and TV audio privately without the tangle of cords. Private Waves provides the intimacy and convenience of personal stereo from a different source—the home-TV or -audio system.

Private Waves operates via FCC-regulated FM radio-frequency transmission rather than the more frequently encountered infrared, which restricts wireless transmission to line of sight. With infrared, it was impossible for the wireless listener to turn away from a direct-line source and still receive the signal clearly. With Private Waves, turning corners and leaving the room is no longer supposed to be an obstacle to wireless listening.

Private Waves seems to be a sophisticated system—its base station operates with a frequency range of 80 to 15 kHz—and a flexible one. It can transmit through walls to the system's lightweight headphones.

Set-up was easy. The paperback-book-sized *WH-100* base station is connected to a stereo's or television's line, earphone, or

speaker output. The user sets the frequency-modulated transmitter with a slide switch that selects one of two crystals—one at 88.1 MHz, the other at 107.9 MHz. Power, via an adapter, comes from a wall outlet.

The *WH-100's* receiver—a cigarette-pack-sized unit weighing 3½ ounces and measuring 4½ inches long, 2¾ inches wide and 1½ inches deep—operates on two “AAA” alkaline batteries (provided). A switch on the receiver matches its frequency to the one selected for the base. A “dual-conversion system” is said to guarantee low distortion. The signal-to-noise ratio is listed as 60 dB. The unit is covered by a 90-day warranty from *Datawave*.

Sitting on the second floor of our home, we were able to listen to a videotape playing on the first floor, with the TV monitor's speakers silent. As we learned from firsthand experience, that is especially appreciated in households with infants. We could listen to music or TV without disturbing the sleeping child. Patching the Private Waves base station into the TV was a simple matter of plugging the mini-size connector into the set's headphone jack. The *WH-100* comes equipped with an adapter that will connect it to a standard cassette deck or receiver jack.

Listening to cable-TV music channels via Private Waves headphones was a close approximation of Walkman-style personal listening. The signal was strong and the wireless receiver sent the music to the headphones virtually static-free. We were able to work with our hands free in a pri-

vate audio environment, without shutting ourselves off from the rest of the household.

Our first disappointment with the system came when listening to the tape deck. Our apartment walls interfere with the signal in certain locations and music came to our ears accompanied by an annoying buzz. When we moved close to the base station, the signal became clear and strong. Listening to radio via the Private Waves system was the most satisfying match of source and reception, with the advantage of a powerful receiver and the mobility of this wireless system. From treble to bass, tones were clear and rich.

We were favorably impressed with Private Waves's supplied headphones. Although literature from *Datawave* refers to “bud-style” headphones, these were the standard over-the-ear models, but they compared favorably with more expensive, separately purchased headphones. There was a slight crackle and the bass tones were rather like those on an audio cassette, but the overall performance was more than acceptable.

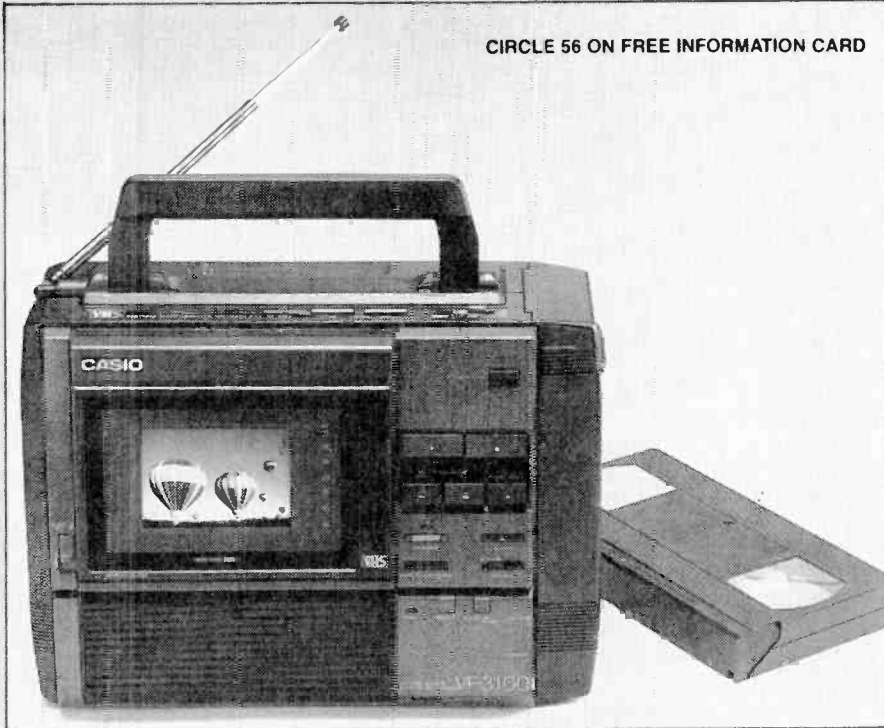
Even outside the apartment, from one floor above, we could pick up the base broadcast signal (although with increasing static) to a distance of about 80 feet. Interference from various metal elements (heating pipes, wiring, and a steel staircase) also increased with distance from the base transmitter. When we tried Private Waves outside the building there was no signal at all.

Private Waves seems to have expanded the notion of private listening, as established by the personal stereo, to include home use. In many apartment buildings, one man's floor is another tenant's ceiling, and disputes and problems regarding TV and stereo volume are among the most common complaints in modern urban living. Private Waves eliminates that problem while giving the listener freedom he or she didn't know they needed. If not demonstrably better than infrared systems in terms of clear reception, the Private Waves FM-transmission system is at least comparable, and a good deal more flexible. ■

Coming Next Month

- Starting Lineup Talking Baseball
- Memo Me Electronic Voice Box
- Casio Electronic Keyboard
- Plantronics Hands-Free Telephone Headset
- New York Toy Fair Report
- And Much More!

CIRCLE 56 ON FREE INFORMATION CARD



Video Voyagers

SONY VIDEO WALKMAN TV-VCR (GV-8). Manufactured by: Sony Corp. of America, Sony Dr., Park Ridge, NJ 07656. Price: \$1,300.

CASIO PORTABLE TV/VCR (VF-3100). Manufactured by: Casio, Inc., 570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801. Price: \$999.

CITIZEN HAND-HELD LCD TV (TC-53-05). Manufactured by: CBM America Corp., 2999 Overland Ave., Los Angeles, CA 90064. Price: \$299.95.

SHARP CRYSTALTRON LCD COLOR TELEVISION (3ML100). Manufactured by: Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07439. Price: \$695.

The garish spell of Las Vegas rains down like jackpot money in the hit motion picture *Rainman*, as Raymond (played by Dustin Hoffman) watches a *Video Walkman*. His attention captivated by the tiny TV screen, he watches the small set constantly, slamming the door shut against the world. Is the Video Walkman an easy fix, or is it Raymond's best connection to the real world?

Television is like a security blanket to some people, but the video industry is claiming that "personal video" can set the consumer free. We can use those small, portable machines to record videotapes,

and to transport and display them later. That frees the user from stationery home-television viewing. Or, to quote *Sony*, "video is no longer a home-based activity . . . Waiting for appointments, taking public transportation, readying a meal in the kitchen or lying on a hammock in the backyard are now opportunities to view video. The *Video Walkman* better enables us to fit video into our busy lives."

The TV we all grew up watching contained a cathode-ray tube that glowed with light. The current generation of mini-portable TV's substitute a liquid crystal display—more compact, but offering less resolution. The transition from cathode-ray tube to LCD screen parallels the change from desktop video-display terminals to portable computers with LCD screens for travel. As anyone who's viewed one can attest, LCD screens of the tiny kind are not without their quirks (angle and distance are all-important in viewing).

The Sony Video Walkman (GV-8) is 5 inches wide, 2½ inches deep, and 8 inches high, and comes complete with a VCR that plays back and records up to four hours on an 8mm videocassette. The unit has a 3-inch color LCD screen with backlight and weighs 2½ pounds. The Walkman offers high-speed picture search to scan recordings quickly. A linear time counter displays tape position in hours, minutes, and seconds. The built-in tuner has full VHF and UHF reception, a telescoping antenna, and an external-antenna connector. The Video Walkman offers on-the-go time shifting, with a single-day/one-event timer and a sleep timer that turns the GV-8 off after one hour. If the viewer

tires of the tiny screen, the unit can be harnessed to a large-screen monitor or TV. The Video Walkman can use AC/DC power, rechargeable NiCd batteries, or alkaline batteries with an optional external-battery case.

Since GIZMO's March report on the *Casio VF-3000 Portable TV/VCR*, the firm has introduced a successor model, the *VF-3100*, which further expands the VHF video unit's capability. In contrast to the VF-3000, this new portable can record in either standard or extended mode, offers a sleep/timer function, and does up to two hours of unattended recording. Besides those new features, the VF-3100 has a suggested retail price significantly lower than the VF-3000's.

About the size of a lunch box, its rod antenna pulls in both VHF and UHF channels. Its high-resolution LCD (twisted nematic type) screen measures 3.3 inches diagonally. Watching the *Oprah Winfrey Show*, the live studio color was washed out and pale in comparison with a standard 21-inch TV screen. However, when we watched a videotape of *The Seven Year Itch*, the color was magnificent and rich. Marilyn Monroe's lips were as shockingly red as a Revlon ad. Cinemascope and Technicolor must be the perfect color and image processes for 3.3-inch LCD TV.

Casio also offers a non-VCR equipped mini LCD TV, the *TV-810*, which incorporates what is called a "unique tilt angle design which makes viewing easy from practically any angle." This portable unit weighs a mere 12.3 ounces and offers VHF channels 2-13 and UHF 14-69. Power can be supplied by battery, AC, or a vehicle battery through an optional adaptor. The suggested retail price is \$249.95.

Citizen's re-entry into the portable-TV "sweepstakes" weighs less than one pound and has a 2.5-inch screen with backlight. The *Hand-Held LCD TV* offers VHF/UHF, front-mounted tuning and 4 hours of viewing on 4 "AA" batteries.

Sharp says that its *Crystaltron LCD Color TV* can also be viewed at just about any angle, from a distance of about a foot and a half. Weighing 10.9 ounces, the unit was praised as a "magnificent midget" when GIZMO tested it last year (*Popular Electronics*, June 1989) and it remains an appealing mini-portable. Cosmetically, it's a handsome product, available in black, red, or silver casings. Its tuning is slide-rule like, with a narrow channel indicator appearing on-screen when the channel controls are engaged. The 3-inch screen offers sharp, bright color and contrast, with the assistance of a fluorescent backlight and what Sharp describes as a "thin-film transistor (TFT) active matrix system." The screen itself is flat and swings away from the main body of the *3ML100* on hinges.

Recording with these units produces a result not perceptively different than with

a standard-size VCR, all things (like TV reception) being equal. Recording is unlikely to be a primary purpose, especially since most purchasers of these units are consumers who already own a home VCR. We wonder why the industry, currently trying to reintroduce play-only video machines, doesn't combine a play-only unit with an LCD TV.

Consumers who purchase one of these minis for travel purposes may find themselves slightly hampered by the need for batteries (used up by these devices at a fairly quick clip) or an adaptor, especially for overseas journeys. The dedicated video viewer may wish to bring along a spare power pack.

There's little doubt that these products have the potential (particularly at lower retail prices) to transform the way we watch television. In much the same way as the development of personal stereo has changed how and where people listen to audio cassettes, book-size VCR units are eventually going to impact on both software and viewing patterns.

We already are expert at adapting to new technology, and adapting TV to our own individual desires and needs. If the average-hours-of-television-watched statistic begins edging upward again (it's been in a slow decline for awhile), it will likely be a reflection of the spread of TVs and VCRs that viewers can take with them. ■

CHILD PRODIGY

(Continued from page 1)

Lessons 15 through 24 teach basic spelling and offer a 120-word vocabulary. A letter is displayed on the screen, Talking Whiz-Kid asks what that letter represents on the displayed picture card, and the child types in the name of the object.

Cards 25 through 35, which include geography questions, ask the child to key in a number from the right side of the card to match a letter on the screen. For example, the child selects the card labeled "World Map" and is asked to identify the continents displayed by matching them with the corresponding lettered answer. If Asia is marked with the letter "G," then the child selects from among eight possible numbered answers and enters the number.

We were particularly impressed with the types of questions in that group. A card entitled "World Structures," has the child identify the Eiffel Tower, London's Big Ben, and the Taj Mahal, among other landmarks. Another asks the user to name the planets.

The learning-to-spell series, cards 36 through 44, are numbered in order of difficulty. First the child is asked to fill in one missing letter in a simple word; then to spell the entire word; next to listen to, read, and repeat a word displayed on the screen. Word games like Hangman and Anagrams make spelling more fun.

The music lessons on cards 45 through 50 encourage children to learn musical notation and make up their own tunes of up to 32 notes.

When the hundreds of questions in the package supplied with the Whiz-Kid are answered, additional software cartridges at more advanced levels can be purchased for a nominal cost.

We tried out the unit on kindergarten children and first-graders. The response was quite enthusiastic. "It's a challenge and I like that," one 7-year-old remarked. "I like it because I'm learning things and it's fun," a 6-year-old responded. "The questions aren't too easy and I like that too. It's not babyish."

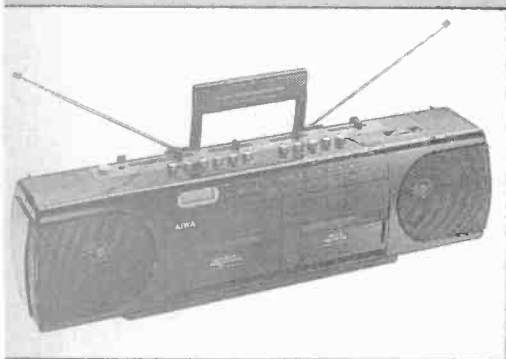
For us, that is what's most appealing about the Talking Whiz-Kid. It doesn't "talk down" to the children, but allows them to learn at their own speed and at their own level of interest.

The Talking Whiz-Kid is particularly helpful for children struggling to master English usage and vocabulary. The unit's creatively drawn graphics and simulated voice, accompanying an expanding vocabulary of everyday words, make learning English a little easier.

Research indicates that children learn faster when sight, touch, and hearing are involved. The Talking Whiz-Kid offers just that, allowing a higher level of participation and retention. ■

ELECTRONICS WISH LIST

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



Aiwa Clock-Radio/Dual Cassette Player

Clock-Radio/Double Cassette Player

Fed up with waking to the sound of commercial radio? This designer-fashioned *Stereo Double Cassette Recorder (CS-WR66)* from Aiwa (35 Oxford Drive, Moonachie, NJ 07074) allows you to awaken to your favorite tape. The clock radio incorporates a double cassette recorder with auto reverse, double-speed dubbing with synchro-start, continuous playback from deck one to deck two, and an auto-stop function. The digital clock features clock/sleep operation and has a built-in daily timer. And if you'd rather wake to the radio, this unit has an AM/FM receiver as well. Price: \$120.

CIRCLE 57 ON FREE INFORMATION CARD



Synchronics Vehicle Lighter Adapter

Three-Socket Car Lighter Adapter

Over the past decade, the automobile has become more and more like a traveling home, what with cassette decks, CD players, cellular phones, power jacks, and electric shavers. It's been said that life in the fast lane means living in your car. The simple, single-connection dashboard lighter may no longer be sufficient to power up the range of contemporary automotive electronics. With the *Three-Socket Car Lighter Adapter*, however, the problem is solved—or at least eased—until more vehicular gizmos arrive. Available from Synchronics (Hanover, PA 17333), the triplex converter plugs right into the lighter and provides three times as much "plugability" to a vehicle. Price: \$19.95.

CIRCLE 58 ON FREE INFORMATION CARD

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

ELECTRONICS WISH LIST

Remote Control Cassette Deck

Making audio tapes at home is becoming an increasingly precise science. The *Auto Reverse Deck (TA-R300)* from *Onkyo* (200 Williams Drive, Ramsey, NJ 07446) uses an optical sensor to reverse tape-travel time faster than mechanical devices, which can also create gaps in playback or record mode. The model also includes Dolby HX Pro, which is designed to improve recording and reduce distortion. The unit features computer-controlled, 2-motor transports that the company says will assure "long-term mechanical reliability." Price: \$360.

CIRCLE 59 ON FREE INFORMATION CARD

Outdoor Loudspeaker

Consumers can have a Eurostyle stereo speaker for their backyards with the *Indoor/Outdoor Mini-Advent* speaker from *Advent* (4138 N. United Parkway, Schiller Park, IL 60176). The system is encased in high-impact black plastic to give it a "sleek and modern look" and to protect it from the weather. It has a power-handling capability rated at 40-watts continuous and 120-watts peak. It utilizes a tuned port enclosure, a 5¼-inch woofer and a ½-inch tweeter with a frequency response of 110 to 21,000 Hz \pm 3 dB. Price (per pair): \$199.95.

CIRCLE 60 ON FREE INFORMATION CARD

Videotape-Splicing Kit

With more and more videotapes in the home library, the need for repair is ever present. The professional-quality *Spliceomatic (V145)* enables the video buff to do fast, accurate tape splicing in any tape format. Made by *Recoton Corp.* (46-23 Crane St., Long Island City, NY 11101), the kit contains a tape-splicing cartridge with 25 tabs, extra blades, a screwdriver, and a pair of gloves to guard against smudging. The user lines up the tape and "just presses the button." Price: \$49.99.

CIRCLE 61 ON FREE INFORMATION CARD

Compact Disc Player

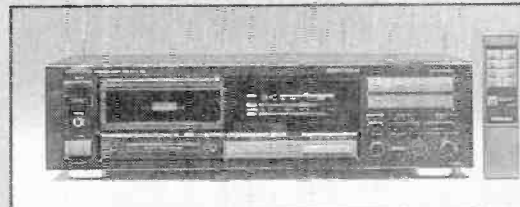
The *Compact Disc Player (CD-06)* from *Teledine Acoustic Research* (330 Turnpike St., Canton, MA 02021) represents the manufacturer's second generation of American-built CD players. This 16-bit 4-times oversampling player uses what's described as a fast-acting, computer-drive laser swing arm with a single laser beam to play the disc. The company says the player's "clear and transparent sound" is assured by analog circuitry that employs a Gaussian filter to virtually eliminate filter delay and provide good "step response." The CD-06 features a cool-blue digital readout, a single-piece door unit, and a smaller remote-control unit, which is capable of scanning, pause, and volume control. There's also random-access programming of up to 20 tracks in any order. Price: \$699.95.

CIRCLE 62 ON FREE INFORMATION CARD

Bookshelf/Floor Speaker

It's a fact of modern life that a lot of Americans move many times in the course of their lives. That, of course, includes stereo owners. The *Three-Way Acoustic Suspension Loudspeaker (Model 205)* from *Altec Lansing Consumer Products* (Milford, PA 18337) allows for some flexibility in that it's designed to "provide wide dynamic range in a moderate-size environment" and can be used as either a floor-standing or bookshelf-style unit. The speakers stand 22 inches high by 12 inches wide by 9 inches deep. Each speaker incorporates an 8-inch long-throw carbon-fiber woofer, a 3½-inch mid-range of the same material, and a 1-inch polyimide vacuum-deposition titanium-dome tweeter with ferro-fluid cooling. Price (per pair): \$600.

CIRCLE 63 ON FREE INFORMATION CARD



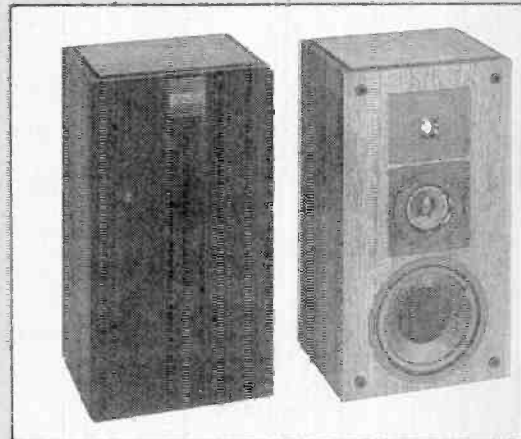
Onkyo Remote-Controlled Cassette Deck



Advent Outdoor Loudspeaker



Recoton Videotape Splicer



Altec Lansing 3-Way Loudspeaker

ELECTRONICS WISH LIST

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

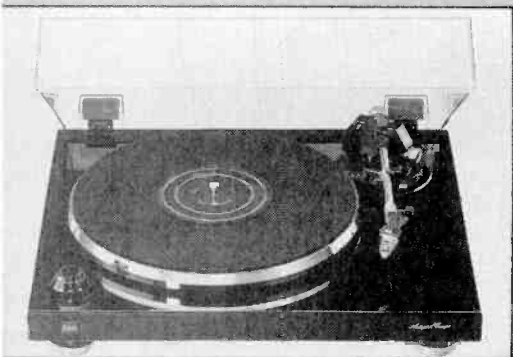


Markdesign Aquatic Personal Radio

Aquatic Personal Radio

Up to now, the swimmer has been unable to enjoy the same boredom-relieving audio entertainment available to dry-land exercisers. With *The Band FM Headband Radio* from *Markdesign Inc.* (Stamford CT 06905) the swimmer can join the exercising audio-buff crowd. It offers FM radio through built-in speakers, all encased in a foam-rubber band that fits snugly around the head. The radio rides at the nape in the elastic band. Each speaker, as well as the band itself, is adjustable. The Band is guaranteed waterproof to a depth of 10 feet and the manufacturer warns that users should not dive into the water while wearing it. But for someone with 100 laps to swim before breakfast it's one answer to the audio boredom of exercise. Price: \$40.

CIRCLE 64 ON FREE INFORMATION CARD

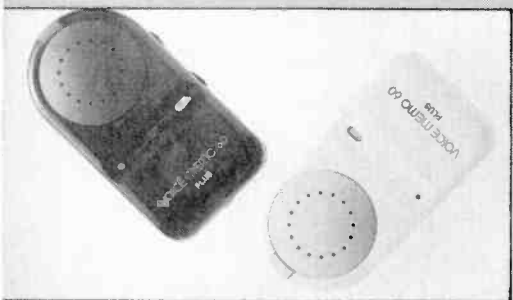


Ortofon Deluxe Turntable

Deluxe Turntable

The deluxe stereo-component field is a world of class and top workmanship, a pair of attributes that *Ortofon Inc.* (122 Dupont St., Plainview, NY 11803) says it has brought together in its new *Dual Turntable (CS7000)*. The company says the acoustic characteristics of the unit's "tonearm tube" have been "improved significantly with internal damping made of proprietary composite material and with gold plating which reduces resonance sensitivity of the tube itself." The turntable also features a unique Optimum Pivot, a gyroscopic-gimbal tonearm system, a carbon-fiber headshell, and a high-quality phono cartridge. The tonearm stays in balance even when the turntable is off-level, and the system "greatly reduces" wow and flutter problems. The black wooden base adds to the acoustic quality and a 24-carat gold-plated finish adds to the classy look. Price: \$750.

CIRCLE 65 ON FREE INFORMATION CARD

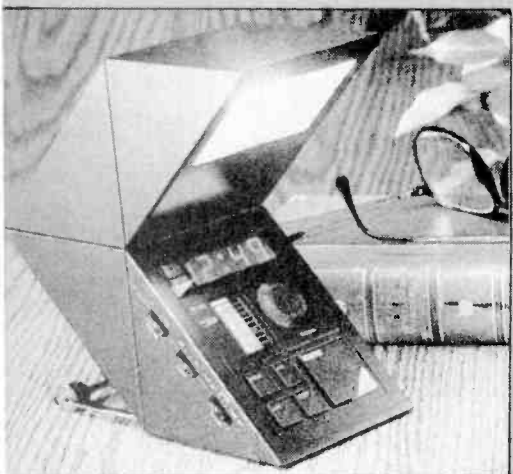


Plus U.S.A. Electronic Voice Memo

Electronic Voice Memo

The mind is often a cluttered place, with a multitude of thoughts zipping and darting around. The *Voice Memo* from *Plus U.S.A. Corp.* (3 Reuten Drive, Closter, NJ 07624) offers a way to capture and organize random thoughts that might come in useful later. A follow-up to the company's "wildly successful" original, the *Voice Memo* resembles an item from the *Starship Enterprise*, and allows its user to capture a 60-second message, play it back, and re-record another message over it, "all without ever having to rewind, search, or put in a new tape." Also, when the unit completes one cycle the endless magnetic tape cues up again for another message round. It also features a microphone switch, volume control, and an alarm that signals the end of each 60-second interval. Available in black or white. Price: \$39.95.

CIRCLE 66 ON FREE INFORMATION CARD



Haverhills Clock-Radio/Reading Light

Children's Flashlight

There are plenty of flashlights around, but this one is special. It's made just for kids and features beams of red, green, or white light so that children can enjoy it as a plaything. The *Flashlight* is made by *Playskool* (1027 Newport Ave., P.O. Box 1059, Pawtucket, RI 02862) and is fabricated of durable plastic with a sturdy vinyl rim. If left unattended for more than 30 seconds it will shut off automatically, saving batteries. Price: \$10.99

CIRCLE 67 ON FREE INFORMATION CARD

Clock Radio/Reading Light

Another entry in the multi-purpose electronic-product market is the *Z-Lite Clock Radio*, available from *Haverhills* (131 Townsend St., San Francisco, CA 94107). It features a high-intensity swivel light combined with an AM/FM radio. The radio has a quartz digital clock with an LED display and a dimmer switch, an alarm switch, and a backup battery so it will play even in the event of a power failure. The 9-volt battery power source (not included) makes the whole unit portable. Price: \$49.95.

CIRCLE 68 ON FREE INFORMATION CARD

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

ELECTRONICS WISH LIST

Volume-Control Unit

This item, the audio equivalent of a light-dimmer switch, can be placed either on top of a table or below a counter top. The *Stereo Volume Control (VC50B)* from *Sonance* (32992 Calle Perfecto, San Juan Capistrano, CA 92675) employs modular construction and strip-terminal connectors mounted on a printed-circuit board. It is suitable to control the output of any amplifier rated at 50-watts per channel or less. Price: \$99.

CIRCLE 69 ON FREE INFORMATION CARD

Satellite-TV Remote Control

For people "who don't like a lot of bells and whistles on their consumer electronics products," the *E-Z View Remote Control* is "ideal," according to manufacturer *R.L. Drake Co.* (P.O. Box 112, Miamisburg, OH 45342). Designed for use with one of the company's new Series 2 line of IRD units, it's a simplified unit that operates all the essential functions including antenna movement, channel, satellite and volume. It comes with a pad of 72 pre-printed labels, 24 function keys and has a range of 30 feet. Price: \$54.95.

CIRCLE 70 ON FREE INFORMATION CARD

Electronic Baseball

Sometimes sounds are as important as sights at a sporting event, and audio can make an important difference in video games as well. The *Starting Lineup Talking Baseball* game by *Parker Brothers* (50 Dunham Road, Beverly, MA 01915) includes a play-by-play announcer, the roar of the crowd, and the crack of the bat as the game progresses. It utilizes a patented speech technology to make players feel as if they're right next to the diamond. It has 10,000 sentences and up to 250,000 play combinations with 15,000 possible outcomes. Built on statistics from superstars of different eras, it allows confrontations between Sandy Koufax and Babe Ruth, Ron Guidry and Lou Gehrig. Players control managerial decisions or can jump in and play themselves. Parker Brothers thinks those features make it "the most advanced electronic baseball game to come on the toy market." Batter up! Price: \$99.95.

CIRCLE 71 ON FREE INFORMATION CARD

Graphic Equalizer

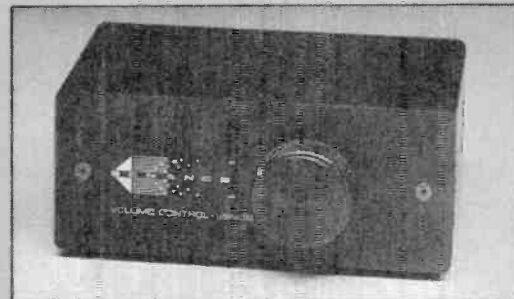
Tonal balance is an important element in any audio system and *Yamaha Electronics USA* (6722 Orangethorpe Ave., Buena Park, CA 90620) says its *10-Band Graphic Equalizer (EQ-330)* permits precise adjustments for "any desired balance." The company says the model is designed for the audio buyer who is purchasing a signal processor for the first time. It can be easily inserted into a system and features an output control so the unequalized and equalized signals can be matched in volume for convenient operation. The output level is shown via a fluorescent display. Price: \$179.

CIRCLE 72 ON FREE INFORMATION CARD

Car Stereo Cassette/Receiver

On-the-road and behind-the-wheel audio performance keeps improving, as evidenced by the *Cassette/Receiver (XR-1604)* from *Sherwood* (13845 Artesia Blvd., Cerritos, CA 90701). It features a full-logic auto-reverse system, Dolby-B and -C noise reduction, and automatic metal-tape switching. The unit also features automatic music search, automatic and manual mono/stereo switching, fader-amp and pre-amp, 2-channel/4-channel switch, CD-input jack in front, and switchable dual illumination. Price: \$399.95.

CIRCLE 73 ON FREE INFORMATION CARD



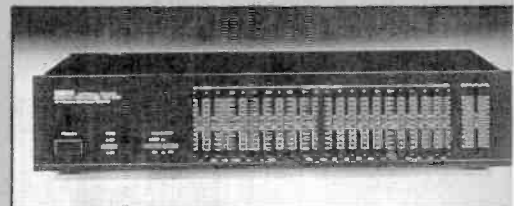
Sonance Audio-Volume Control



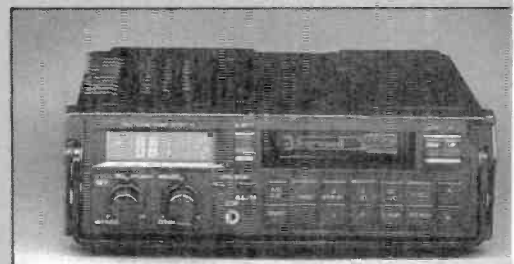
R.L. Drake Satellite-TV Remote Control



Parker Brothers Electronic Baseball



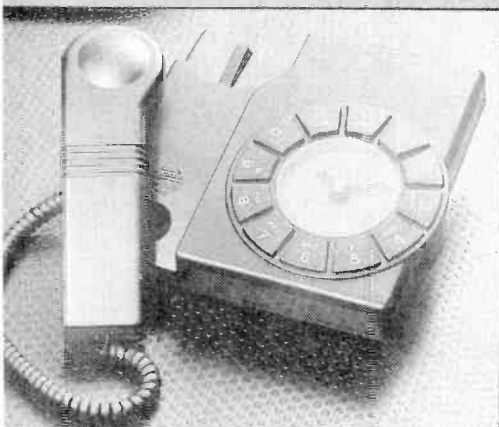
Yamaha 10-Band Graphic Equalizer



Sherwood Car Stereo Cassette/Receiver

ELECTRONICS WISH LIST

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

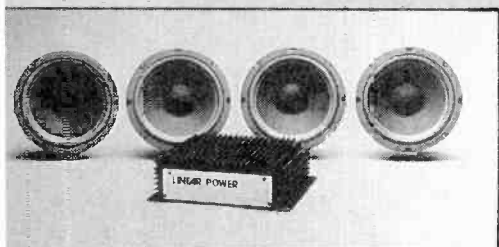


Canetti Clock/Telephone

Clock Telephone

Ever lose track of the time when you're on the phone? The *PhoneClock* by *Canetti, Inc.* (230 Fifth Ave., New York, NY 10001) combines a standard clock with a touch-tone keypad arranged like a rotary dial, allowing it to do double-duty as the analog-style clock face. Telephone features include last-number redial and music on hold. The clock features battery-powered quartz movement. Besides being handsomely functional, it could cut down on unanticipated long-distance charges. Price: \$85.

CIRCLE 74 ON FREE INFORMATION CARD



Linear Power Auto Subwoofer System

Auto Subwoofer System

If you have fought the "battle of the box" with your car-stereo system, *Linear Power* (11545 D Avenue, Auburn, CA 95603) thinks it has a solution: The closed-loop *Servo-Subwoofer (1752S)*. It works completely independently of its enclosure, removing the constraints that space problems sometimes impose on bass response. Its information comes from one of three sources: the head unit of the radio, tape, or CD. It gives only one signal to the amp, and the woofers move, adjusting to whatever shape the enclosure is. The company says it will, therefore, "produce a perfect bass response in every car." Price: \$1,500.

CIRCLE 75 ON FREE INFORMATION CARD

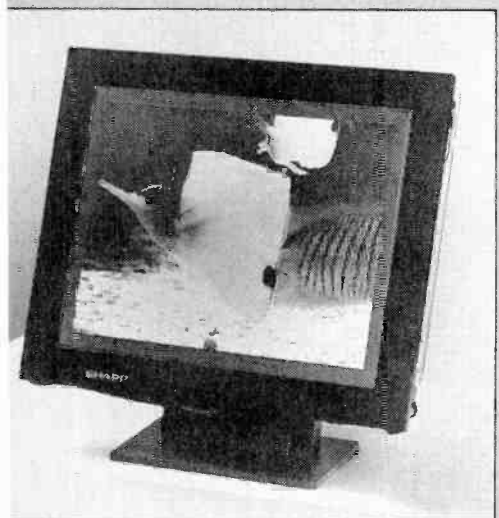


Timex Exercise Wristwatch

Exercise Wristwatch

Exercise buffs demand timepieces that not only give them the time, but can give them their times. Enter the *Aerobix Wristwatch* from the venerable *Timex Corp.* (P.O. Box 2126, Waterbury, CT 10672), a "sports specific" model featuring 7 preset countdown timers—6 for exercise segments and a pulse calculator. The 6 countdown timers are geared for exercise periods of 1, 5, 10, 20, 30, and 60 minutes. The watch, available in five different colors, also has a Velcro closure for easy removal and a top-mounted push button for ease of operation. Enclosed in a durable resin case, the *Aerobix* is water resistant to a depth of 25 meters. Price: \$24.95.

CIRCLE 76 ON FREE INFORMATION CARD



Sharp 14-Inch LCD TV

Video Handbook

To help keep consumers abreast of the ever-changing world of video, *Maxell Corp. of America* (22-08 Route 208, Fairlawn, NJ 07410) has updated its *Maxell Video Tape Handbook*. The 60-page book offers current information about everything from camcorders to the S-VHS format to new video technology from around the world. It is available by sending a self-addressed, stamped #10 envelope with \$.75 postage to Maxell Product Guide Offer, P.O. Box 4686, Reidsville, NC 27322. Price: free.

CIRCLE 77 ON FREE INFORMATION CARD

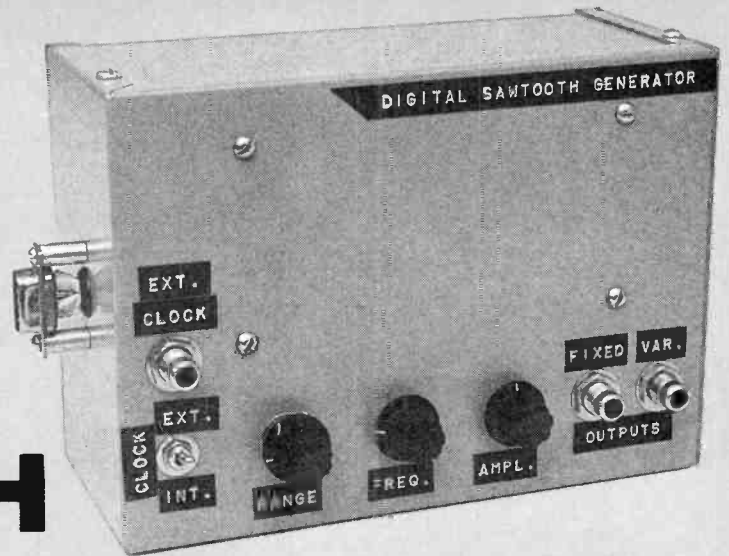
Fourteen-Inch LCD TV

The long-awaited flat TV, suitable for wall-hanging, took another step toward the consumer-electronics marketplace this year with the unveiling of a *14-Inch LCD TV*, measuring a mere 1-inch thick, by *Sharp Electronics Corp.* (Sharp Plaza, Mahwah, NJ 07430). No information is available regarding its actual market introduction date, but the prototype unit is the largest LCD-style set yet seen. Price: Not available.

CIRCLE 78 ON FREE INFORMATION CARD

Add this sawtooth generator to your collection of electronics test gear.

DIGITAL SAWTOOTH GENERATOR



BY JOSEPH J. CARR

Sawtooth signal generators are used for a variety of electronics applications: For example, in electronic music synthesizers, in audio-signal generators, and in voltage-controlled oscillators (VCO's). They are also used to sweep RF circuits, and used in calibrating oscilloscopes, as well as in other similar applications.

In addition, there are many circuit applications for embedded sawtooth generators. For example, situations where the sawtooth is used to provide precision calibration of an oscilloscope timebase. If a sawtooth generator (one controlled from a stable crystal oscillator) is used to sweep an oscilloscope horizontally, then a very precise sweep rate is possible.

The "standard" solid-state sawtooth generator consists of a Miller integrator op-amp circuit excited by a square-wave. But there are problems with such circuits. Figure 1 helps to illustrate part of the problem with standard, op-amp based, sawtooth-generator circuits. As can be seen, the waveform has two principal defects. First, the positive-going edge of the waveform (T1-T2) is not linear; note the slight curvature in the waveform.

The curvature is due to capacitor charge/discharge in the original design, causing the ramp to take the shape of a normal capacitor-charge waveform. What is needed is a linear ramp; *i.e.*, one that rises as a straight line.

The second defect lies in the waveform's fall-time: it's too long. The use of a few low-cost digital components—as in the *Digital Sawtooth Generator*

described in this article—produces a more perfect sawtooth waveform.

The circuit provides two outputs; a fixed, positive-going output of about 1.5 volts and a variable, positive-going output of 0 to 5 volts.

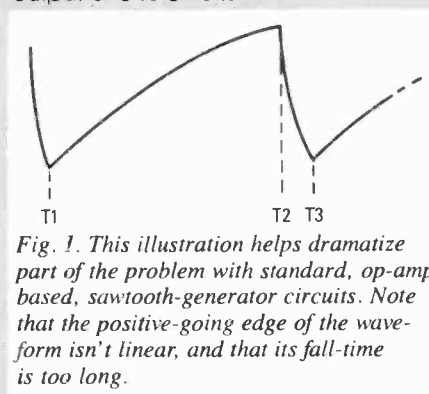


Fig. 1. This illustration helps dramatize part of the problem with standard, op-amp based, sawtooth-generator circuits. Note that the positive-going edge of the waveform isn't linear, and that its fall-time is too long.

Circuit Description. Figure 2 shows the schematic diagram of the Digital Sawtooth Generator. The circuit, built around several integrated circuits, has at its heart a DAC0806 (U1). The DAC0806 is an eight-bit monolithic Digital-to-Analog Converter, or DAC, featuring a full-power output-settling time of 150 nanoseconds. It dissipates only 33 mW when operating from a ± 5 -volt power supply.

When power is applied to the circuit, U4 (a 555 oscillator/timer, which is configured as an astable multivibrator) begins to oscillate at a frequency determined by the range capacitor (selected via S2), R3, R4, and R12. The actual clock frequency is given by:

$$f = 1.44 / [R3 + R12 + 2R4]C$$

where f is frequency in hertz (Hz), C is capacitance in farads, and R3, R4,

and R12 represent resistance in ohms. Select a clock frequency that is 256 times the desired fundamental sawtooth frequency.

Note: The values shown in the schematic for the range capacitors (C7, C9, C11, and C12) are a starting point only. The level of capacitance required for a given range should be calculated using:

$$C = 1,000,000 / (6.28 \times R3 \times f)$$

where C is capacitance in microfarads, f is the -3-dB cut-off frequency in hertz (Hz), and R3 is resistance expressed in ohms.

The output of U4—a chain of pulses with an amplitude of about +4 volts—is fed to the clock input of U2 (a 7493 4-bit binary counter) at pin 14, which provides four bits of the 8-bit word fed to U1. A tap on the pin 11 output of U2 feeds a portion of that output to the clock input of U3 at pin 14, forming the other four bits of the 8-bit input to U1. Integrated circuit U1, in turn, outputs a current that's proportional to the reference voltage and the *binary word* applied to its digital inputs. The controlling function for U1 is:

$$I_o = I_{ref} \times (A/256)$$

where I_o is the output current (at pin 4), I_{ref} is the reference current applied to pin 14, and A is the decimal value of the binary word applied to the eight binary inputs (pins 5 through 12) of U1.

The reference current (which can be calculated using Ohm's Law) is the quotient of the reference voltage and the series resistor at pin 14. In data-acquisition systems, the reference is

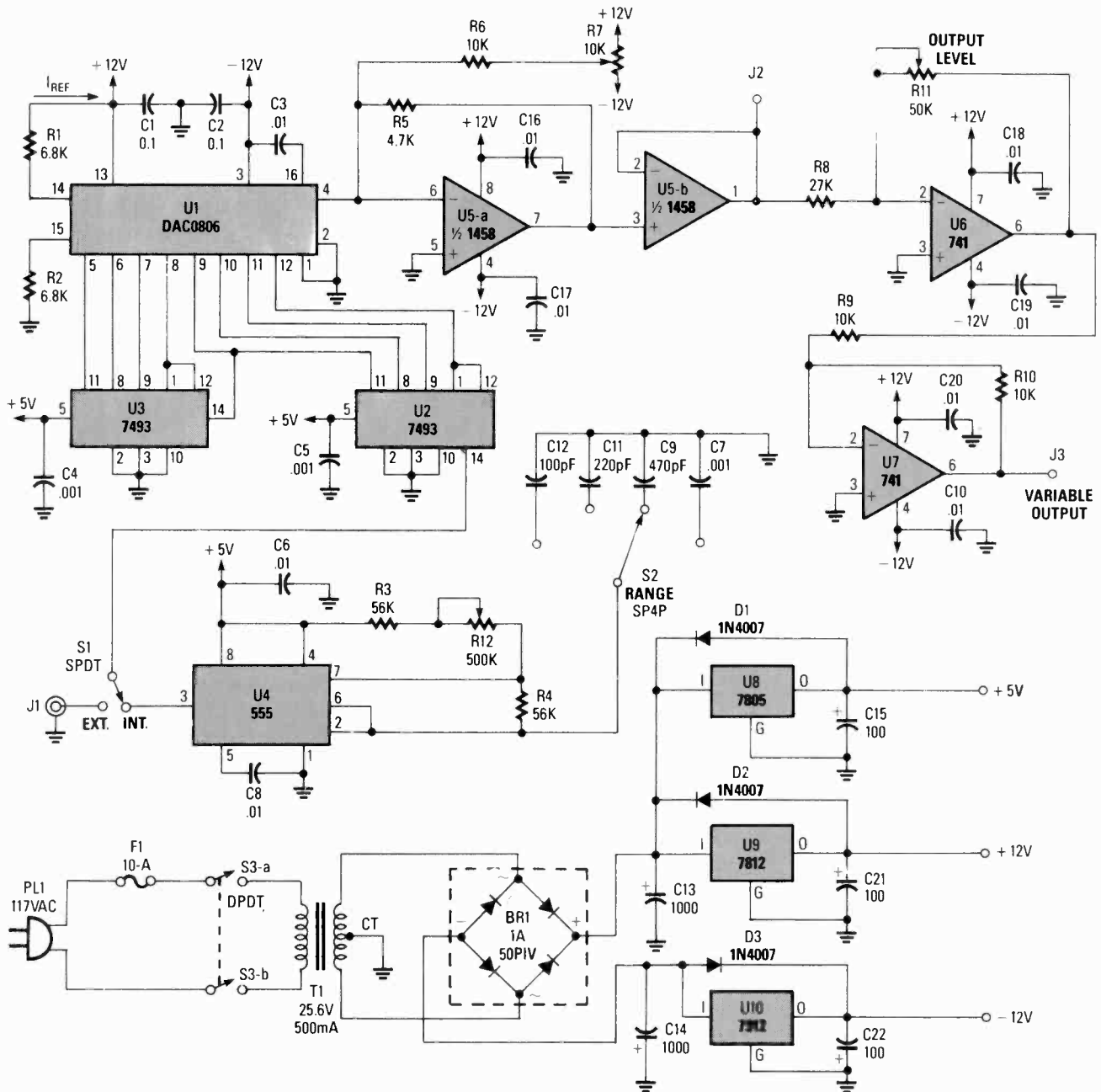


Fig. 2. Here is the schematic diagram of the Digital Sawtooth Generator, the heart of which is a DAC0806 eight-bit monolithic digital-to-analog converter, or DAC.

usually a precision, regulated voltage. But in this case, we do not need the precision, so the +12-volt supply is substituted as the reference. Hence, the reference current is equal to the supply voltage divided by R1 (or 12/6800).

With the value of R1 shown, I_{ref} is 0.0018 amp, or 1.8 mA. Values from 500 μ A to 2 mA are permissible with the DAC0806. If you elect to change the reference current, be sure to keep R1 equal to R2. The reference current sets the maximum value of output current, I_o . When a full-scale binary word (11111111) is applied to the binary inputs, the output current is:

$$I_o = 1.8 \times (255/256)$$

$$I_o = 1.8 \times 0.996$$

$$I_o = 1.78 \text{ mA}$$

The output of U1 is fed to a current-to-voltage converter—which is built around a 1458 dual op-amp (U5) that's configured as an inverting follower without a input resistor—to provide a sawtooth voltage. The output voltage (V_o) rises to a value of $I_o \times R5$.

The waveform produced by the circuit has a period of about 5 milliseconds (200 Hz), and an amplitude of about 3 volts. The actual output waveform is "staircased" in binary steps that

are equal to the Least-Significant Bit (LSB) current or voltage of U1. The LSB is the smallest change in output voltage caused by flipping the LSB either from 0 to 1, or 1 to 0.

Because the circuit will see a lot of different applications in my shop, S1 is included in the circuit to allow easy selection between the internal and an external clock. That switch is optional, however, and may be eliminated if desired.

Other Waveforms. The Digital Sawtooth Generator can output almost any waveform by applying the right binary word(s) to the digital inputs

PARTS LIST FOR THE DIGITAL SYNTHESIZED SAWTOOTH GENERATOR

SEMICONDUCTORS

- U1—DAC0806 8-bit digital/analog converter, integrated circuit
- U2, U3—7493 4-bit binary counter, integrated circuit
- U4—555 oscillator/timer, integrated circuit
- U5—LM1458 dual op-amp, integrated circuit
- U6, U7—LM741 op-amp, integrated circuit
- U8—7805 5-volt, 1-amp, positive-voltage regulator, integrated circuit
- U9—7812 12-volt, 1-amp, positive-voltage regulator, integrated circuit
- U10—7912 12-volt, 1-amp, negative-voltage regulator, integrated circuit
- D1—D3—1N4007 1-amp, 1000-PIV, rectifier diode
- BR1—1-amp, 50-PIV, full-wave bridge rectifier

RESISTORS

(All resistors are 1/4-watt, 5% units, unless otherwise noted.)

- R1, R2—6800-ohm
- R3, R4—56,000-ohm
- R5—4700-ohm
- R6, R9, R10—10,000-ohm
- R7—10,000-ohm, trimmer potentiometer
- R8—27,000-ohm
- R11—50,000-ohm, potentiometer
- R12—500,000-ohm, potentiometer

CAPACITORS

- C1, C2—0.1- μ F, ceramic disc
- C3, C6, C8, C10, C16—C20—.01- μ F, ceramic disc
- C4, C5, C7—.001- μ F, ceramic disc
- C9—470-pF, ceramic disc
- C11—220-pF, ceramic disc
- C12—100-pF, ceramic disc
- C13, C14—1000- μ F, 35-WVDC, electrolytic
- C15, C21, C22—100- μ F, 35-WVDC, electrolytic

SWITCHES

- S1—SPST toggle switch
- S2—SP4P rotary switch
- S3—DPDT toggle switch

ADDITIONAL PARTS AND MATERIALS

- T1—25.6-volt, 500-mA, center-tapped power transformer
- PL1—117-volt AC line cord with molded plug
- F1—10-amp fuse
- Perfboard, enclosure, IC sockets, knobs, wire, solder, hardware, etc.

of U1. Because a sawtooth waveform was needed, U1's inputs were connected to the outputs of an eight-bit binary counter built from a pair of 7493 TTL 4-bit binary counters.

The function of the counter is to increment U1 in steps from 00000000 to

11111111 under control of a clock signal applied to its pin 14 input. You could use any eight-bit counter that outputs a TTL-compatible signal in place of the 7493 devices. The 7493 was selected for the best of all engineering reasons: I had a pair of them in my junk box.

If you want a triangle waveform, then it is possible to replace the 7493 counters with two up/down counters, as indicated in Fig. 3. Arrange the digital control logic to reverse the direction of the count when the maximum state (11111111) is sensed. Since that design was not needed, we did not work out the required circuitry. As such, we'll leave that as an exercise for the enterprising reader.

There are two ways to generate waveforms other than a sawtooth or triangle, and both of them involve

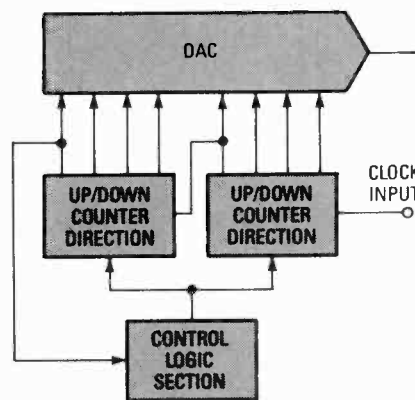


Fig. 3. The two 7493 binary counters can be replaced by a pair of up/down counters to produce a triangle-wave output. The control logic should be configured to reverse the direction of the count when the maximum count is sensed.

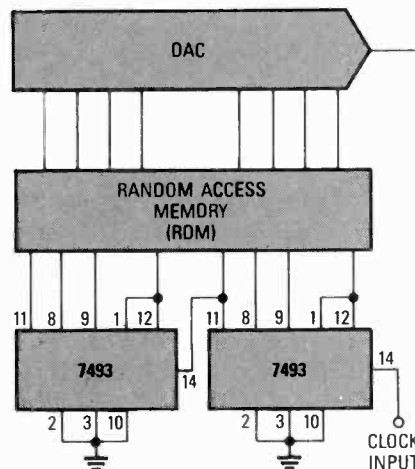


Fig. 4. Another signal-generating scheme uses a random-access memory to store the bit pattern put out by the counters. Then the bit pattern can be output to the DAC in the proper sequence to produce the desired waveform.

using a computer memory to store the binary bit-pattern representing the waveform (see Fig. 4), and then outputting that data in the proper sequence. The first of those memory-oriented methods uses a read-only memory (ROM), which is pre-programmed with the bit pattern that represents the desired waveform. A binary counter, connected as an address generator, is then used to select the bit-pattern sequence.

In the second scheme, the bit pattern is stored in a computer and output under program control via an eight-bit parallel output port. That method is suitable for both generating special waveforms, and for linearizing the tuning characteristic of circuits, such as VCO's, swept oscillators, etc.

The solution to the linearization problem involves storing a look-up table in either a ROM or computer memory—a system that I learned in a laboratory where it was once used to linearize low-level pressure transducer measurements. Interfacing a computer output (assuming that you have an 8-bit parallel port available) is simple: Connect the output of the computer directly to the input of U1.

Construction. The Digital Sawtooth Generator was built into a standard, gray utility box, but any suitably sized enclosure will suffice. Because the circuit operates at a relatively low frequency, there are no unique layout problems to contend with.

The prototype was assembled on perfboard, and the interconnections between the components was accomplished using point-to-point wiring techniques. You can build as many ranges into the circuit as needed (with-in reason, of course). For instance, a 12-position rotary switch would allow for 12 ranges, rather than the four shown in Fig. 2.

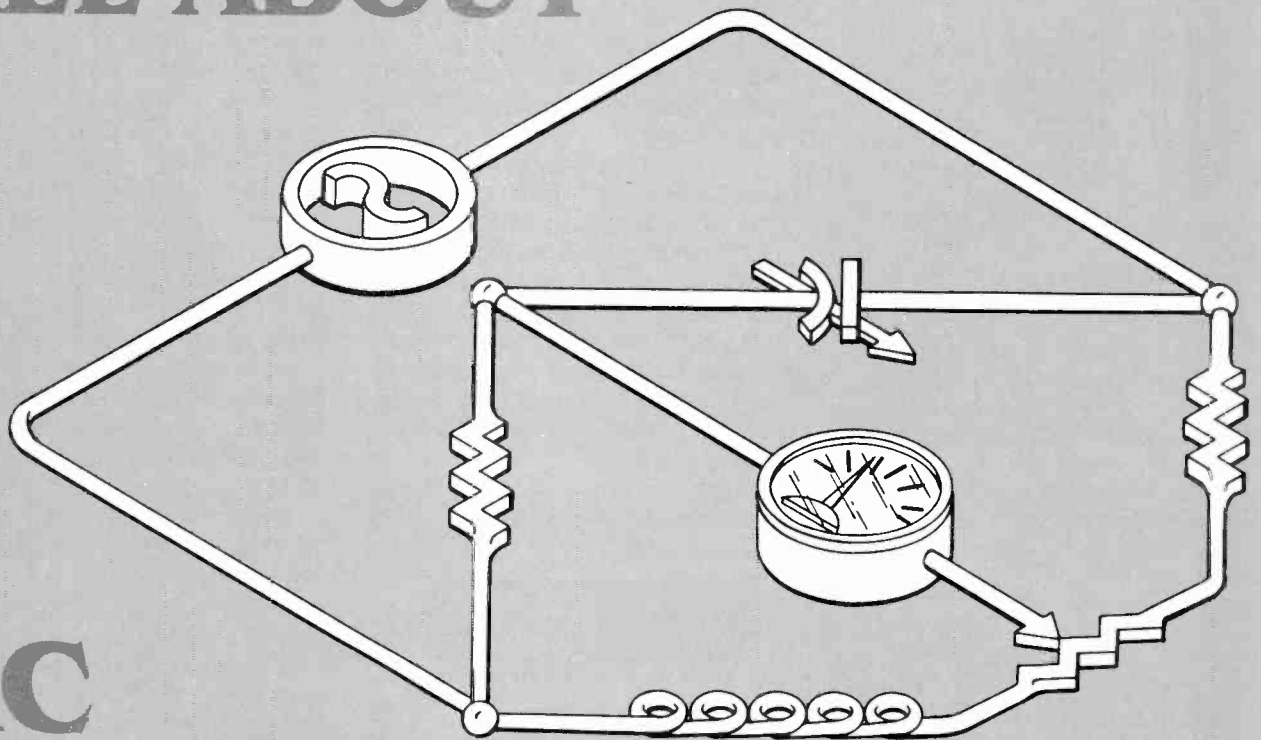
In the author's prototype, the individual capacitors were mounted directly to RANGE switch S2, which is located on the front panel. In order to create precise frequencies, it is possible to produce any capacitance value by connecting two or more units in parallel. (Just remember, however, that capacitors in parallel add like resistors in series.)

The prototype uses a fixed unit in parallel with a 6- to 70-pF ceramic trimmer capacitor. That tactic allowed me to set a specific frequency. If only a

(Continued on page 105)

ALL ABOUT

AC BRIDGES



BY WALTER W. SCHOPP

These bridges do not cross any rivers, but a complete understanding of how they work can add a lot to your electronic-design creativity

As common as dirt, DC-bridge circuits are very useful and have been around for many years. Anyone who has taken a course in basic electronics is familiar with DC-bridge circuits, since such circuits are usually analyzed quite thoroughly in texts. You may have seen many yourself, but when was the last time you built or even saw an AC-bridge circuit? Even in texts, AC bridges are examined vaguely, if at all, and leave a lot of unanswered questions. Although everyone familiar with electronics knows something about them, there are few hobbyists that design projects containing them. You may even hear horror stories from the few that try to use them, but find them too difficult to balance. Because of such stories and a lot of misinformation, bridges are often overlooked as a possible solution for special problems.

The truth is that they are often contained in electronic products, but hard

to recognize. The circuits are hard to recognize because one of the components of the bridge is used as a sensor and is often placed at a remote location. When positioned away from the rest of the bridge, the sensor is used to detect small changes in its environment that cause changes in its value.

What They Can Do. Of course, the kind of changes a sensor detects depends on the sensor. For instance, changes in a resistor's resistance caused by varying heat dissipation can track the temperature of a cooling medium that it is placed in. Air-dielectric capacitors can be used to sense gases that have a different dielectric constant than that of air. Inductors can be used to sense small magnetic-field changes.

Almost any physical change can be sensed with some type of component placed in a bridge. But why should we place the sensor in a bridge circuit

instead of just measuring its value directly? Well, there are times when we must measure tiny changes in a component's value, and a delicately balanced bridge responds strongly to even small changes. That means that just placing a component in a bridge circuit is almost like amplifying the changes in its value. Also, by using two elements of a bridge as sensors, the sensitivity of the bridge can be even further enhanced.

Some Review. To get started let's review the simple DC-bridge circuit (i.e. a bridge containing resistances only), as shown in Fig. 1. The circuit contains four "legs" of equal value. The top-left leg consists of the left portion of R_5 (we'll denote it $R_{5_{\text{eff}}}$) and R_1 , let's call that leg R_A . Another way of putting that is:

$$R_A = R_1 + R_{5_{\text{eff}}}$$

The top-right leg consists of the right

portion of R5 (we'll denote that R5_{right}) and R2, let's call that leg R_B, so:

$$R_B = R_2 + R_{5_{\text{right}}}$$

The bottom two legs are just R3 and R4.

The bridge's operation is simple if you recall a little about Ohm's Law and voltage dividers. It can be seen that R_A and R3 form a voltage divider across the applied power. Resistors R_B and R4 form another voltage divider across the same supply.

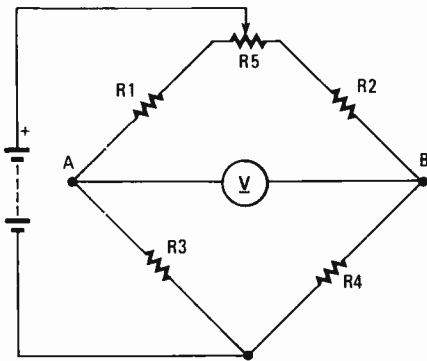


Fig. 1. The simple adjustable DC bridge shown here, is thoroughly covered in most texts, while its AC counterpart receives little attention.

By definition, for the bridge to be in the "balanced" state, R5 must be adjusted so that the voltages at points A and B are equal. If the voltages at those points are equal, then no current flows through the meter because there is no potential difference (voltage) across it. Note that that doesn't mean that current will not flow through the resistors; it just won't flow through the meter.

Let's call the current that flows down through node A I_A. All current through A must flow through R3 as well, since none of it can flow through the meter. So, by Ohm's Law, the voltage at A (V_A), which is the voltage drop across R3, is:

$$V_A = R_3 I_A$$

Similarly, if the current through B is I_B, the voltage at B would be:

$$V_B = R_4 I_B$$

Now, the condition we started with—that the voltages at A and B are equal—allows us to say:

$$R_3 I_A = R_4 I_B$$

Rearranging we get:

$$R_3/R_4 = I_B/I_A \text{ (eq.1)}$$

By Kirchoff's Voltage Law the voltage of the battery, must equal the sum of the voltage drops across R3 and R_A.

The voltage of the battery, must also equal the sum of the voltage drops across R4 and R_B. The voltage drop across R_A is R_AI_A, and the voltage drop across R_B is R_BI_B. Setting the sum of the voltage drops for each voltage divider equal to one another we get:

$$V_A + R_A I_A = V_B + R_B I_B \text{ (eq. 2)}$$

By our initial condition:

$$V_A = V_B$$

so we can eliminate those voltages from equation 2 to get:

$$R_A I_A = R_B I_B$$

Rearranging that into a more useful form, we get:

$$R_A/R_B = I_B/I_A$$

Note that we can set that resistor ratio equal to the one given in equation 1 to get:

$$R_A/R_B = R_3/R_4 \text{ (eq. 3)}$$

Which has another useful form:

$$R_A/R_3 = R_B/R_4 \text{ (eq. 4)}$$

What all that means is that balancing occurs when R5 is adjusted so that equation 3 (and thus equation 4) is true.

However, we can get even more specific about the parts values for the balanced condition. For instance, if we set R_A equal to R_B, equation 3 becomes:

$$1 = R_3/R_4$$

Which can be rewritten as:

$$R_4 = R_3$$

Put succinctly, balance occurs if R_A = R_B, and R4 = R3. If we instead set R_A equal to R3, equation 4 becomes:

$$1 = R_B/R_4$$

Which can be rewritten as:

$$R_4 = R_B$$

So another balanced state exists when R_A = R3, and R4 = R_B. Of course you can meet both sets of conditions for balance if:

$$R_A = R_B = R_3 = R_4$$

The variable resistor, R5, is used to balance the bridge against small tolerance variations in the resistors values. That balance control can also be put at points A (see Fig. 2) or B of the bridge.

If, after the bridge is adjusted for balance, any leg of the bridge is changed, the voltage across the

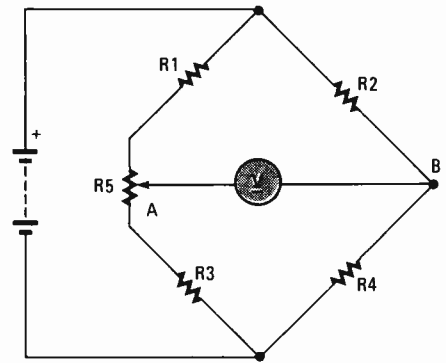


Fig. 2. Having the adjustable resistor at one of the meter connection points allows you to adjust the bridge for a zero reading without changing the current flowing through either leg.

meter will change, causing it to give a reading. A meter is shown as the read-out device in the drawings, but usually the output points (A and B) are connected to the inputs of a differential amplifier before readout. By the way, the AC source must have its zero-voltage level at ground if you are using a dual-supply amplifier to condition the signal for the readout device.

Let's summarize the three conditions that can lead to balance that we've derived. First, having:

$$R_A = R_B, \text{ and } R_4 = R_3$$

will lead to balance, or having:

$$R_A = R_3, \text{ and } R_4 = R_B$$

will also balance the bridge, and fulfilling both sets of conditions will mean:

$$R_A = R_B = R_3 = R_4$$

Now that we have the ground rules covering the basic DC-bridge circuit, we can analyze the AC versions of the bridge.

General AC Bridges. Before we start discussing the AC bridge containing capacitance and/or inductance, we must learn a few new terms. Ideal capacitors and inductors represent *reactance* in an AC circuit instead of resistance. Reactance is the AC version of "resistance," and it is expressed in ohms.

Impedance is another new term. It is used to describe the total combined effect of reactance and resistance in some portion of a circuit and is expressed in ohms. Capacitors and inductors in the real world contain both resistance and reactance, so we talk about them having impedance instead of just reactance.

Since the legs of AC bridges may

contain both reactances and/or resistances, we'll talk about a leg's impedance instead of its resistance. In fact, resistance and impedance are so similar, the conditions for balancing an AC bridge are the same as a DC bridge, we just put an impedance (represented by a Z) in place of each resistance. That will give us very general equations we can apply to any circuit. Starting with the first conditions, having:

$$Z_A = Z_B, \text{ and } Z_4 = Z_3$$

will lead to balance, or having:

$$Z_A = Z_3, \text{ and } Z_4 = Z_B$$

will also balance the bridge, and fulfilling both sets of conditions will mean:

$$Z_A = Z_B = Z_3 = Z_4$$

However, there is one important distinction between AC and DC bridges: Elements containing reactance—capacitors and inductors—introduce what is called a "phase shift" to the incoming signal. That means that peaks in current do not occur at the same time as peaks in voltage, as they would in a purely resistive circuit. A phase shift in only one leg of an AC bridge will make balancing the bridge impossible. That is why active components, are used in pairs; so the phase change is the same for both bridge outputs.

Measuring Capacitance. If we wish to measure small changes in capacitance, we can use a bridge circuit such as the one shown in Fig. 3. Since a resistor's impedance is purely resistive and a capacitor's impedance is

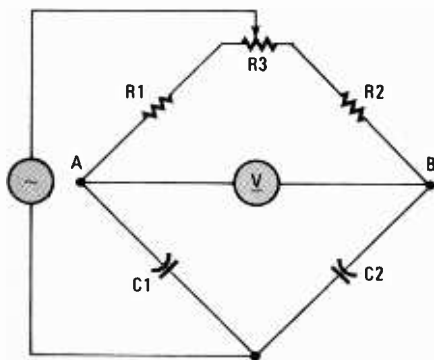


Fig. 3. AC bridges are rather useful for measuring component values such as capacitance. If one of the capacitors here was under test, its value could be calculated for by using the value of the fixed components and the value of R3 needed for a null reading.

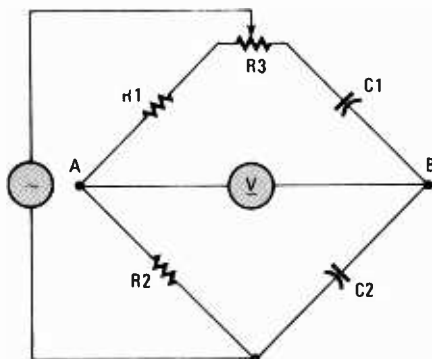


Fig. 4. The problem with this bridge is that one end of the meter would be AC coupled. The meter must, of course, be an AC type to be of use here.

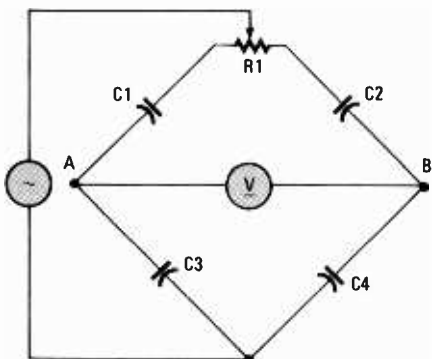


Fig. 5. A capacitance bridge can be used for very accurate measurements of capacitance or even ion detection.

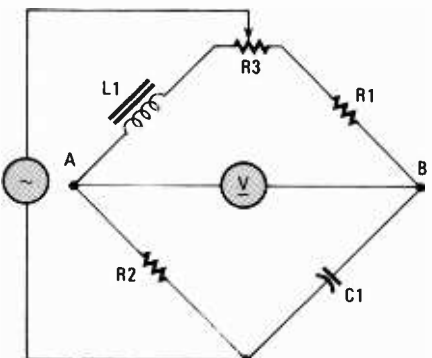


Fig. 6. Bridges containing both inductors and capacitors can only be balanced if the left and right halves have equal but opposite phase shifts.

almost totally reactive, the impedance of the upper branches cannot equal that of the lower branches. That means that the second set of conditions for balance ($Z_A = Z_3$ and $Z_4 = Z_B$) cannot be met. The third conditions for balance cannot be met either. However, the first conditions ($Z_A = Z_B$ and $Z_3 = Z_4$) can be met. The impedance Z_A is composed of R1 and a portion of R3, while the impedance Z_B is composed of R2 and a portion of R3. The impedance Z3 is the impedance of C1, while Z4 is the impedance of C2. As

long as $C_1 = C_2$ and any difference between R1 and R2 is adjusted for by R3, then the bridge will be balanced.

The impedance of active components, such as resistors and capacitors is frequency dependent. But the circuit in Fig. 3 is frequency independent since the reactances of C1 and C2 will change in unison if the frequency changes.

Another version of the same bridge is shown in Fig. 4. The circuit balances under the second conditions for balance. Although it works quite well, it is not a popular version of the circuit because of the DC isolation of only one side of the meter (at point B). If there is a DC component from the source, it will cause undesirable results. Also it can be difficult to bias a meter-input amplifier connected to point A without changing the signal level at A.

An all-capacitor bridge can be constructed as shown in Fig. 5. The same three sets of conditions for balance can apply to the circuit. Let's examine the first condition ($Z_A = Z_B$ and $Z_3 = Z_4$). Since the reactance of pairs C1/C2 and C3/C4 will vary identically with changing frequency, the balanced state is frequency independent. That is also true for the third condition ($Z_A = Z_B = Z_3 = Z_4$).

The other variation is that C1 and C3 are equal, and C2 and C4 are equal. With that condition met and the input frequency adjusted for equal phase shift at points A and B, balance can be achieved. That, however sacrifices frequency independence.

No matter which conditions for balance we design our circuit to maintain, any variation in one of the capacitors will produce an AC-voltage output between points A and B. Since both points are equally isolated from the AC power source, connection to the high-impedance input of a differential amplifier is fairly simple.

Mixing Active Elements. Both inductors and capacitors can be used in a bridge circuit, see Fig. 6. Up to now, the sign of the phase shift of active elements has not required consideration. But while inductors and capacitors both cause phase shift, capacitors have a positive phase shift, and inductors have a negative phase shift. So, if an inductor is placed in one leg of the bridge, a capacitor should be placed in the opposing leg (unless you wish to use another inductor in an adjacent

(Continued on page 102)



ARCHER PROFESSIONAL SOLDERING STATION

A thrifty way to step-up to professional soldering for any hobbyist!

Here is a short scenario that occurs all too often; imagine an experimenter like you telling the story:

"The other evening I set up the bridge table to do some repair work on a 1950-vintage radio that I purchased at a flea market the previous weekend. Some soldering would be required, so I got out my trusty soldering iron and screwed in a 25-watt tip. I rested it on an old metal ash tray I equipped with a make-shift holder that worked most of the time. Then I wet a small sponge and dropped it in a ceramic saucer that I procured just for when I solder. I unplugged a lamp and used its extension cord to power up the iron. Now I was ready to roll!"

When you stop to think about it, a lot of water was churned by that experimenter just to get started. Is that your



The Professional Soldering Station uses standard-size tips, making finding a proper replacement hassle-free.

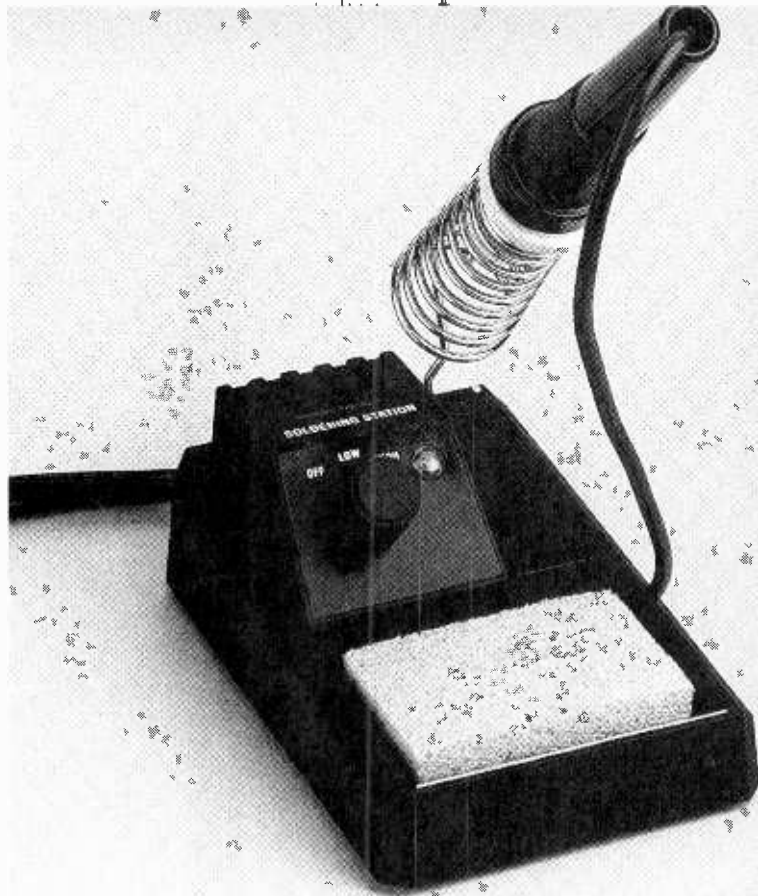
story, too? At any rate, our story goes a bit further:

"After I was finished, I remembered seeing an item listed in the latest Radio Shack catalogue, and I decided to purchase it. So since the hour was still early, I unplugged the old soldering iron and was off to the mall and my local Radio Shack. There I purchased the *Archer Professional Soldering Station* (Catalog No. 64-2057) for \$39.95."

A New Soldering Experience. Our experimenter's story continues: "The Archer Professional Soldering Station was a snap to set up. So easy, in fact, that the manual was referred to *after* everything was set up. The parts were removed from the packaging, the base was placed in a convenient spot on the table, the spring-like soldering-iron holder was attached to it and the soldering iron was placed therein. The molded three-prong plug was plugged into a standard grounded electrical outlet, and the POWER control was rotated to the HIGH setting. A light came on and the iron heated quickly."

But, not so fast; the manual does require *some* reading because it contains valuable information, too, as our experimenter discovered.

"The sponge that fits in a recessed tray in the iron-holder base must be moistened with distilled or de-ionized



CIRCLE 120 ON FREE INFORMATION CARD

water. I didn't know that! I'm lucky I didn't fill the tray yet. It seems that even ordinary drinking water from the tap will cause a soldering tip to pit and corrode, and/or contaminate the solder joint with unknown elements that may cause problems in the future."

As our friend had also discovered, the soldering tip should be tinned immediately and thereafter always kept clean and tinned, even when powering down. (The airlines would say de-heating.)

The Melt Test. The set up procedure used by the experimenter was repeated by the editors of **Popular Electronics**, and was followed by some tests.

A piece of 60%-tin/40%-lead, rosin-core solder, of .065-in. diameter, was held against the unheated tip, and the power set to HIGH. After a wait of 2 minutes, 23 seconds, the solder began to melt. After the soldering iron cooled to room temperature, the test was repeated with the switch set at LOW and the time was 2 minutes, 48 seconds. The AC voltage at the time of the test was 121 volts.

The POWER control limits the amount of heat poured into IC's and other semiconductors. During the lifetime of the unit, it will save you its cost several
(Continued on page 101)

FUN WITH INDUCTION COILS

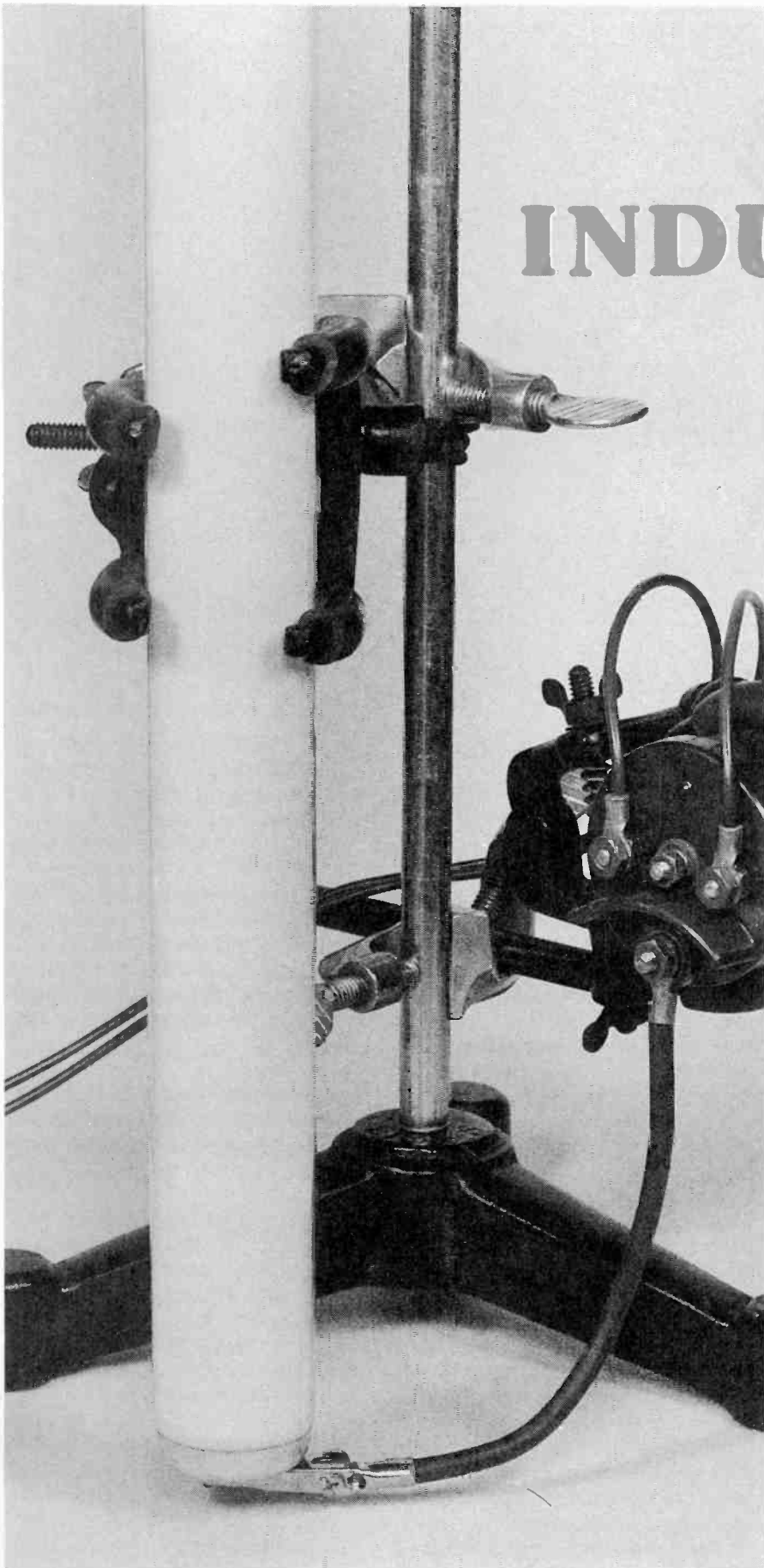
BY STAN CZARNIK

Read about the path induction coils have traveled over the years, and try a fascinating experiment of your own.

In 1831, Michael Faraday (1791–1867) found that if two coils of wire are wound around the opposite sides of an iron ring and if a current is switched on or off in one coil (the primary), a momentary pulse of electricity is created in the other coil (the secondary).

Faraday's great experiment marks the discovery of electromagnetic induction. Other developments followed in rapid succession. It was soon noticed that if the secondary coil consists of a large number of turns of wire relative to a small number of turns in the primary, a strong direct current of low potential in the primary would induce a weaker current of high potential in the secondary. Such induction coils provided electrical science with a means of transforming low-voltage currents into high-voltage currents. The problem was that the conversion worked for pulsed DC or AC only. It happened only when the circuit was opened or closed. What was needed was a way to make-and-break the circuit quickly, repeatedly, and automatically.

The Trembler. No sooner said than done: In 1836, or thereabouts, an American experimenter by the name of Charles Page (1812–1868) came up



with the necessary innovation. It was trembling mechanism similar to that found on an electrical bell. The device became known as a "trembler" or "vibrator." The entire arrangement was perfected by a German physicist, Heinrich Ruhmkorff (1803-1877). Ruhmkorff improved the mechanism so significantly that induction coils in general were soon called "Ruhmkorff Coils."

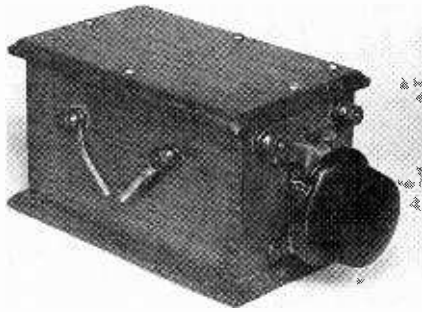
Antique Discharges. What first attracted experimenters to the high-voltage induction coil was the same thing that attracts people today: sparks! Early high-energy discharges from induction coils were small. The original sparks reported by Charles Page were only 1.57 millimeters long, or about 1/16 inch. In Paris in 1855, Heinrich Ruhmkorff exhibited a coil capable of producing sparks that were 40 centimeters (about 16 inches) long. Thirty years after that, in 1886, an English craftsman named Apps built a coil that generated sparks of up to 1.05 meters long. That's over 3 feet, which is some spark! Apps' machine contained almost one-half ton of wire. The creation of longer and longer sparks had become a kind of contest.

The historical situation here is actually very interesting. It is a case in which utilitarian necessity was not the mother of invention. The invention, the high-voltage induction coil, came first. The practical applications, like X-ray machinery, wireless telegraphy, and automobile-ignition systems, came later.

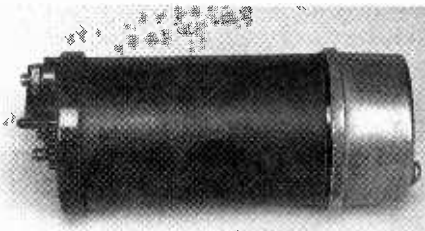
By the beginning of the 20th Century, the induction coil had become a common piece of laboratory equipment. Plans for building coils appeared in science books. All it took was a lot of patience and a lot of wire. No serious amateur experimenter was without a spark machine. The induction coil was, and still is, a fascinating device.

A Coil For You. Over the years, a variety of induction coils have been manufactured for a variety of purposes, and many of you probably already own one (especially if you own a gas-burning car). But, if you don't, you can order a very good one from an antique automobile parts supplier called Vintage Auto Parts located in Washington state. See the Materials List for more information.

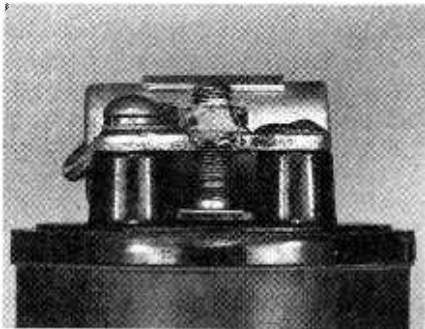
The coil, made by Delco-Remy, is a cylinder about 5 inches long and 2



Back in the 1950s, high-voltage induction coils like this were designed for use in high school and college physics classes. Note large plastic knob for adjusting the vibrator points.



Here's a profile of the induction coil from Vintage Auto Parts. The vibrator mechanism is concealed beneath the metal cap on the right. The input and output connections are on the left.



The points on the coil should be just barely touching. The capacitor (once called a condenser) is visible just behind them. To avoid damaging yourself or the coil, make no attempt to adjust the points while the coil is operating.

inches in diameter. The low-voltage input and high-voltage output connections are both at one end. The vibrator mechanism and capacitor—concealed and protected under a metal cap—are at the other end. The cap is held in place by two screws and can be easily removed.

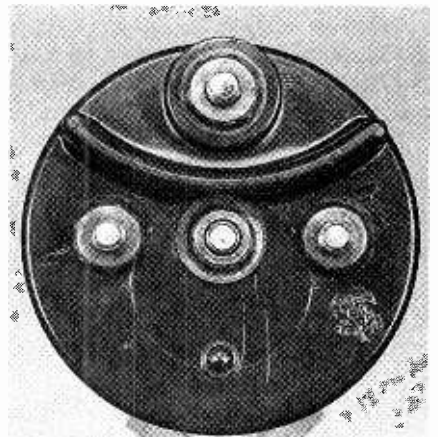
When you receive your coil, take off the metal cap and look at the contact points. They should be just barely touching. If the points are too far apart or too close together, the coil will not work; adjust the points with a screwdriver. Never attempt to adjust the points while the coil is operating.

If you look dead on at the input-output end of the coil, the connection at the very center of the coil is ground. Close to the ground connection, to the immediate right and immediate left, are the low-voltage input terminals. The last connection—separated from the others by a ridge of plastic—is the high-voltage output.

The coil requires no assembly and comes ready for use. So, let's get right down to work!

Testing and Operation. Attach one end of a 3- or 4-inch piece of stiff hook-up wire to the ground terminal of the induction coil. Bend the wire up and over the plastic ridge so that the other end remains stationary about 1/2 inch from the high-voltage output terminal. Now connect a 6- to 12-volt DC power supply to the input of the coil. If at all possible, use a power supply with an on-off switch and a continuously variable range of output voltages for the experiments.

The coil is round and also quite heavy, and I had a very hard time getting it to stay still on the surface of my workbench. I recommend clamping the coil to some sort of stand or building a simple base out of wood, plastic, or some other non-conductive material. High-voltage experimentation requires equipment that is stable, steady, and secure. Under no circumstances should the coil be permitted to roll around the surface of your work area. That can be very irritating, and much more importantly, just plain dangerous.



The ignition coil has input and output connections just like any other transformer. The ground terminal is dead center. Low-voltage input and output are to the immediate right and immediate left of ground. The remaining terminal, separated from the others by a ridge of plastic, is the high-voltage output.

MATERIALS LIST FOR THE INDUCTION-COIL EXPERIMENT

Automobile spark plug cable (or equivalent)
 Binding posts or fahnestock clips
 6- to 12-volt DC power supply
 Fluorescent tube
 Vibrator-type 12-volt ignition coil
 Iron filings
 Metal strips
 Salt shaker
 Wood block

ADDITIONAL MATERIALS

Alligator clips, soldering lugs, hardware, hook-up wire, solder, etc.

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

Small containers of iron filings (catalog number C-10276) are available for \$1.25 (with a minimum order of \$10) from JerryCo Inc., 601 Linden Place, Evanston, Illinois 60202. The JerryCo catalog is 50-cents.

Make sure that the input wires are clear of the output connections and you're ready to test the coil. Turn on your power supply. If the points are set properly, a strong spark will jump between the end of the test wire and the high-voltage output terminal. The coil should work perfectly. If not, turn off and unplug the power supply and check the points. Once again, the points should be touching, but just barely.

As noted earlier, an induction coil with a mechanical vibrator works a lot like an electric bell. The cycle of actions is as follows:

1. A current flows in the primary winding and creates a magnetic field around the core of the coil.
2. The magnetized core attracts the vibrator and the primary circuit is broken.
3. The magnetic field around the core collapses and the vibrator returns to its original position.
4. The vibrator, now back where it started, closes the primary circuit, and the cycle begins again.

The capacitor shunted across the vibrator points absorbs some of the self-induced energy of the primary winding and prevents the points from being prematurely burned away.

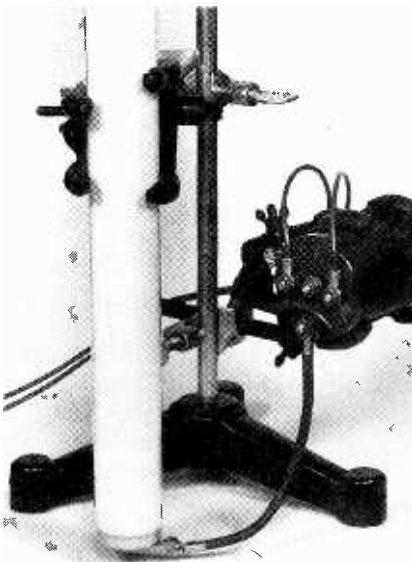
And now for a couple of experi-

ments guaranteed to awaken the mad scientist in everyone!

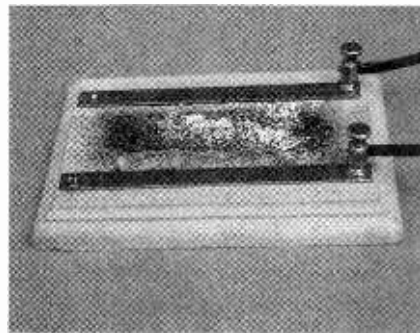
Ghostly Flashes. Obtain a piece of flexible wire 6 to 10 inches long. Automobile spark-plug cable works very well, but any kind of heavily insulated wire will do fine. With the power off, attach an alligator clip to one end of the wire and connect the other end to the high-voltage output of the induction coil. Now get a large fluorescent tube and connect the alligator clip to the pins at one end of the tube. Suspend the tube from a stand or lean it against a table, a bookshelf, or something similar. Make absolutely certain that the fluorescent tube will not move or fall down.

Your work area should be free of things that conduct electricity; that includes tools, soldering irons, desk lamps, aluminum soda-pop cans, and so on. It should also be very dry and very clean; high-voltage discharge can travel easily across a thin layer of ordinary household dust.

When everything is ready, darken the room and turn on the coil. The vibrator will buzz and the fluorescent tube will flicker with a grayish-white light. The entire effect is very weird. Low input voltages, between, say, 6 and 9 volts, produce the most obvious pulses. With an input voltage at or close to 12 volts, the flashes become too rapid for the eye to catch and the illumination begins to appear almost continuous.



Connect the high-voltage terminal of the coil to one end of a long fluorescent tube and turn on the power supply. The tube will flicker in a most mysterious fashion. Do not touch the tube while running the equipment.



The spark platform is a simple device. Two metal strips about two inches apart are screwed to a block of wood. Iron filings are sprinkled onto the surface between the strips with an old salt shaker. The high-voltage discharge will dance among the filings. The display that results resembles a miniature lightning storm.

Warning: Do not touch the fluorescent tube while the coil is operating. There is enough energy in the tube to give you a nasty electric shock!

Spark Platform. If you liked that experiment, you'll love this one. Locate a piece of wood 6 or 7 inches long and 4 or 5 inches wide. Now get a couple of stiff metal strips about 1/2 inch wide. Brass and aluminum strips are often available at large hobby shops. Cut the strips to match the length of the wood block. The strips should be placed on the block parallel to one another about 2 inches apart; that is very important. Fasten the strips to the wood. A binding post or fahnestock clip attached to one end of each strip will facilitate wiring.

You will need some iron filings and an old salt shaker. See the Materials List for information on how to obtain some. Fill the shaker with the filings and sprinkle the iron on the wood block between the metal strips. The layer of iron should not be too thick or too thin, and as even as possible. If you overdo it the first time, just clean off the platform and try again.

Now, without moving the board or disturbing the filings, connect the strips to the induction coil. Again, darken the room and turn on the coil. If you have used just the right amount of iron, the sparks will move between the strips and among the particles of metal. What you will see is simply fantastic. The display resembles a miniature lightning storm on your workbench. And, of course, remember not to touch the coil or the platform while running the experiment. ■

We looked at the many different games available for the IBM PC last month. However, not all PC's are suitable for game playing. And the PC is not the only computer that's suitable for fun and games. This month, we'll look at the hardware side of computer game playing. Let's start off with a look at the current king of the computer field—the ubiquitous PC.

King of the Hill. Probably the biggest reason that "game fever" has struck the PC market is that there are a great many of those machines, their clones, and compatibles out there. Up until just a few years ago, there were relatively few commercial games that were available for the PC. Most of the ones that were available were simply revisions of ones originally written for other computers, such as the Apple, Atari, or Commodore. But now games that take full advantage of the power of the PC are reaching the marketplace, and games originally written for other

machines are being enhanced and improved to make better use of the computer's abilities.

Besides the millions of clones now in the field, another reason for the surge in popularity of PC games is the large amount of memory those systems have when compared with what was formerly thought of as a "home computer." The typical PC user today has at least 256K, and usually 512K or 640K of user memory. The expanded memory allows more involved games than are possible on computers like the Commodore 64, which has but 64K of RAM, to be played. What's more, the larger memory allows an entire game to be stored in the PC's RAM, rather than being loaded in segments as the game progresses, thereby eliminating annoying disk-access waits. Also, since increasing numbers of PC systems today are equipped with a hard disk (HD), games often can be loaded onto the HD and run in no time.

A big factor in favor of the IBM PC is its 16-bit architecture. When com-

pared with the 8-bit microprocessor used by earlier systems, the PC simply does a better and faster job of processing data at clock rates of 4.77 MHz and higher—a big factor in the performance of large and complex games.

Use of the fast 80286 microprocessor in the AT and its clones, and the even-faster 80386 in many of the new PS/2-series computers, have contributed to those machines' popularity. But by no means do most games need the speed offered by the new machines. In fact, some games may play too fast at higher clock rates and may have to be "throttled back" to lower speeds in order to achieve realism.

Some Disadvantages and Cautions.

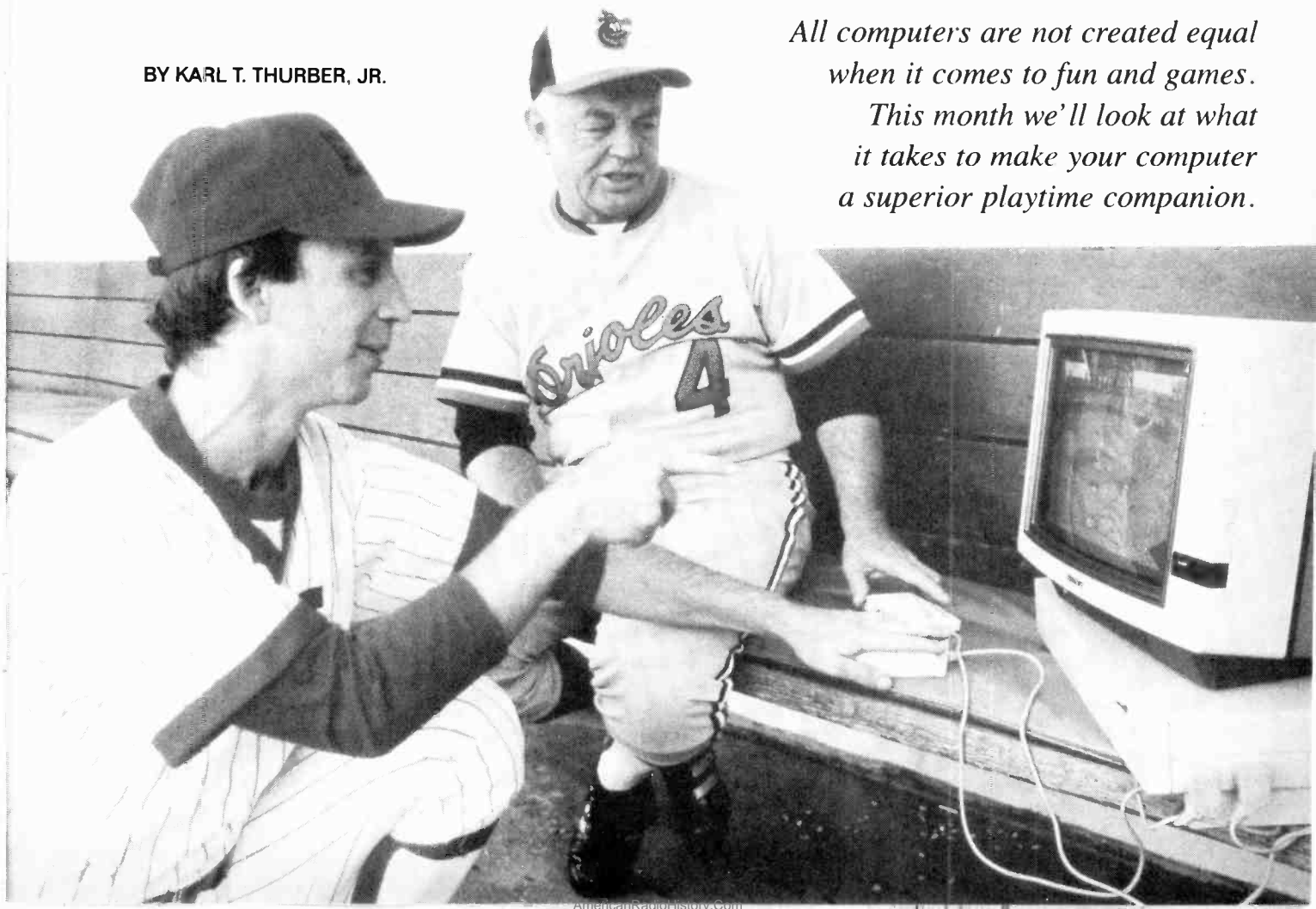
While the large RAM and high clock rates are great for game playing, the fact remains that IBM originally designed its PC as a business workhorse, not as a recreational machine. There are several limitations and cautions you should be aware of. Let's look at some of them.

Executive Diversions

BY KARL T. THURBER, JR.

All computers are not created equal when it comes to fun and games.

This month we'll look at what it takes to make your computer a superior playtime companion.





The PC and its clones, like this pcPopular from Blue Chip Microcomputers, make excellent game-playing machines, but only if they are equipped with an appropriate graphics interface, a suitable monitor, and game ports for use with a joystick. You must also check to be sure that your game software is compatible with your machine's capabilities.

● **Monitors.** The businesslike environment of the IBM PC is still a largely color-blind world: monochrome monitors (green or amber screens) predominate. Many game players, especially children and teens, would much rather play a game on an old 4K-ROM Atari Video Computer System (VCS)—with its low 192 × 120 picture-element (pixel) resolution using a color TV set for display—than on a 640K PC having a green-screen monitor. The monotonous green-on-black screen is just not very attractive for most action games, though text-only adventures and other games that don't benefit much from vivid color are passably playable.

● **Graphics-Card Confusion.** One of the most important factors in game compatibility is the type of graphics card the computer uses. The early PC's were equipped with a Monochrome Display Adapter (MDA), which offered good resolution (720 × 350 pixels) and provided an 80 × 25-character text grid, but no color or

control of individual pixels for graphics. Only the simplest games, such as all-text adventures, work with the MDA.

The Hercules monochrome adapter (and its clones) offers a high resolution of 720 × 348 pixels, with good graphics capability; it will work with many (but far from all) games. The combination of a Hercules card and an amber monitor is fairly attractive and is easy on the eyes—if you can do without color.

The closest thing to a "standard" color-graphics adapter for home use is the popular Color Graphics Adapter (CGA), for which most game software is written, and which allows the simultaneous use of four colors from a 16-color palette. Its resolution is adequate—640 × 200 or 320 × 200 pixels, depending on its mode. However, its text characters tend to be fuzzy, and the graphics are not particularly colorful or as sharp as with the monochromatic Hercules adapter.

Other, more advanced adapters such as the Enhanced Graphics

Adapter (EGA) offer advantages over the CGA, especially for gaming. EGA resolution is a sharp 640 × 400 pixels, or higher, and up to 16 colors from a palette of 64 colors are available. If you combine the EGA with a high-resolution monitor, you'll find that games written especially for the EGA have a quality all of their own.

The new Video Graphics Array (VGA) adapter board that's built into the new IBM PS/2 line offers resolutions of 640 × 480 pixels, or more, and can display up to 256 colors at a time—out of an incredible palette of 262,144 colors—for an amazing variety of tints, tones, and hues. Few, if any, games presently take advantage of VGA graphics, however, and many arcade-action *mavens* insist that the EGA and the VGA both generate screens that respond too slow for good game play. Fortunately, most EGA and VGA adapters are downward-compatible with the CGA, so that you can still play CGA games.

And what if you're playing games on your laptop while high in the sky? Some portable screens lend themselves well to gaming, while others do not. Many LCD-type screens with low scrolling speeds don't handle action games well. Plasma-type screens offer very good resolution, are easier on the eyes, can be viewed at any angle, and generally yield better overall results for fast-paced game software. Anyway, most portable computers have an external monitor port that you can use to hook up to a color monitor when you ultimately arrive at your destination.

The bottom line on graphics: Be sure that your computer supports the level of graphics used by a game before you buy it. The game's video-display requirements can almost always be found on the game packaging.

● **Floppy Frenzy.** Most PC users cut their teeth on 360K 5.25-inch floppies, which are still the industry standard. However, other formats are rapidly gaining in popularity. Those include 1.2-MB 5.25-inch disks (AT), and 720K and 1.44-MB 3.5-inch microfloppies (AT and PS/2). Game players will find the 3.5-inch disks particularly attractive, since the small, sturdy disks can be casually carried about much like audio cassettes, or in a shirt pocket.

Most commercial games for the PC still are furnished on 5.25-inch disks only. A few vendors give the purchaser a choice of 3.5- or 5.25-inch disks, and

some supply both disk formats in the game package. A few of the manufacturers who supply the 5.25-inch disk as standard offer the purchaser the opportunity to obtain a 3.5-inch disk for a nominal fee. Eventually, the 3.5-inch format will become standard, but for the foreseeable future you'll need to check that the game's disk format matches your PC's disk drive.

● **Joysticks and Rodents.** For most games, the computer's keyboard provides a practical and efficient means of control. However, many games, such as flight simulators, give you the option of using either a keyboard or a joystick (or other type of external controller, such as a mouse or "flight stick" control yoke). A few games require a joystick, or are infinitely better when played using one.

A joystick requirement is no big drawback on games-oriented computers such as the Commodore 64 and the Atari machines, but on the PC there can be some special problems. The IBM PC and most clones don't have a built-in joystick-controller port. That means that you'll have to pop for a joystick-controller or game-adaptor board (which will occupy one of your computer's expansion slots) in addition to the joysticks themselves. Be sure to check the game's equipment requirements to see if a joystick or other controller is required.

A few PC's that are sold with the home market in mind, such as the Amstrad PC1512 and PC1640, Commodore Colt, and Blue Chip "pcPopular," have built-in joystick-controller ports. Also, many clones are "packaged" with a "multi-I/O" board that combines the joystick-controller port with one or more parallel and serial interfaces (used for connection to a modem, a printer, etc.). But there is no built-in joystick port on a "bare-bones" PC/XT/AT model.

● **Copy Protection Capers.** Disk copy protection has been around for a long time, though most PC productivity-software users are seeing protection schemes slowly fade away. That is mostly due to strong objections from legitimate users who refuse to put up with such inconveniences as the inability to back up expensive program disks and the difficulties in installing programs on hard disks.

But game-program copy protection is still very much with us, and it promises to be around for some time to come—at least as long as the rampant piracy



Copy-protection schemes present many nuisances to the game player, but software manufacturers feel they are needed to protect their products. One scheme that presents fewer problems than most, at least to legitimate buyers, is the use of a security chart or code wheel like the one used in Infocom's A Mind Forever Voyaging.

of entertainment software persists. Many game manufacturers justify the use of copy protection by reasoning that if a game disk owned by a "registered user" goes bad, nothing but some play time is lost while securing a replacement.

If you own a hard disk, you'll find that installing copy-protected games on the HD requires special procedures; the same goes for removing or "deinstalling" the game from your HD. If you don't follow the game manufacturer's instructions to the letter, you may find that you've used up all the "allowable installation counts" and have a dead game on your hands. All that

spells hassles to serious game players, many of whom simply won't purchase a copy-protected game, or, won't install the game on their HD if they do.

On the brighter side, more and more game manufacturers are deleting the more troublesome forms of on-disk copy protection and going to "off-disk" protection. In such schemes, you may need to use a decoder wheel, look up numbers on a chart, or perform some similar task, for the game to work properly. Or the game may be so complicated that you must have a copy of the instructions to productively use it.

● **Sound Enhancements.** Many games use sound and music to en-



Low cost and excellent game-playing features have helped the Commodore 64 endure. On the sheer strength of numbers, it must be considered the number-one computer for games



A game-player's dream come true, the Amiga's features include arcade-quality 4,096-color graphics, two mouse/joystick ports, four-voice digital stereo sound, multitasking capability (you could conceivably play two games at once), and even left- and right-audio outputs for driving a stereo-sound system.

hance play. The PC's beeper-like audio is not particularly advanced sound-wise, though it is adequate for many games that don't rely heavily on music to support the action. The multi-voice, speech-synthesis, and digitizing capabilities of computers such as the Atari ST, the Amiga, and the Apple IIGs can, frankly, run rings around the PC in this area.

Some Alternatives. Thus far, we've only looked at playing games on IBM's or clones. That's not to say, however, that if you own another system that you are shut out of the fun. In fact, that's far from the truth. For instance, since its introduction in 1982, the Commodore-64 has gradually built up steam so that it's now the top dog in the games market. More games are written and sold for it than any other personal computer, though games for the IBM PC are coming up fast.

The 8-bit, 6510 microprocessor-based C-64 has persisted these seven

long years thanks, in part, to the ever-sharpening skills of some very innovative game programmers, and through the dint of sheer numbers in the marketplace. The C-64's excellent 40-column, 16-color graphics and three voices have helped its popularity and staying power greatly. Low cost and the ability to use a standard color TV set for display help make it a nearly ideal machine for non-business, home applications.

The Commodore 128, with its 8-bit 8502 microprocessor, is basically an upgraded C-64 with improved graphics and an 80-column display when operated in its native "128 mode." Few games, however, take advantage of its full set of capabilities. The computer is 100% compatible with programs written for the C-64. The computer also features a built-in Z80 microprocessor for CP/M capability; unfortunately, neither the Z80 nor CP/M have much to offer the game player.

Apple computers have been

around since 1976, when the historic but unsuccessful Apple I of Jobs and Wozniak fame made its appearance. It was followed closely by the remarkably successful Apple II.

Upgrades of the 8-bit 6502 microprocessor-based Apple II appeared in the 1980's; those included the II+, the enhanced IIE, and the portable IIC. All are popular among game players, and are widely used in schools. Though much more expensive than the workhorse Commodore 64, the Apple machines—when coupled with a color monitor or TV set and some system-expansion cards—make very competent game machines.

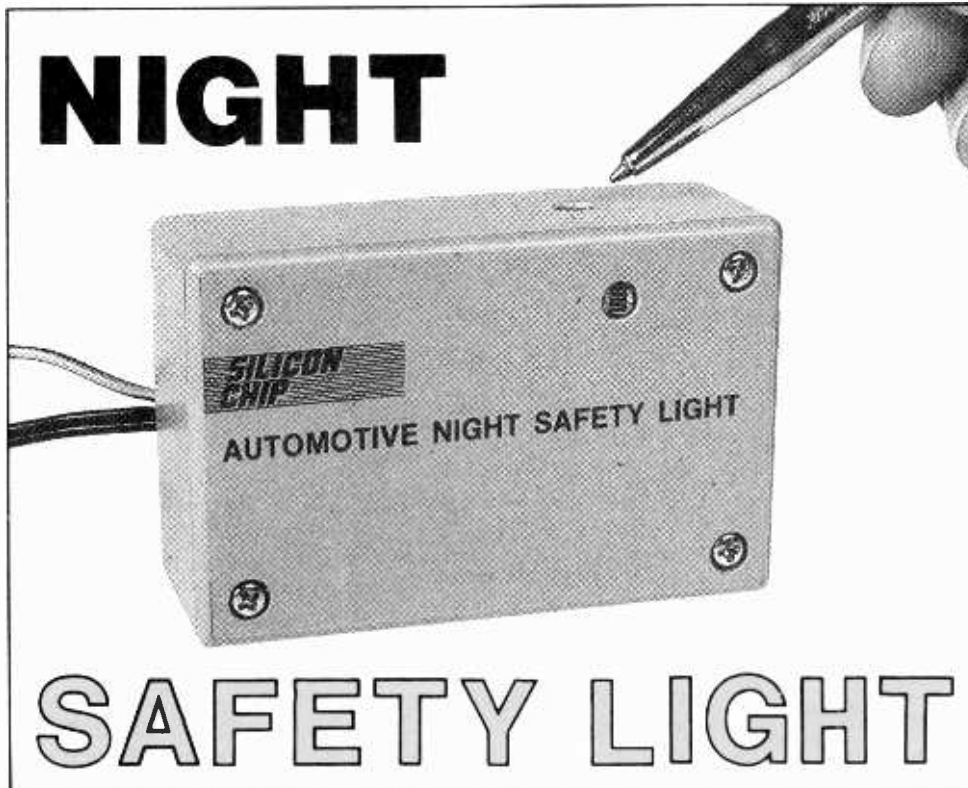
The newest-generation Apple is the Apple IIGs, a high-end 8/16-bit machine with seductive graphics and sound capabilities that offer superb game play. While the computer can run most 8-bit Apple II-series software, its gaming muscle is focused in its Western Digital W65C816 microprocessor, which is a 16-bit version of the 6502. The 256K RAM (128K ROM) color-oriented computer, having two new graphics modes and sporting many of the features of the very upscale Macintosh, lets you play very large and complex games. The sound chip on the IIGs is especially impressive; it can generate up to 15 voices at the same time—more voices than any other computer presently on the market, including the made-for-games Amiga and Atari ST.

The Apple Macintosh, on the scene since late 1983, has great capabilities as a gaming machine due to its excellent graphics capabilities and user interface, though its high cost has generally kept it out of all but the most upscale homes. Many Macs, however, are only equipped with a small (9-inch) built-in monochrome display.

Later incarnations of the 16/32-bit Mac have been increasingly competitive as game machines. Those include the Macintosh Plus, with its Motorola 68000 chip and four-voice monaural audio synthesizer, and the powerful Macintosh II. The latter is a true 32-bit, 1MB machine that uses the Motorola 68020 CPU (running at a fast 15.7 MHz) and includes a four-voice "wavetable" audio synthesizer and customized sound chip. Its options include a 13-inch color monitor with a resolution of 640 x 480 pixels and 256 on-screen colors, out of an incredible 16-million-color palette.

(Continued on page 108)

NIGHT



SAFETY LIGHT

FOR YOUR CAR

Anyone who parks a car on the street at night is aware of the danger of sideswipes, particularly in wet weather, or if the street is poorly lit. The problem is even worse if the parked car is dark in color, with no reflective trim to warn an approaching driver.

To intensify things, that problem has been made worse in recent years by the switch from reflective chrome bumper bars to non-reflective plastic bumpers. These days, it's all too easy for a tired or inattentive driver to be unaware of a parked car—until it's too late.

At least that was the case until now. The *Automotive Night Safety Light* described in this article is designed to overcome that problem. It mounts in the rear window of your auto and watches for an approaching car's headlights. As soon as headlights are detected, the circuit turns on the parked car's brake lights to warn the driver in the approaching vehicle. About five seconds after the car passes, the brake lights automatically switch off.

This story first appeared in *Silicon Chip*, Australia (November 1988); reprinted with permission.

BY JOHN CLARKE

Chase the fender-bender blues with this warning light for parked cars.

During the daytime, an additional light sensor disables the circuit to prevent the car's battery from going dead. The circuit is also disabled while the ignition switch is on. That means that the car's brake lights function normally when the car is being driven.

How It Works. Figure 1 shows the schematic diagram of our Automotive Night Safety Light—which is built around a 4093 quad 2-input NAND Schmitt trigger and controlled by two light-dependent resistors (LDR's), R1 and R4. Light-dependent resistors are semiconductors whose resistance varies proportionately with light striking its sensory area. In darkness, an LDR has a high resistance (a few megohms); under intense light, its resistance drops (to about 100 ohms).

Let's assume initially that the ignition

is off and that both R1 and R4 are in darkness, so those components both have a high resistance. Pins 5 and 6 of U1-b are pulled low by R3 (a 100K resistor), causing it to output a high at pin 4. That high is fed to pin 2 of U1-a.

The other input to U1-a (pin 1) is pulled low by R5 (a 47K resistor). With U1-a pin 2 tied high and pin 1 held low, the output of U1-b at pin 3 is high, reverse-biasing D2, so the circuit is disabled.

Now consider what happens when R4 detects an approaching car's headlights. Light falling on R4 causes its resistance to decrease, pulling pin 1 of U1-a high. Because both inputs to U1-a are high, its output goes low. That low output sets off a chain reaction through the circuit.

Assuming S1 is closed, D2 is now forward-biased and C1 (a 10- μ F capacitor) discharges into pin 3 of U1-a. That pulls the inputs to U1-c and U1-d (which are connected in parallel) low, forcing their outputs (at pins 10 and 11) to go high. The high output of the U1-c/U1-d parallel combination is fed to the base of Q1 via R7 and R8 (respectively). That causes Q1 to turn on, providing a path to ground for relay K1, which in turn activates the brake lights.

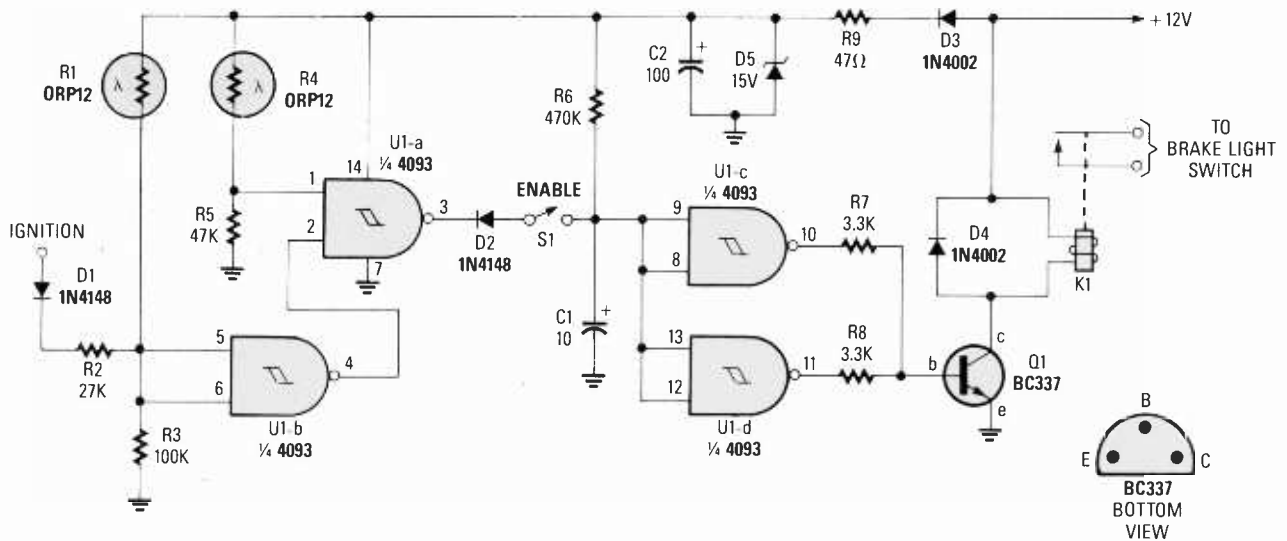


Fig. 1. The circuit uses a 4093 quad 2-input NAND Schmitt trigger to provide the logic and to drive transistor Q1. Light-dependent resistor R4 is the headlight sensor while R1 disables the circuit during daylight hours.

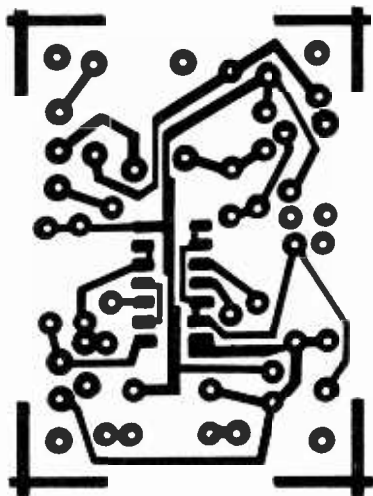


Fig. 2. Here is a template of the printed-circuit layout used by the author in the production of the prototype.

The brake lights stay on while light shines on R4. As soon as the car passes, R4's resistance goes high again and pin 3 of U1-b switches high. Diode D2 is now reverse-biased and so C1 charges, via R6, toward the positive-supply rail.

After about five seconds, the voltage on the capacitor is high enough to cause U1-c and U1-d to switch low again and turn Q1 off. The brake lights now turn off and the circuit is ready for the next approaching vehicle.

Automatic Override. Light-dependent resistor R1, along with D2 and U1-b automatically disable the circuit during daylight hours or if the ignition is turned on. During daylight, R1's resis-

tance is low and pins 5 and 6 of U1-b are pulled high. Thus, pin 2 of U1-a is held low and the circuit is disabled.

Similarly, when the ignition is turned on, pins 5 and 6 of U1-b are pulled high via D1 and R2, so the circuit is disabled as before. Note that R1 must be aimed in a different direction from R4, so that it cannot "see" an approaching car's headlights. If that were to occur, pin 2 of U1-a would be pulled low each time a car approached and the circuit would be disabled, thus defeating the purpose of the circuit.

The ENABLE switch (S1) allows the cir-

cuit to be manually switched off when not required. Power for the circuit is derived from the car's battery. Diode D3, plus R9 and C2 provide supply-line decoupling. Diode D5 clamps any spikes on the supply line. Diode D4's job is to protect Q1 from spikes when the relay turns off.

Construction. While the Automotive Night Safety Light is simple enough to be assembled on perfboard using point-to-point wiring, it is recommended that the circuit be assembled on printed-circuit board. Figure 2 shows a full-size template of the printed-circuit board artwork.

Once you've etched your printed-

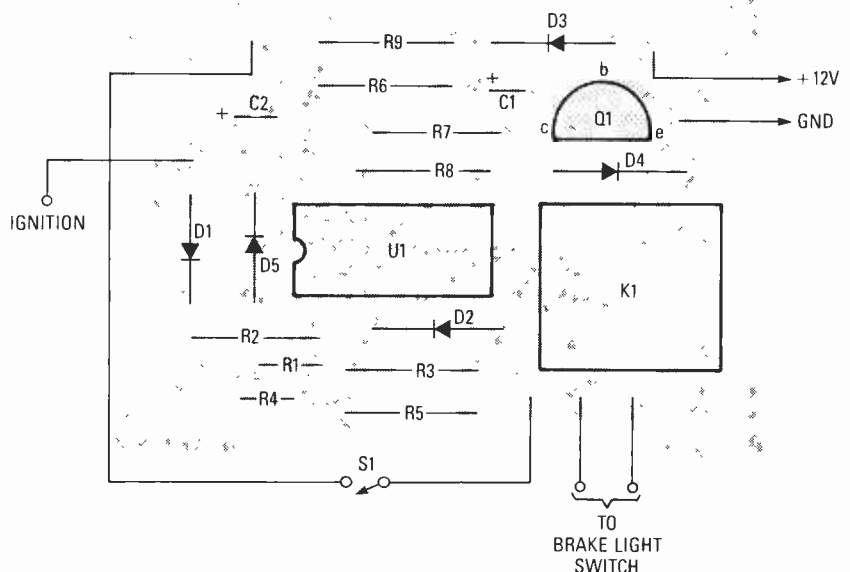


Fig. 3. This diagram shows the location and orientation of the components on the printed-circuit board. Note: The two light-dependent resistors, R1 and R4, should be mounted to the board at full lead length to allow those parts to be properly positioned in the holes drilled in the project's enclosure.

PARTS LIST FOR THE AUTOMOTIVE NIGHT SAFETY LIGHT

SEMICONDUCTORS

U1—4093 quad 2-input NAND Schmitt trigger, integrated circuit
Q1—BC337, ECG188, or similar general-purpose silicon NPN transistor
D1, D2—1N4148 or 1N914 general-purpose signal diode
D3, D4—1N4002 1-amp 100-PIV rectifier diode
D5—15-volt, 1-watt (1N4744A or similar) Zener diode

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1, R4—ORP12 or similar light-dependent resistor
R2—27,000-ohm
R3—100,000-ohm
R5—47,000-ohm
R6—470,000-ohm
R7, R8—3300-ohm
R9—47-ohm

CAPACITORS

C1—10- μ F, 16-WVDC, electrolytic
C2—100- μ F, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

K1—Miniature SPDT 12-volt relay
S1—SPST toggle or pushbutton switch (see text)

Printed circuit materials, enclosure, IC socket (optional), connectors, wire, solder, hardware, etc.

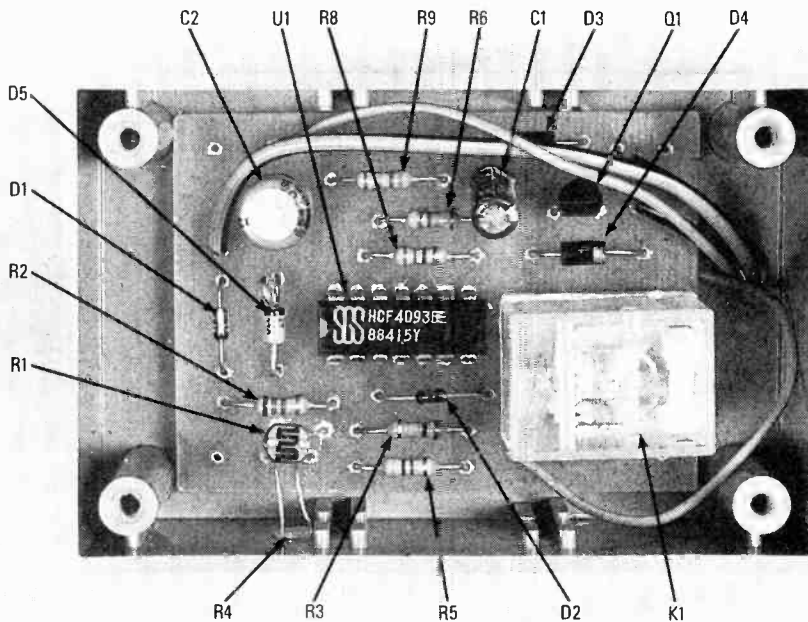
nal wiring points. Those leads should be made long enough to reach their respective destinations from the rear window.

The fully populated printed-circuit board fits easily into a small plastic case, measuring about $3\frac{1}{2} \times 2\frac{1}{4} \times \frac{1}{4}$ inches. The board simply sits on the base with the leads emerging from a small hole drilled nearby. It is then held in place by a small piece of foam rubber when the lid is screwed down.

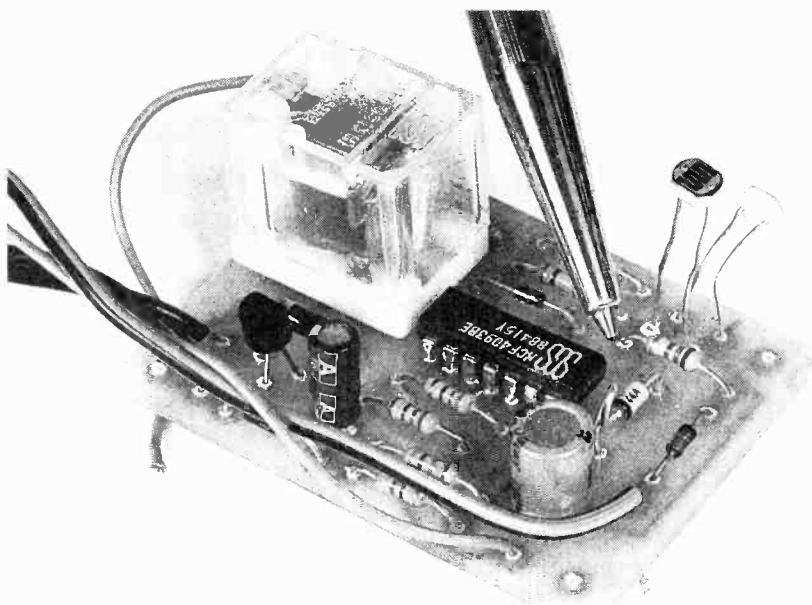
The most critical aspect of the assembly is the orientation of the LDR's, R1 and R4. Light-dependent resistor R4 (the headlight sensor) must be oriented so that it faces out through the side of the case while R1 is mounted on the lid. You will have to drill and ream the holes in the appropriate locations to accept R1 and R4. Make the holes just big enough so that the LDR's are a press fit.

If you make the holes too big, the LDR's can be glued in position from the rear using epoxy glue. Be careful not to

(Continued on page 104)



This inside view shows how one of the LDR's (the headlight detector) is arranged to face through the side of the case. The other LDR faces upwards, through the lid.



This close-up view of the printed-circuit board shows how diode D5 is installed with a loop in one end to give stress relief. Sleeve the leads of R1 and R4 with plastic tubing to prevent shorts when the board is installed in the case.

circuit board and obtained the relatively few parts needed to complete the project, assemble the components on the board using Fig. 3 as a guide.

Follow the parts-layout diagram (Fig. 3) carefully when assembling the circuit. In particular, make sure that the IC, transistor, diodes, and electrolytic capacitors are all correctly oriented. Zener diode D5 should be installed with a loop in one lead to provide some degree of stress relief. The glass

envelope of D5 is fragile, so it doesn't take much in the way of stress to damage the unit.

The two LDR's (R1 and R4) should be mounted at full lead length so that they can later be pushed through holes in the case. Sleeve their leads with plastic tubing to prevent shorts when the board is later installed in the case.

Construction of the board can now be completed by connecting lengths of insulated hookup wire to the exter-



Auto Racing Enters the Computer Age

BY LEO SIMPSON

Just how do you squeeze the very maximum performance out of a racing sedan over a distance of 500 miles, without running the risk of blowing it up before the finish? That is a question that continually haunts racing drivers and their backup teams as their cars hurl around a track. Drivers must be able to judge just how hard to push a car while still keeping enough in reserve to be able to finish the race. In other words, there is more to winning a race than just being able to go fastest around the track.

But as motor racing becomes more competitive, even superlative drivers need more than just the "seat of their pants" to keep them out in front. And this is where computers are being brought into the picture.

Not that computers have not been involved in motor racing for a number of years. Most of the cars competing this year at major tracks around the

world, will have one or more on-board computers in their "engine-management systems." These systems are used to control the ignition timing and fuel injection.

The problem with existing engine-management systems in cars is that they don't tell the driver anything about the state of the engine. They have been designed that way so that they are as unobtrusive as possible. But even if the engine-management system did provide feedback to the driver, he would still want to know more, about the state of the tires, brakes, suspension, and so on.

If racing drivers had that information about their cars' condition, they could push them a lot harder. In the meantime, they have to err on the side of caution if they are to finish a race.

Overcoming that lack of information has been a joint project between one of Australia's leading data-communications manufacturer, Netcomm Pty Ltd, and Australia's top driver, Peter Brock, and his BMW racing team.

Computers and racing crews are teaming up to get the most out of man and his favorite machine.

Netcomm and Brock are in the process of developing a comprehensive monitoring scheme that will give real-time information about virtually every aspect of the car during a race. Called the Netcomm Racing Modem System (RMS) it was first featured in the car driven by Murray Carter in the 1987 Bathurst (Australia) 1000-km Race. This past year it was featured in the Mobil BMW car driven by Brock as well as a Ford Sierra driven by Murray Carter.

Racing Modem System. As the name suggests, the RMS is based on modems, but there is far more to it than that. The basic racing modem system

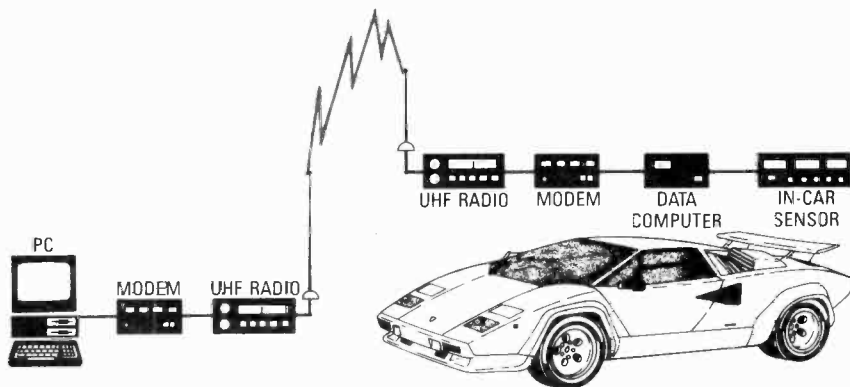
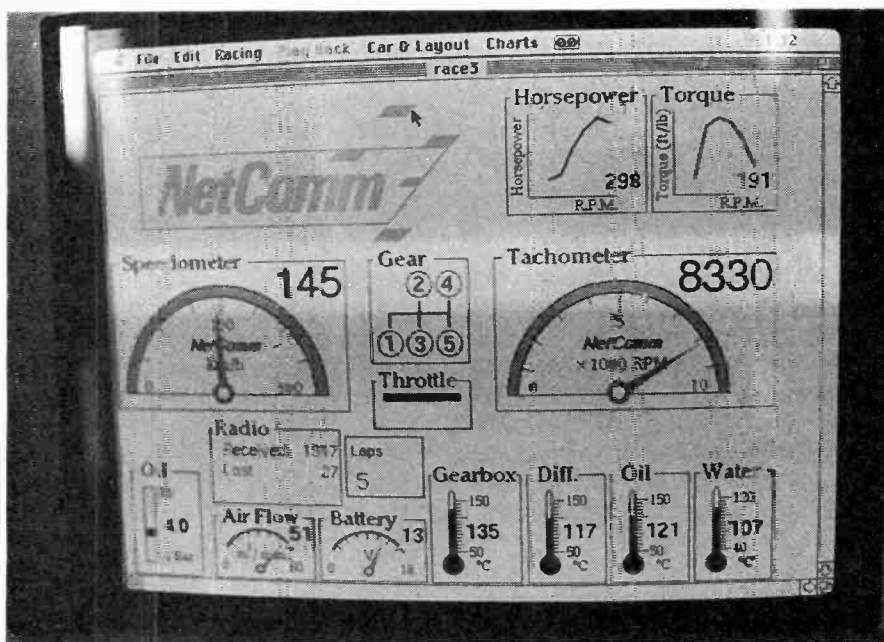
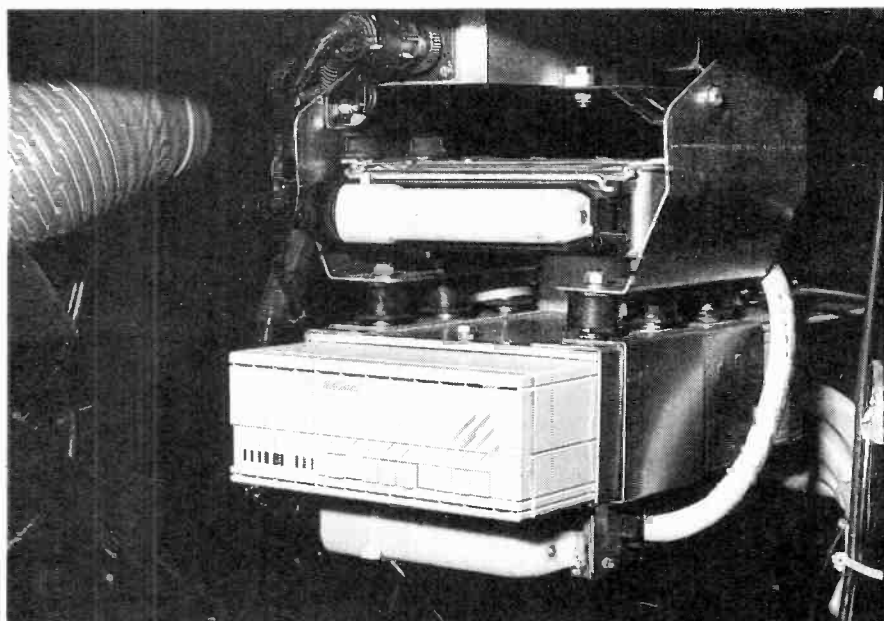


Fig. 1. This diagram shows the main components of the Netcomm Racing Modem System. The system can cope with more than 37 sensors on the car.



This is one of the screen displays used on the Apple Macintosh to display car-sensor information. Note the thermometer displays for temperature readouts and the dial displays for speedometer and tachometer readings.



This photo shows how the Netcomm modem and UHF transceiver are installed under the dash of Peter Brock's BMW sedan. The modem transmits between 2400 and 9600 baud.

consists of a bank of sensors placed around the car, an on-board computer, a modem, and a UHF transceiver (see Fig. 1). The computer converts all the signals from the sensors into a digital data stream that is fed via the modem into the transceiver.

The transmitted information is picked up at the pit by another transceiver and modem, and fed into a computer where it is displayed on a video monitor for constant analysis by technicians.

As the race progresses, technicians can monitor every aspect of the car and thereby are able to spot problems before they become disasters.

Sensor Functions. Just to show how comprehensive the monitoring is, the various sensors and their functions are listed, as follows:

- Engine tachometer: measures engine revolutions up to 9000 RPM.
- Speedometer: measures up to 300 km/h (about 186.5 mph).
- Backward/forward accelerometer: measures the acceleration and braking forces on the car and driver.
- Up/down force: measures the downward force applied to the car by the spoilers.
- Left/right accelerometer: measures the cornering forces on the car and driver.
- Engine-oil pressure.
- Engine-oil temperature.
- Fuel pressure: measures temperature of the fuel to determine if vaporization is occurring.
- Water temperature: measures the temperature of the water as it passes from the engine to the radiator.
- Detonation: an acoustic sensor monitors for the onset of this critical condition. If detonation occurs at racing speeds, it can destroy the engine.
- Exhaust gas: measures the carbon monoxide content of the exhaust.
- Exhaust-port temperature: each cylinder exhaust port is measured. This is another critical engine parameter. The piston heads are run at a temperature that is at times just below melting point.
- Relative horsepower: a figure obtained from the existing engine-management system on the BMW.
- Battery voltage.
- Battery current.
- Fuel pumps: monitors which pump is operating.
- Fuel flow: measures the rate of fuel consumption.
- Gearbox-oil pump.



Here's the prototype Netcomm system as used on Murray Carter's Nissan in 1987.

- Gearbox-oil temperature.
- Engine-bay temperature.
- Differential oil-cooler pump.
- Brake temperature: brake discs will glow red hot when braking at the end of the straights. If the calipers become too hot there is a risk that the brake fluid will boil.
- Brake-pedal pressure.
- Brake-pad wear.
- Brake lockup: determines if the wheels lock up under braking.
- Wheel spin: determines if the rear wheels lose traction under acceleration.
- Throttle position.
- Cabin temperature: air conditioning is not a feature of racing sedans.
- Air temperature: measures the ambient temperature around the car.
- Humidity: measures the ambient humidity around the car.
- Air pressure: measures the atmospheric pressure.
- Driver temperature: measures body temperature.
- Driver heart rate.
- Tire temperature: the temperature of the tread casing of all four tires is measured. If it exceeds a critical level, the tire will disintegrate.
- Tire pressure.
- Shock-absorber temperature: each shock absorber is measured. If shock absorbers get too hot they cease to work properly and the car's handling suffers accordingly.
- Vibration: measures vibration of the car body.

That adds up to 37 sensors, although we understand that some of them are

not yet installed on the car. Tire-pressure monitoring is a particular problem, just how do you measure pressure in a spinning tire? Netcomm wasn't saying.

Tire temperature, on the other hand, is measured by infrared pyrometers spaced a critical distance away from each tire. They have to get the spacing just right. Too far and sensitivity is degraded; too close and the oscillating wheel will rip out the sensor.

Many of the sensor functions are already provided by the existing engine-management system on the BMW and its anti-skid braking system (ABS). But that still left a great many others that have had to be installed.

Processing the Data. Signals from the sensors are fed to a data-acquisition computer that can accept up to 66 inputs. The computer is based on an 8-bit microprocessor with 32K of ROM (read-only memory) and 8K of RAM (random-access memory). The computer prescales the inputs (i.e., attenuates or amplifies the signal for optimum data transmission) and then performs analog-to-digital conversion.

The digital data is encoded with a parity system for error correction—very important in a telemetry system of such complexity.

The resulting 8-bit parallel data is then converted to a serial data stream to pass via an RS-232 port to the Net-

Our thanks to Netcomm Australia Pty Ltd and Communications Solutions Australia Pty Ltd for their assistance in the preparation of this article.

comm modem. The FSK (frequency-shift keyed) signal from the modem is then fed to a transceiver (a combined transmitter and receiver) transmitting in the 470-MHz band.

The transmitted signal is picked up by another transceiver in the pit area of the track and the detected signal is fed to another modem to produce an RS-232 signal, which is fed to the port of an Apple Macintosh. That Macintosh computer is specially programmed to display the information from the car sensors.

Graphic Displays. Rather than just display the information as numerical quantities, the computer is programmed to display the information graphically. Hence, there are displays on the screen that depict a speedometer, tachometers, various thermometers to show the many temperatures being monitored, and other gauges.

In that way, it is easier for the technicians to monitor any changes just by glancing at the pointers, thermometer levels, etc., rather than having to pick



Peter Brock in his BMW M3 sedan. With the help of the Racing Modem, he won this race at Australia's Oran Park last August.

specific figures off the screen.

Not only is all the sensor information able to be displayed on the screen, it is stored in the computer for later, more detailed analysis.

Of course the Racing Modem System is heavily used in practice and training sessions. During those times, the drivers can really push the car to the limits and beyond. That enables the technicians to build up comprehensive information about the onset of failure for all of the car's systems.

It remains to be seen whether the Netcomm Racing Modem System, or any similar system, will give race-car drivers and their teams the necessary edge to win. But one thing is certain—it will be used on more racing cars in the future. ■



CADDYLAK SYSTEMS CALENDARS UNLIMITED

Develop personal and business calendars of events quickly, easily, and at a budget price!

At last! An inexpensive, easy-to-use, software package that provides instant access to daily, weekly, monthly, and yearly information. *Caddylak Systems' Calendars Unlimited* will help you keep track of your personal and business appointments, important dates, and all the events and happenings you should not forget.

Calendars Unlimited is a one-disk package that's so easy to use, you *don't need to read the manual!* Hardware requirements are just as agreeable: IBM PC, XT, AT, or compatible; 256K of RAM; one double-sided floppy-disk drive, or one floppy drive and one hard disk if you want Hard disk operation; and a printer if you want printouts.

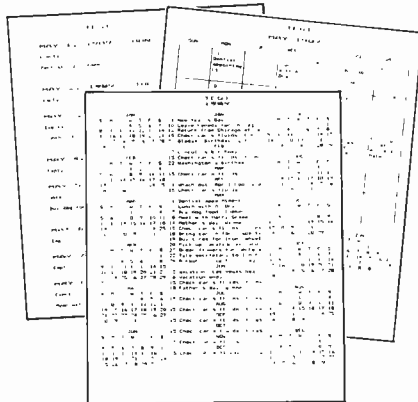
Hard Disk Installation. Before you proceed, make a copy of the software disk, write-protect the original, and store it. If you are going to load the software onto a hard disk, we suggest you start by creating a sub-directory (we called our sub-directory CU because the starting program is called CU.EXE) and moving into it. Now insert the floppy you copied the software onto in drive and type A:TRANSFER <ENTER>. The transfer program will automatically load the software onto your hard-disk drive. If you need help (which is unlikely) take a look in the manual.

Using it. When the opening screen appears, press s for Set-up. Follow the

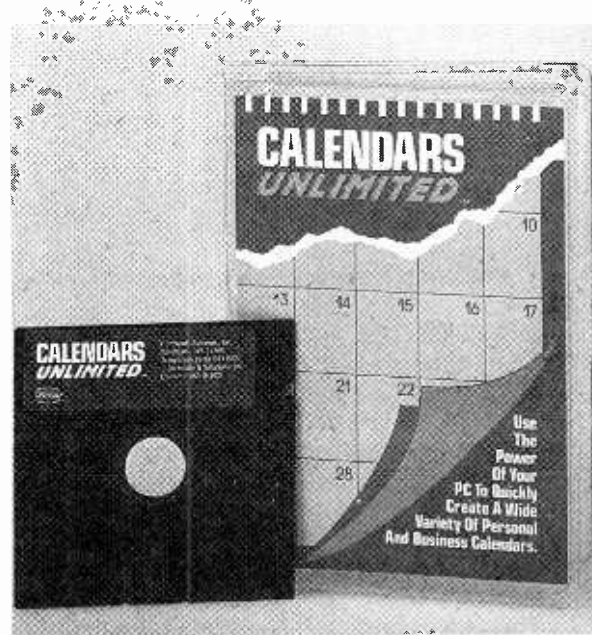
simple instructions for supplying information about your system's drives. Then press p, if you own a printer, to begin entering your printer's characteristics.

Calendars Unlimited is designed to work with any dot-matrix or laser printer. You'll see that the menu has three groups of printers: IBM and IBM compatibles, Epson MX, and a group called "Others." The last group contains printers that do not support standard IBM line-graphic characters. The program will use standard ASCII characters in place of the line-graphics characters. If you're not sure of the type of printer you use, you'll need to try all three options until the printer works properly.

Menus and Functions. The menus are short, simple, and complete. You could read the 38-page manual or just



What you see is what you get! Shown are a monthly block calendar, yearly calendar, and a daily listing for one week.



CIRCLE 119 ON FREE INFORMATION CARD

skip reading it like this reviewer did. To be as brief as the manual, here are the options that are offered:

Add—enter appointments and optional notes. Dates and times of events need not be entered in order—the program sorts them out itself.

Edit/View—Appointments and people change, so this option takes into account that we are human.

Merge Calendars—more than one calendar can be made to cover business, home, and club activities. This option merges the different calendars to discover when activities overlap.

Carry Forward—Birthdays don't change, mortgages are always due, and Christmas comes every year, so those dates can be carried forward to the next year's calendar, thus reducing the time and energy spent inputting information next year.

In addition to the menus there are several function keys defined that can be used at any time. They provide a rapid and easy way to move to the various parts of the program. The keys and their function are: <F1> View options, <F2> Pop-up calendar, <F3> Change active calendar, <F5> Calendar menu, <F10> Help screens, and <ESC> Quit.

A "function line" at the bottom of each menu shows the information the program is expecting you to input. It changes with each menu and is context-sensitive to previous input. You'll need such prompting the first few times you use the program.

(Continued on page 99)



Antique Radio

NOT TWO OF A KIND

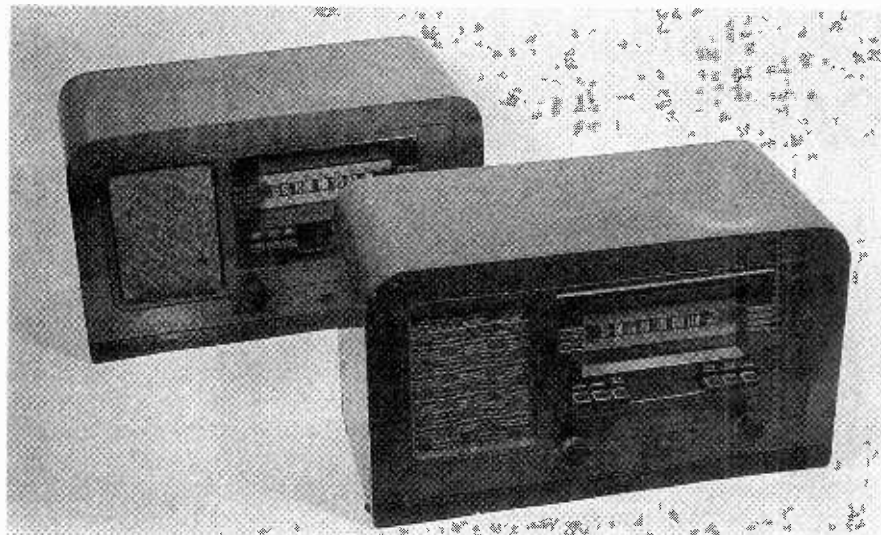
By Marc Ellis

Early one morning some months ago, I groped my way into the kitchen to perform the usual coffee-making ritual. Since I still wasn't quite conscious, I was only mildly surprised to see a familiar-looking radio on one of the countertops—a nice little wood-cabinet RCA. But what was it doing there? When I'd last noticed the set, it had been displayed on one of the living-room bookshelves. Was this a hint that my wife (normally very tolerant of old radios) needed the space for something else?

After getting a little of the coffee inside me, I checked out the living room only to discover that the radio was still in its accustomed place! Luckily (since my mind doesn't work real well first thing in the morning), Carolyn soon appeared on the scene and explained. She had been at a business meeting the previous evening. One of the other people at the meeting, knowing of my interest in relic radios, had brought the set in and sent it along with her. She'd left it in the kitchen so I'd find it when I got up.

Study Your Acquisitions! Since the new acquisition seemed identical to the set I had on display, and was in about the same condition, I put it aside for possible use as a trading piece—leaving the original where it was. Time passed, and I never did get around to trading that radio. Now I'm glad I didn't, because I recently discovered that the set's not a duplicate after all! While reorganizing my storage shelves, I happened to take a close look inside the cabinet and was surprised to see that the radio had no power transformer. That wasn't strange in itself, but I was positive that the set on the display shelf did have one.

Placing the sets side by side, I saw that I had two different models housed in identical cabinets. The one without the power transformer was RCA's



Would you say that these radios are duplicates? Read the text before you answer!

Model X55, an AC/DC design with the standard "All-American 5" tube lineup (12SA7, 12SK7, 12SQ7, 50L6, and 35Z5). The transformer-powered radio was the Model T55, using a lineup of 6-volt tubes (6SA7, 6SK7, 6SQ7, 6F6, and 5Y3). The speakers, the antennas, and most of the chassis-mounted components looked identical.

It wasn't at all unusual for set manufacturers to make different models using identical cabinets—although one wonders why RCA bothered to design this particular pair. Except for heater voltages, the tubes in the two sets were virtually identical—so there couldn't have been much difference in the performance of the two models. About the only advantages to owning the more expensive transformer-powered set would be extended tube life (heaters burned out much more often in the AC/DC designs) and improved personal safety (the chassis of the AC/DC sets were notorious for shock hazard—though that didn't seem to be a major concern in the early 1940's when these radios were marketed).

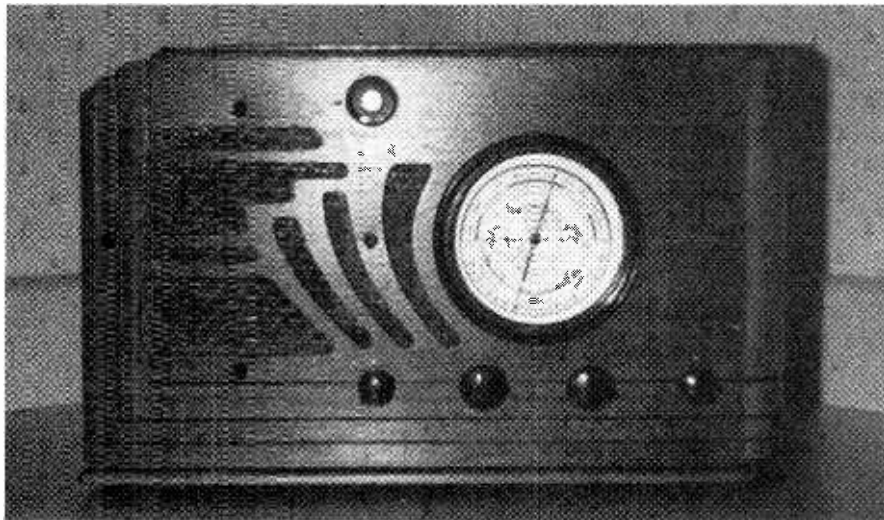
Which set is worth more? If I had to

get rid of one, which would I keep? I'm not sure if I could answer those questions. The T55 certainly cost more when new, but neither radio is exactly a high-priced collectible. And sold individually, they'd probably bring very similar prices at a radio swap meet. My inclination is to keep both variations. Owning a pair of this kind enhances the value of both sets, and it's very interesting and instructive to be able to compare their construction and design.

But whatever your personal philosophy on duplicates and variations might be, be sure you know exactly what you have before you consider disposing of it!

Show and Tell Time. I still have a backlog of nifty photos showing recent reader restorations or acquisitions. For example, last month we took a look at Randy Eppmethe's (Camden, AR) Crosley 148CP—housed in a homebuilt cabinet of his own design. But we didn't have room to do justice to a couple of his other neat restorations. Here, then, are Randy's very good-looking Silvertone Model 4470 and Atwater Kent Model 74 sets, both in original cabinets.

Ken Sanderson, who's an Electronics Technician with the USAF, sends a nice shot of his elegant Philco Model 37-610. Ken's other photo shows a neat 1940's wood-cabinet Emerson table model cheek-by-jowl with a Weston Model 785 Industrial Circuit Tester. He picked up the tester for the princely sum of two bucks, and finds himself using it constantly. Ken's now restoring a German set (NordMende Fidelio 56



Reader Randy Eppmthe's Silvertone 4470 boasts an Art Deco design and a tuning eye.

[3]D). A couple of the tubes are broken and burned out, and have no identifying markings. If you can help Ken with a tube-location chart (hand-drawn is fine) and/or any other information about this set, please write him at 2506 Back Acres Rd., Virginia Beach, VA 23454.

Dan Zeh (3876 Greenbrier Rd., Long Beach, CA 90808) sent along a shot of an Atwater Kent Model 35 battery radio, complete with original speaker, that's been in his family since it was new. Dan and his dad would like make the set play, but aren't sure how to obtain and connect the necessary operating voltages. Dan would like to correspond with people who have been successful in firing up similar equipment.

Info On Early Ham Gear. Every once in a while, a reader will inquire about



Reader Eppmthe tackles consoles with the same flair he uses on table models. This Atwater Kent Model 74 boasts a completely refinished cabinet.

schematics and/or servicing information for early ham radio equipment. For example, Reno Ruggere (504 Grill Ave., Shillington, PA 19607) needs a manual for a Heathkit DX60 transmitter; Bob Perry (5409 South Watterson Trail, Louisville, KY) needs a schematic for a Hallicrafters SX-99 receiver. If you can help Reno or Bob, please write them directly. But the best source I know of for information on old ham, CB, and test gear is an outfit called Hi Manuals (P.O. Box H-802, Council Bluffs, IA 51502).

Here's how you do business with Hi-Manuals: first you must have a copy of their current catalog—which will cost you a buck. The catalog contains complete specifications on all of the schematics, manuals, etc. they have in stock. It also includes prices and ordering information. Pick out what you want, send in your order, and you'll promptly receive your literature. (Typically, you will receive a high-quality, carefully-made reproduction of the original material.) I've turned to this fine source whenever I've needed information on early ham gear, and haven't stumped them yet.

Parts and Services Needed. Bruce Mateer (16 Clarissa Lane, E. Northport, NY 11731) needs a replacement turntable for a 1906-vintage Victrola. Can anyone help?

John H. Rodriguez (123 Colonel's Lane, Weymouth, MA 02189) needs a replacement speaker for a Fada 1000 series radio (Jenson ST-540 or Utica 4PZ will work). He'd also like to get his hands on a phono cartridge for a Symphonic Console #1261 (such as Astatic 80TS-TB or Sonotone 10T2-S).

John W. Dell (608 Marian Drive, Santa Maria, CA 93454) has a Crosley Model 52 with two open audio transformers. Can someone suggest where he could purchase replacements or get his originals repaired? He could also use a schematic of the set.

By the way, if you haven't heard about the "quick and dirty" open audio-transformer winding repair, here it is in a nutshell. Get hold of a high-capacity (perhaps 30 microfarads or so), high-voltage (350 volts or so) electrolytic capacitor and place it across a power supply (be sure to observe marked polarity) delivering close to the capacitor's rated voltage. After letting the capacitor charge for several seconds, shut off the supply, carefully disconnect the capacitor (being



Ken Sanderson's Philco Model 37-610 is a truly elegant piece.

very careful not to come in contact with the terminals), and connect it across the open transformer winding.

By doing this, you will create a spark within the transformer at the location where the winding has opened up. And there's a more than even chance that your spark will weld the severed wire ends together, restoring continuity. At any rate, you certainly have nothing to lose by trying!

Karen L. Warseck (Building Diagnostics Associates, 1109 North 21 Ave., Suite 118, Hollywood, FL 33020) recently received an Atwater Kent Model 84 for her birthday. She needs some assistance in getting the set operational again, and would like to make contact with an antique-radio club in her area.

Christine Stevens (27 Myrtle Ave., No. Plainfield, NJ 07060) has a similar problem. Can anyone suggest where, in the NJ-NY area she could take her Dewald Model H-533 for repair?

Emmett Bonner (53 Warren Ave., Tuckahoe, NY 10707) has a Reinartz 2 antique-radio kit purchased from Dick Smith Electronics of Australia. Emmett needs two replacement VT-50 tubes
(Continued on page 98)



Computer Bits

DISASTER STRIKES

By Jeff Holtzman

It was bound to happen: my two-year old true-blue IBM XT gave a final cough, sputtered, and died. It couldn't have happened at a worse time. I try to be prepared, so I had a spare clone motherboard lying around. I disassembled my PC, installed the clone, and put it all back together.

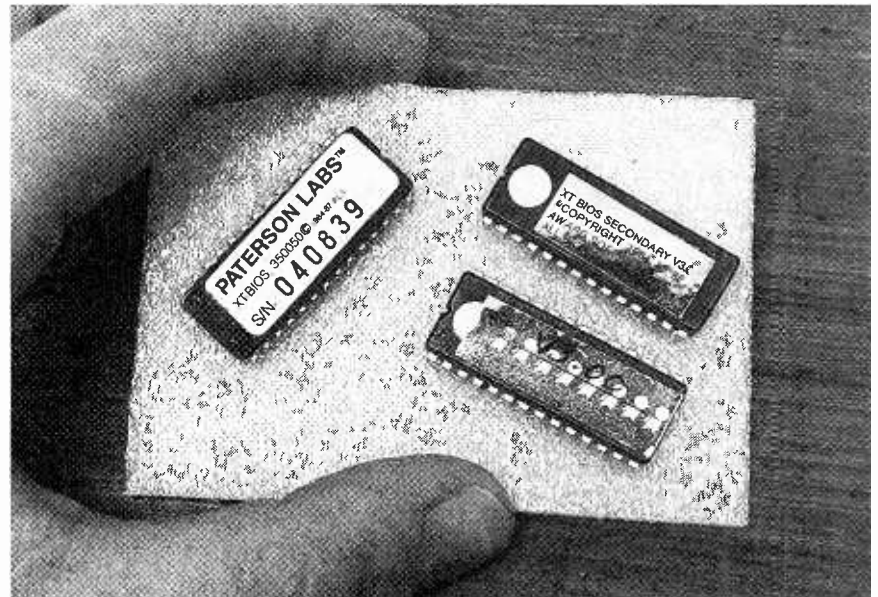
However, some of my software wouldn't work. The problems weren't serious—my screen output kept getting messed up, but my data seemed intact. Also, my 101-key keyboard wouldn't work; I had to use an XT-style board, and switching between it and my AT (which has a 101-key style board) was driving me crazy.

The obvious culprit was the BIOS on the clone board. Unfortunately, there was no way to get a new BIOS from the distributor. However, I thought I had an easy fix. A few years ago, something similar happened to a friend. And was he mad! He figured that he paid a premium to own a real IBM and expected it to last forever. I told him there was a way to have his cake and eat it too; he could copy the ROM BIOS on his old motherboard into EPROM's that would fit on his new motherboard.

As long as he didn't run more than one copy of that BIOS at a time (or give away copies), I didn't see anything unethical about it.

So when my IBM motherboard went belly-up, I prescribed the same medicine for myself. I ordered a set of 2764 EPROM's, went through a rather complicated procedure to copy the BIOS and BASIC ROM's into the EPROM's, and at last plugged them in to my system board.

No go. No sign-on message, no memory count. Nothing. After thinking about it, I realized that my IBM XT's motherboard is different from earlier versions. The biggest external difference is that the newer motherboard can handle 640K of memory; the older ones, only 256K. I also surmised there



Resuscitate that "compatible" XT with a new BIOS. An 8K Phoenix BIOS is shown on the left; a 16K version from Award (also available in a single chip) is shown on the right.

were other differences that prevent the BIOS from running on the older board, on which virtually all low-cost clone boards are modeled. So much for cloning my IBM BIOS.

Then I recalled clipping ads from several companies selling BIOS'es for XT's and AT's. I dug the ads out of my files and ordered a BIOS from two companies.

Seeing what problems I had running the IBM BIOS on my clone, I was suspicious about those third-party BIOS's. As it turned out, however, both worked fairly well; neither suffered the screen-incompatibility problems I'd been having with the no-name BIOS that came with the board. I got a 101-key keyboard to work too.

Each BIOS was written by a major software house (Phoenix Technologies and Award Software), so you won't have to fear compatibility problems. However, neither is sold directly by those companies; you must make purchases through authorized dealers. Though I tested XT BIOS's, versions for AT's and 386's are also available.

Award BIOS. Komputerwerk sells the Award BIOS; it comes on either one 16K (\$60) or two 8K (\$65) EPROM's. Older motherboards with six ROM sockets usually require the 8K set; newer boards with only one socket take the single 16K IC. The price aside, the two versions are identical.

The main features of the Award XT BIOS are as follows:

- Comprehensive POST (Power On Self Test)

- Supports 1.2MB (5.25-inch) and 720K (3.25-inch) disk drives (with appropriate disk controller)
- Supports both XT (84-key) and 101-key keyboards
- Speed switching on dual-speed (turbo) motherboards

I got the two-IC set, installed it, booted, and ran all my software and hardware with only one problem (discussed below). My hardware included a Hayes 2400-baud internal modem, a Teletek EMS memory board, a generic multi-I/O board, a PC3G accelerator card, and a Western Digital hard-disk controller. My software included OmniView 4.1, AutoSketch 1.04, Q&A Write, GrandView, PC-File+, and numerous utility programs.

The Award BIOS redefines the meaning of several positions of the DIP switch on the motherboard: Switches 2 and 3 choose between 3.5- and 5.25-inch drives, and switch 4 chooses between XT- and AT-type controllers. (See "Computer Bits," March 1989, for a discussion of the differences between the types of controllers).

The only problem I experienced was that my 101-key IBM keyboard would not work; the machine booted with a message stating "Keyboard error or keyboard not present." Then I plugged in the 101-key keyboard from my AST (an AT compatible) and it worked fine, the IBM keyboard also worked fine on the AST. Now, for the first time in months, I've got keyboards with identical layouts on my two main machines!

Komputerwerk acknowledges the possibility that a BIOS may not work on some odd-ball clones, so the company offers a money-back guarantee (less a \$10 restocking fee), as long as the IC(s) are returned in saleable shape.

The company also sells a number of subroutine libraries for BASIC programmers.

Phoenix BIOS. Wholesale Direct sells the Phoenix BIOS in versions for XT's, AT's, and 386's. Like the Award BIOS, the Phoenix BIOS supports enhanced (101-key) keyboards and 3.5-inch disk drives, but the Phoenix also supports high-density (1.4MB) 3.5-inch drives. It comes in a single 8K ROM, and is also less expensive (\$34.95) than the Award.

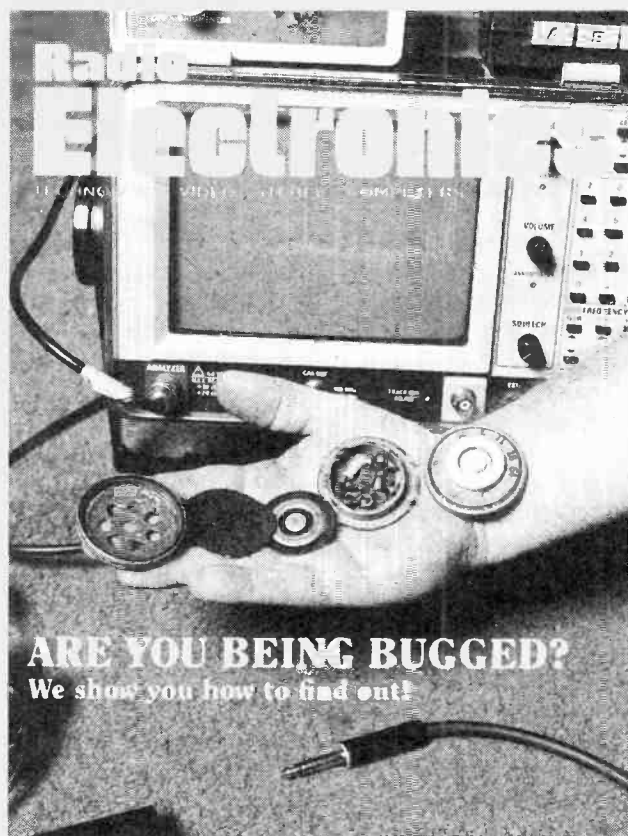
I had good experiences with the Phoenix BIOS. All hardware and software I tested worked fine, except for the IBM keyboard. When it was connected, the machine wouldn't boot. The AST keyboard worked fairly well, but some applications programs could not read some keystrokes properly—shifted versions of the cursor-pad keys, in particular.

Wholesale Direct offers a 30-day money-back guarantee; the company also sells a number of books, software, and hardware accessories for PC's.

Conclusions. The Phoenix BIOS is more compact, supports both 3.5-inch floppy-drive types, and is less expensive; however, its inability to handle some key combinations made using GrandView difficult, so I'll stick with the Award BIOS.

Of course, I wouldn't buy an XT today; but I couldn't just throw away my old system. I need two PC's, and I couldn't afford the upgrade I'd like (junk the XT, make the AT my "girl Friday," and buy a 386 for work that demands speed). So for about \$150, my XT got a new lease on life. Next time it breaks...we'll see. ■

WATCH FOR THIS ISSUE ON SALE MAY 4, 1989



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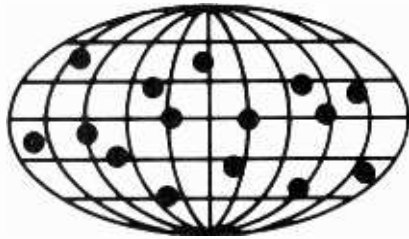
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DX Listening

SUNSPOT CYCLE HEATS UP

By Don Jensen

In the December, 1988 column, I noted that the experts had suggested that the present sunspot cycle, now on its upswing, could prove to be the most active cycle recorded in two centuries. As of this writing, nothing has happened to significantly alter that prediction. It still looks like the current cycle, which should peak late this year, will be a memorable one.

As regular readers are aware, for I've talked about them from time to time, sunspots affect radio reception in various ways. Those eruptions on the solar surface, which burst into geomagnetic "storms" of energy, occur in roughly 11-year cycles. They go from near nil in the low month of a cycle to anywhere from 100 to 200 sunspots a month at the cycle's peak.

In past centuries, they have been blamed for everything from insanity to prolific rabbit breeding. Today we know a good bit about sunspots, although scientists still do not understand their full impact on our planet. Daily newspapers have reported, and often exaggerated, the negative impact. The press accounts tend to focus on worst-case scenarios, noting that geomagnetic storms can knock satellites from their orbits, cause surges of power in electric lines, block critical communications, and once blacked out all of Sweden.

In fact, most DX listeners are finding positive results as a result of the increased sunspot activity. Now, in mid-1989, shortwave listeners are finding improved reception on the higher frequencies, especially around 17 MHz. The 21-MHz band is often wide open during the daylight hours, bringing in top quality SW signals from around the world.

But of special interest right now is the

11-meter band—the frequencies from 25,600 to 26,100 kHz—which has come alive with a number of interesting shortwave signals after being (quite frankly) dead as the proverbial doornail for a number of years.

In fact, you may have tuned around that band a few years back when you bought your receiver. If so, you undoubtedly found it completely devoid of signals and may have never returned to those frequencies. If that's the case, then look again now. There are a number of stations to be heard there, and often with quality signals.

Here are some 11-meter targets for your listening:

25,690 kHz—*Radio Liberty* (RL) is the American-sponsored partner of the better-known *Radio Free Europe* (RFE). That frequency is used by an RL transmitter at Gloria—near Lisbon, Portugal—for Russian-language programs to the Soviet Union. Look for it shortly before 1300 UTC, with ID as "Radio Svoboda," followed by Russian-language news.

25,730 kHz—*Radio Norway International* (RNI) can be found on that frequency at about 1151 UTC with an interval signal and identification in both Norwegian and English. Norwegian programming follows until 1250 UTC.

25,750 kHz—The *British Broadcasting Corp.* (BBC) airs its English language World Service on this 11-meter frequency from a transmitter in the British Isles. The channel opens at 1100 UTC and continues during the morning hours.

25,790 kHz—*Radio South Africa* (RSA) is South Africa's international shortwave service. It has been noted with English programming at around 1530 UTC.

25,820 kHz—*Radio France International* (RFI) has French programming to Africa, but as daylight comes to North America this station puts in a decent signal into the western hemisphere, as well. Listen in at around 1130 UTC.

25,850 kHz—*Radio Denmark* (RD) uses this frequency to beam its programs to Australia and India. It too can be heard in the U.S. and Canada. Listen in on RD when it comes on the air at about 1155 UTC with identification in both Danish and English. This transmission closes at 1252 UTC.

25,900 kHz—*Voice of the United Arab Emirates* (VUAE) at Abu Dhabi in the Persian Gulf area periodically has been operating on this frequency, noted as early as 1230 UTC until sign off at around 1600 UTC.

Feedback. The Rev. William J. O'Donnell of Mary Queen of Peace Church in Mandeville, LA, a licensed radio amateur (W5UPM) as well as a shortwave listener, has some questions about the *American Forces Radio and TV Service* (AFRTS).

"A missionary in Guatemala usually listens to American Forces Radio for news and sports, especially U.S. football games. But it seems he can no longer hear these transmissions in Cen-

*Credits: Ray Bauernumber, NY; Harold Sellers, ONT; Tom Daly, NY; Richard Cooper, CT; Richard D'Angelo, PA; Dan Sheedy, CA; Harold Levison, PA; North American SW Association, 45 Wildflower Rd., Levittown, PA 19057.



Like most major SW broadcasters, China's Radio Beijing sends out a regular program schedule to listeners. This is the attractive cover of one of its recent schedule brochures.

tral America. Did AFRTS cut back on their programming? Did they change frequencies? How can I get a schedule of AFRTS broadcasts?"

Bad news, not only for your missionary friend but for an unknown number of Americans overseas—both military and civilians—who for years have relied upon the AFRTS shortwave transmissions for a real taste of what's going on at home.

Last fall, the American Forces Radio and TV Service discontinued its shortwave transmissions. The Department of Defense decided that the Voice of America—the government-operated shortwave service, whose transmitting facilities AFRTS has used for decades—was charging too much. The VOA's bill to the military was about \$1.5 million annually.

Although SWL's may not have been aware, for a number of years the primary purpose for AFRTS shortwave was to feed programs to local military stations, FM and some AM, at bases around the world. The direct listenership to SW was considered distinctly secondary, although for some small Navy ships at sea it did provide a primary service.

AFRTS is replacing its former shortwave transmissions with satellite links. That may be fine for feeding sports and news broadcasts to military outlets abroad, but it leaves many former listeners high and dry!

It is a ludicrous situation, in my view. Both the VOA (which sold the shortwave air time) and AFRTS (which bought it) are different agencies of the same government, so the "cost" of using VOA's transmitter is really no more than transferring money from one pocket to another!

AFRTS had many faithful listeners who are not being served by the replacement satellite system. Included among those listeners are American expatriates and travelers abroad; U.S. listeners who find its radio play-by-play sports coverage to be unmatched on AM medium-wave, domestic radio; and foreign nationals abroad who find it a refreshing alternative to the VOA for news and features about the United States.

Readers who strongly feel AFRTS should return to shortwave are urged to write their Congressmen and Senators to complain!

Here's a tip on how, at least for the time being, you may still be able to hear some AFRTS programming on

ABBREVIATIONS	
AFRTS	American Forces Radio and Television Service
AM	amplitude modulation (modulated)
BBC	British Broadcasting Corporation
DX	long distance (over 1000 miles)
FM	frequency modulation (modulated)
kHz	kilohertz (1000 hertz or cycles)
MHz	megahertz (1-million hertz or cycles)
RAE	Radiodifusion Argentina al Exterior
RD	Radio Denmark
RFE	Radio Free Europe
RFI	Radio France International
RL	Radio Liberty
RNI	Radio Norway International
RSA	Radio South Africa
SW	shortwave
SWL(s)	shortwave listener(s)
US	United States
UTC/GMT	Universal Time Code/ Greenwich Mean Time
VOA	Voice of America
VOK	Voice of Kenya
VUAE	Voice of the United Arab Emirates

shortwave. A non-VOA point-to-point, lower-sideband transmitter at Barford, England is still used by the U.S. military for relaying AFRTS programming. It is operating on 9,334 kHz at certain times of the day, for instance, around 0130 UTC. How long it will continue to be on the air, however, is not at all clear.

Down the Dial. Why not let us know what you are hearing. Your SW loggings for our monthly "Down the Dial" segment, as well as your letters, comments, and questions on shortwave subjects, are always welcome. Send them to *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. And now, here are some of the shortwave catches others are logging.

Argentina—11,710 kHz. *Radiodifusion Argentina al Exterior* (RAE) is the international shortwave station of the Argentine government in Buenos Aires. Look for English programs about 0200 UTC.

Bulgaria—7,670 kHz. The Bulgarian home service station at Stolnik can sometimes be heard here around 0330 UTC.

Czechoslovakia—5,930 kHz. *Radio Prague* is noted around 0320 UTC with a musical program, "Made in Czechoslovakia."

England—6,080 kHz. *Voice of America* (VOA) programs in Hun-

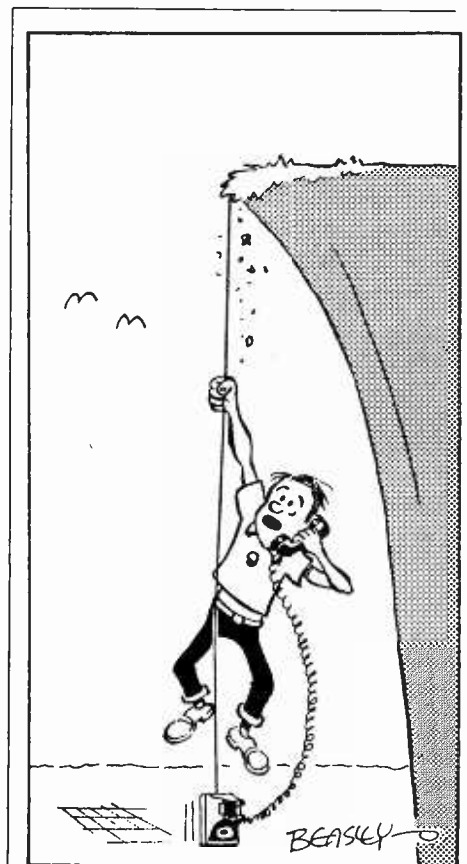
garian are relayed from a British Broadcasting Corp. shortwave transmitter at Wooferton until 0600 UTC. After that, the VOA programming you hear is from a Stateside transmitter at Greenville, NC.

Kenya—4,934 kHz. *Voice of Kenya* (VOK) has been noted from shortly after 0300 UTC with a young woman announcer reading the news in English.

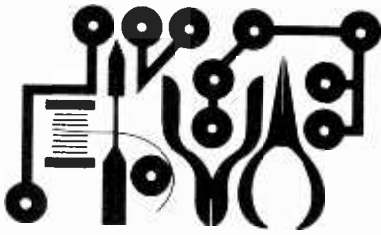
USSR—4,996 kHz. Most SWL's are familiar with the time-signal stations WWV in Fort Collins, CO., and WWVH in Hawaii, both of which operate on 5,000 kHz. However, a time-ticker has been noted 4-kHz lower, and is believed to be RWM from Moscow. Look for parallel signals on 9,996 and 14,996 kHz.

Vatican—9,605 kHz. *Vatican Radio* broadcasts in English at 0050 UTC on this 31-meter band frequency.

Venezuela—4,980 kHz. *Ecos del Torbes*, which is located in the Venezuelan city of San Cristobal, can be heard on this frequency with Spanish language programming during the early evening hours, from around 0100 UTC. ■



"No, I don't have a cordless phone—and to tell you the truth, right now I'm glad I don't."



Circuit Circus

MORE TRANSISTOR CIRCUITS

By Charles D. Rakes

This month's first circuit picks up where we left off in our last column—namely, exploring the world of power MOSFET's. There's one important area that we didn't cover and that's where the power MOSFET really shines. It's an ideal device to use in high voltage circuits because it doesn't suffer from the dreaded secondary-voltage breakdown that plagues the common power transistor. And any number of MOSFET's can be paralleled without requiring a special high-wattage, current-equalizing resistor.

Our shop's treasure chest of spare parts contained a number of IRF731 hexFET's with a V_{DS} (drain-to-source voltage) rating of 350-volts; a 1-ohm R_{DS} (on-state resistance); a maximum I_D (drain current) of 3.5 amps; and a maximum power-dissipation rating of 75 watts. There are a number of similar hexFET's that are available for less than \$3.00 that will work just as well in a high voltage circuit. I'd suggest obtaining a copy of Digi-Key's (701 Brooks Ave. South, PO Box 677, Thief River Falls, MN 56701; Tel. 800/344-4539) catalog, which lists two full pages of hexFET's.

Flip the Switch. Our first application (see Fig. 1) has an IRF731 hexFET operating as a high-current switch in a high-voltage generator circuit. Two gates of a 4049 hex inverting buffer (U1-a and U1-b) are configured as a simple squarewave-generator circuit. The output of the squarewave generator

(a narrow positive pulse) at pin 2 of U1-b is fed to the gate (G) of Q1 through an R/C combination (consisting of R2 and C2), causing it to switch on and off at the same rate.

The fast switching current through the primary of T1, an automobile-ignition coil, is transformed into a high-voltage at T1's secondary. Caution! Keep all attached body parts away from the output of T1. The high-voltage output of T1 is great enough to jump from the output terminal to one or both of the primary terminals.

If the high voltage circuit is to be operated for any length of time, a heat sink with a minimum area of 9 square inches should be attached to Q1. A piece of scrap aluminum will do just fine. The circuit can be operated with an input voltage as high as 16 volts for short periods of time for even greater output voltages.

PARTS LIST FOR FIGURE 1

- U1—4049 inverting hex buffer, integrated circuit
 - Q1—IRF731, or similar hexFET
 - R1—2.2-megohm 1/4-watt, 5% resistor
 - R2—10,000-ohm 1/4-watt, 5% resistor
 - C1—.0036- μ F, mylar-capacitor
 - C2—680-pF, ceramic disc capacitor
 - C3—220- μ F, 16-WVDC, electrolytic capacitor
 - T1—Automobile-ignition coil (any type)
- Printed-circuit or perfboard materials, heat-sink material, 12-volt 2-amp power source, IC socket, wire, solder, hardware, etc.

Non-Integrated Inverter. Have you ever needed just one more gate or inverter stage to finish that special circuit design? Or do you sometimes find that an inverter or gate is lacking in output drive? If so, why not consider one of the following simple add-on circuits, built around discrete transistors, to fill that void.

The circuit shown in Fig. 2 is a simple inverting amplifier that can be driven from most CMOS or TTL IC's. The truth table for that circuit is the same as what might be expected from an ordinary integrated-circuit inverter: *i.e.*, high in, low out; low in, high out.

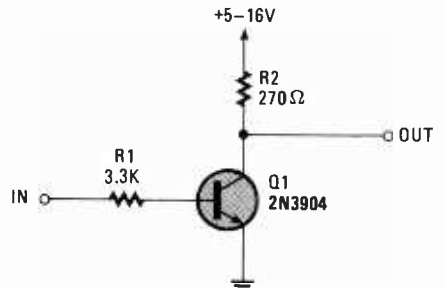


Fig. 2. This simple inverting amplifier, built around discrete components, can be driven from most CMOS or TTL IC's.

When the inverter's output is high, it will supply drive current, limited by the value of R2 and the transistor, to whatever circuitry is connected to its output. When the inverter's output is low, the circuit connected to its output will be pulled to ground. The amount of current the transistor can sink depends on its gain and power handling capabilities.

PARTS LIST FOR FIGURE 2

- Q1—2N3904, 2N2222, or similar NPN silicon transistor
 - R1—3300-ohm, 1/4-watt, 5% resistor
 - R2—270- to 1000-ohm, 1/4-watt, 5% resistor (see text)
- Printed-circuit or perfboard materials, 5- to 16-volt power source, wire, solder, etc.

Non-Integrated Buffers. The circuit in Fig. 3 is a non-inverting amplifier that can be used to increase output drive current. Like its integrated counterparts, its truth table says that a high input gives a high output, and a low input gives a low output (see note below).

Unlike the previous circuit, this one is somewhat more complicated, so a brief circuit description is in order: When a positive input is applied to the base of Q1, it turns the transistor on, pulling the base of Q2 low, turning Q2

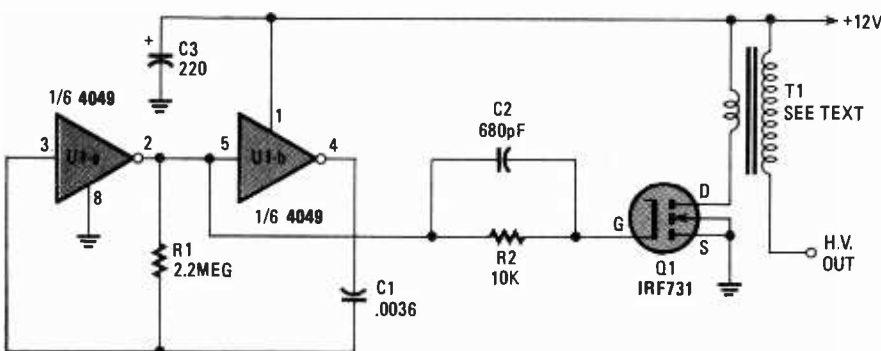


Fig. 1. In this circuit, an IRF731 hexFET and two gates of a 4049 hex inverting buffer are configured as a squarewave-generator circuit, with Q1 operating as a switch.

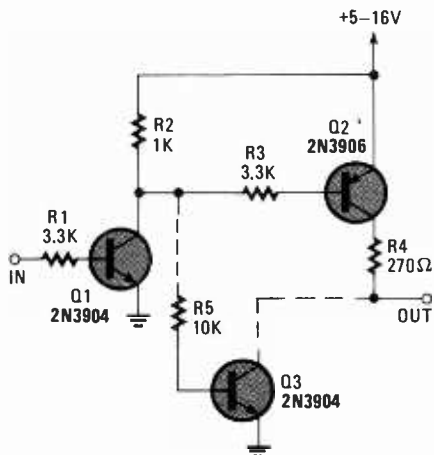


Fig. 3. The non-integrated buffer, like its integrated counterparts, can be used to increase the output drive current.

on. At the same time, the low at the collector of Q1 is also applied to the base of Q3, causing Q3 to turn off. That means that the circuit's output is the supply voltage minus the voltage drop found across Q2 and R4.

When the input is low, Q1 and Q2 are both off. With Q2 off, it can not sink any current from its output. If the circuit that the driver is connected to requires the load to be pulled to ground, transistor Q3 must be added. With Q1 off its collector is near the supply voltage, which supplies bias to Q3, turning it on and clamping the output to ground. When Q1 turns on, bias is removed from the base of Q3, turning it off and unclamping the output.

The circuit in Fig. 4 is actually two of the single inverting stages of Fig. 2 connected in tandem. The truth table for this circuit is the same as that for the circuit in Fig. 3, and its output drive and sink-current capabilities are the same as the circuit in Fig. 2.

Figure 5 is an inverting circuit with an output driver similar to the one in Fig. 3, but it offers the maximum in output drive capabilities, limited only by Q3 and R5. Naturally the ultimate limita-

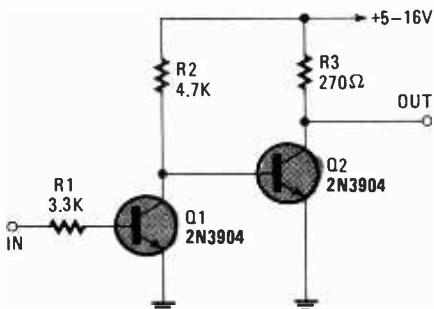


Fig. 4. Two of the single-transistor inverter circuits shown in Fig. 2 are connected in tandem, forming this non-integrated buffer/amplifier circuit.

PARTS LIST FOR FIGURE 3

Q1, Q3—2N3904, 2N2222, or similar silicon NPN transistor
 Q2—2N3906, 2N3638, or similar silicon PNP transistor
 R1, R3—3300-ohm, ¼-watt, 5% resistor
 R2—1000-ohm, ¼-watt, 5% resistor
 R4—270- to 1000-ohm, ¼-watt, 5% resistor (see text)
 R5—10,000-ohm, ¼-watt, 5% resistor
 Printed-circuit or perfboard materials, 5- to 16-volt power source, wire, solder, hardware, etc.

tion is dictated by the current-handling capacity of the power source that supplies the circuit.

The next two add-on circuits feature the almost "perfect" transistor, the power MOSFET, to perform jobs that are ideally suited to those component's superior electrical characteristics.

PARTS LIST FOR FIGURE 4

Q1, Q2—2N3904, 2N2222, or similar silicon NPN transistor
 R1—3300-ohm, ¼-watt, 5% resistor
 R2—4700-ohm, ¼-watt, 5% resistor
 R3—270- to 1000-ohm, ¼-watt, 5% resistor (see text)
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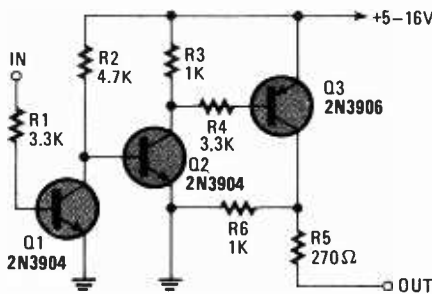


Fig. 5. This non-integrated buffer, like the circuit in Fig. 4, uses two inverter stages, but its output is fed to a transistor driver circuit.

PARTS LIST FOR FIGURE 5

Q1, Q2—2N3904, 2N2222, or similar silicon NPN transistor
 Q3—2N3906, 2N3638, or similar silicon PNP transistor
 R1, R4—3300-ohm, ¼-watt, 5% resistor
 R2—4700-ohm, ¼-watt, 5% resistor
 R3—1000-ohm, ¼-watt, 5% resistor
 R5—270- to 1000-ohm ¼-watt, 5% resistor
 R6—1000-ohm, ¼-watt, 5% resistor
 Printed-circuit or perfboard materials, 5- to 16-volt power source, wire, solder, hardware, etc.

The simple inverter circuit in Fig. 6 operates like a switch when the input goes high, and is capable of sinking up to 3 amps at its output. If 3 amps isn't enough, you can sink up to 6 amps by connecting another power MOSFET in parallel. The maximum drive current at the output of Q1 is determined by the value of R2 and the maximum drain-current capacity of the power MOSFET.

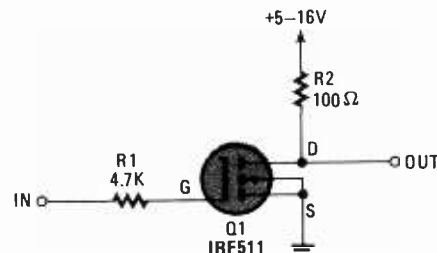


Fig. 6. Here a single MOSFET is used to form a switch, whose operation is like that of an inverting-buffer.

One of the best features that the power MOSFET has to offer in such applications is the extremely low gate-drive current needed to switch from an off to an on condition. If you need to drive additional circuitry from an IC gate or inverter stage that is functioning at its maximum output, the power MOSFET add-on circuit is the way to go. Note: Although R2 is shown as a 100-ohm resistor, its value can range anywhere from 100 to 1000 ohms.

PARTS LIST FOR FIGURE 6

Q1—IRF511 power MOSFET
 R1—4700-ohm, ¼-watt, 5% resistor
 R2—100- to 1000-ohm, ¼-watt, 5% resistor
 Printed-circuit or perfboard materials, 5- to 16-volt power source, wire, solder, hardware, etc.

The non-inverting stage, shown in Fig. 7 uses two power MOSFETs in a circuit similar to the one in Fig. 4, and the same truth table applies.

These few add-on logic circuits are by no means a panacea for all of our

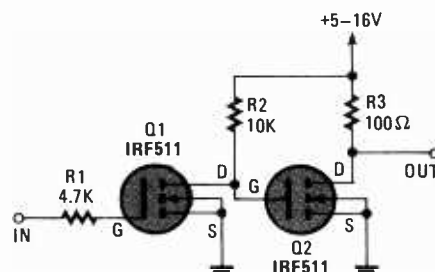


Fig. 7. Here two FET inverters (like those in Fig. 6) are connected in series, producing a non-inverting buffer.

inverter and gate shortfalls but, in many instances they can fill in where there's no room or desire to add one more IC for a single function. And there's no reason that the add-on circuits can't be useful in projects that are designed around discrete components.

Now, for a change of pace . . .

PARTS LIST FOR FIGURE 7

Q1, Q2—IRF511 power MOSFET
 R1—4700-ohm, ¼-watt, 5% resistor
 R2—10,000-ohm, ¼-watt, 5% resistor
 R3—100- to 1000-ohm, ¼-watt, 5% resistor
 Printed-circuit or perfboard materials, 5- to 16-volt power source, wire, solder, hardware, etc.

PARTS LIST FOR THE ELECTRONIC WHEEL OF FORTUNE

SEMICONDUCTORS

LED1-LED10—Light-emitting diode (any color)
 Q1—2N3904 NPN or similar GP transistor
 U1—353 dual op-amp, integrated circuit
 U2—4017 decade counter/divider, integrated circuit

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
 R1, R8, R9, R10—10,000-ohm
 R2—15,000-ohm
 R3, R12—100,000-ohm
 R4, R5, R6, R11—47,000-ohm
 R7—4700-ohm

R13—1000-ohm
 R14—10,000-ohm potentiometer

CAPACITORS

C1—0.22-μF, 100-WVDC, mylar
 C2—47-μF, 16-WVDC, electrolytic
 C3—220-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—9-volt transistor-radio battery, or AC power supply
 S1—Normally-open pushbutton switch
 S2—SPST toggle switch
 Printed-circuit or perfboard materials, enclosure, IC socket, 9-volt transistor-radio battery and battery connector, wood, wire, solder, hardware, etc.

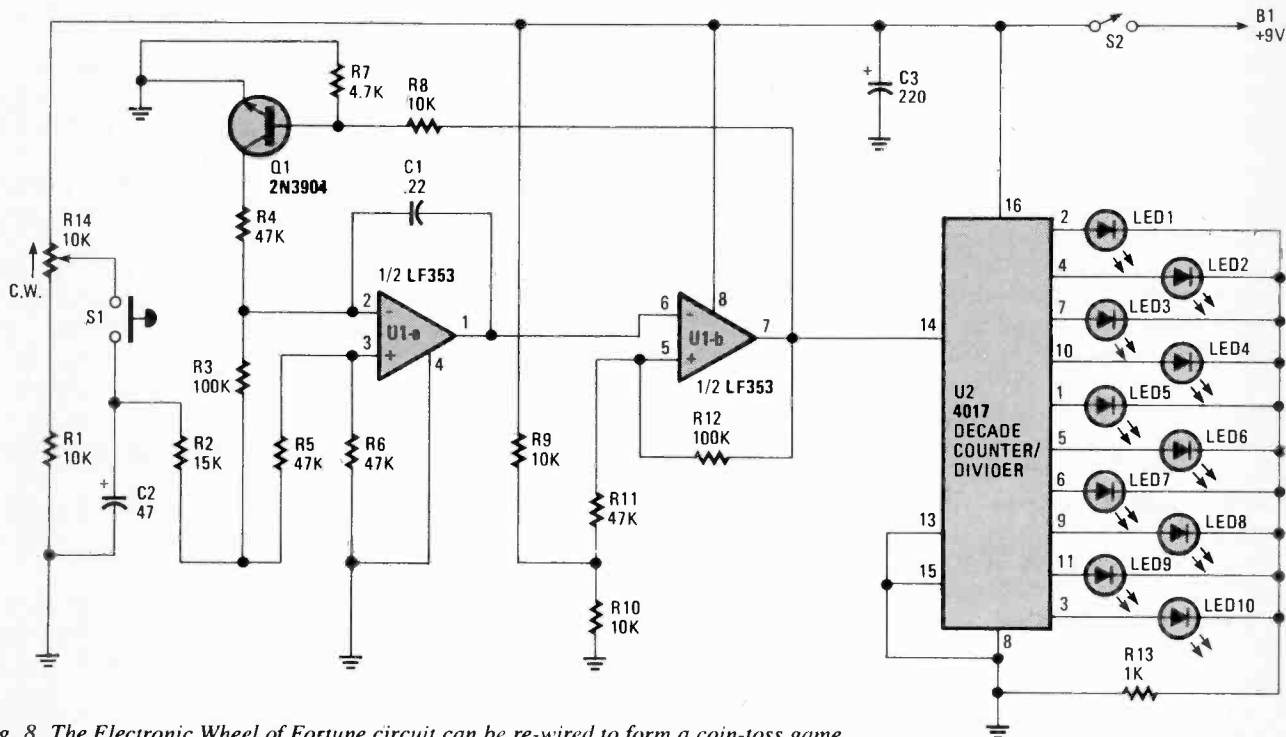


Fig. 8. The Electronic Wheel of Fortune circuit can be re-wired to form a coin-toss game, an electronic decision maker, and other similar game circuits.

Electronic Wheel of Fortune. The next circuit (see Fig.8)—comprised of a couple of IC's and several assorted components—is, more or less, an electronic version of the mechanical "Wheel of Fortune" game. The actual wheel can be sketched out to whatever size and shape you desire on a piece of thin plywood or similar material and painted to suit your needs.

The art work and layout design, along with the neatness of construction, can turn this project into a real success story for parties and fun get togethers.

Integrated circuit U1 (an LF353 dual op-amp) is configured as a low-frequency, voltage-controlled oscillator (VCO). The oscillator's operating frequency is determined primarily by the value of C1 and the voltage feeding the VCO's input. The oscillator's output (at pin 7) is fed to pin 14 of U2 to step the ring of LED's around in a circle.

To give the wheel a little "english," the input voltage feeding the run-timing capacitor, C2, is made variable via R14. When S1 is pressed, capacitor C2 charges to the voltage that's preset by R14. The VCO starts oscillating at its

highest frequency, for that input voltage, and as the timing capacitor discharges, the frequency slows down, giving the effect of the wheel turning slower and slower until it stops at one of its 10 positions.

The circuit can be put together on perfboard, printed-circuit board, or any other workable method you desire, but in any case, sockets should be used for the IC's. If the game is to be used for long periods of time, an AC-operated power supply would be a wise choice. But for light use, even a small 9-volt, transistor-radio battery will give several hours of wheel turning.

(Continued on page 101)

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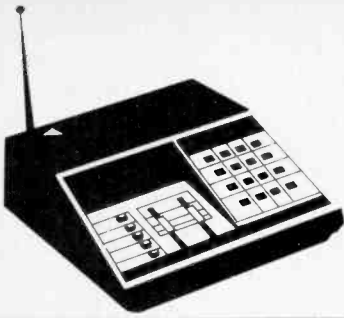
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Scanner Scene

By Marc Saxon

AN INEXPENSIVE SCANNER

What with so many sophisticated and upscale scanners being moved out into the market place, you begin to wonder what they had in mind for a beginner to use; or someone working within a limited budget; or a person who simply doesn't require 300 channels of memory, selectable monitoring modes, etc. Well, all is not lost! Radio Shack's *Realistic PRO-57* is a nice little \$139.95 scanner that meets all of the requirements stated above.

This very recent addition to Radio Shack's scanner line (it's not even listed in their current catalog) is a small and attractive ten-channel programmable unit. Its frequency coverage ranges from 30 to 54 MHz, 138 to 174 MHz, and 380 to 512 MHz, with 1.0- μ V sensitivity on all bands.

Nothing fancy, mind you, but all of the basics are there like a respectable scanning rate of 8 CPS (Channels-Per-Second), selectable delay, individual channel lockouts, keyboard programmability, an easy-to-read LCD display, and small size (about 2 x 7 x 8 inches).

It's so simple to program and operate that it makes a perfect gift for anyone who would enjoy getting into scanning if only they could be introduced to it in the most basic way possible. Or, you might consider the PRO-57 as a suitable candidate for a backup scanner, or for taking along on your vacation (it weighs only 24 ounces). You can check out the Realistic PRO-57 at your nearest Radio Shack.

In the Mail. Jim Carlisle, Houston, TX advises that the Houston Channel Area Emergency Mutual Aid Network is made up of the numerous refineries and chemical plants that abound along the Houston Ship Channel. Whenever an accident at one of those plants takes place, the frequency makes for fascinating listening, or at least it did.



Radio Shack's Realistic PRO-57 is a small, ten-channel programmable scanner that provides frequency coverage from 30 to 54 MHz, 138 to 174 MHz, and 380 to 512 MHz, with 1.0- μ V sensitivity in all bands; it lists for \$139.95.

Jim says that the frequency has been strangely silent of late, even during a recent plant mishap that should have triggered it into several hours of activity. He suspects that the whole operation has switched to another frequency while he wasn't looking.

And right you are! Look for that active network on its new frequency of 488.8875 MHz. That should put you right back in the middle of all of the action.

From the Pacific Northwest comes a note from Kirk Carlson specifying that scanner owners in the Seattle area can keep on top of local news crews by monitoring the following frequencies: KING-TV on 450.5125 and 450.6125 MHz; KOMO-TV on 161.76 MHz; KING-AM on 161.73 MHz; KIRO-AM on 161.64 MHz; and KOMO-AM on 450.4125 MHz.

A question about 800-MHz reception has come in from several readers asking about improving reception in that band without too much fuss. One

Florida reader reported an easy route was to get a Radio Shack mag-mount cellular mobile antenna (Radio Shack 17-302) and use that. Note that cellular antennas come with cables that terminate in TNC-type connectors. You can easily snip off the TNC and replace it with a PL-259 or BNC as required by your scanner.

If you don't want to cut off the TNC, you can rig up an adaptor to connect it to your scanner. For instance a UG-273/U (Radio Shack 278-121) BNC

female to PL-259 plug adaptor will work if you gently file down the posts on the sleeve of the jack until they are flush against the sleeve and the TNC fits.

Johnny Balsam, Brandon, VT complains that some handheld scanners never seem to have sufficient audio output and he wonders what might be done to improve things in that department.

For more audio, try a 1-watt amplified speaker (Radio Shack 32-2031) or CD cassette adaptor (Radio Shack 12-951). Just plug it into the headphone jack of your scanner and you'll probably have more audio than you need.

Milt Harrison, who lives in southwestern Missouri likes to monitor law-enforcement agencies and notes that sometimes they announce that they are shifting to a tactical ("TAC") frequency. He says that he has been able to monitor the regular local frequencies in the VHF high band, but he

hasn't been able to locate the TAC frequencies either by searching the VHF high band or by checking all of the frequencies listed in a recent Police Call. He now wonders if perhaps the frequencies he seeks are not in the 150- to 155-MHz band, but are in the 400- or 800-MHz bands, instead.

Milt wasn't specific enough about the agencies he was monitoring and which frequencies were tried, however a couple of observations can still be made. First, I'd hardly consider Police Calls to be a suitable first line of information for anyone into monitoring beyond the knowledge and interest of the rankest novice.

While the tactical frequencies sought might well be (as suspected) in the 400- or 800-MHz bands, they might also be using low-power handheld transceivers for direct (non-repeater) communications on frequencies you've already monitored without success in the 150-MHz band.

Such transmissions would be picked up only within a mile or two range. I might also add that more than a few law enforcement agencies are now using regular cellular mobile telephones for surveillance and certain other tactical activities.

Phil O'Donnell, Memphis, has "bleed over" problems in his scanner from an FM-broadcast station located about a mile from his home. The FM station causes quite a ruckus on several frequencies and has rendered the search/scan feature of his scanner virtually useless. The unit simply locks up on the FM signal and refuses to budge. He asks if we can offer any solutions to his dilemma.

That's is not an uncommon problem and can often be eliminated with an FM trap such as a Radio Shack 15-577, or equivalent.

A number of readers have written to say that the Soviet manned space program uses a number of frequencies, including one that can be picked up on many scanners. That is 143.625 MHz, with your scanner (preferably) set for wideband FM mode. You might hear voice, telemetering, or RTTY at various times.

We would like to hear from you with your questions, comments, news items, suggestions, and frequency information. If you've got a photo of your radio room, send that along, too. Our address is, *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

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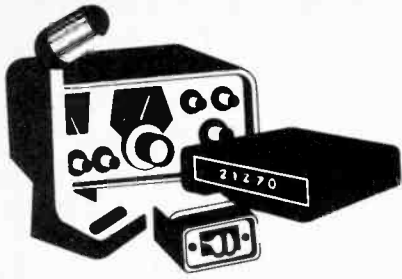
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Ham Radio

HAMFEST SEASON IS HERE!

By Joseph J. Carr, K4IPV

Spring is for romance, winter for surviving, but summer and fall are for hamfests; an absurd get together (usually held out of doors) at which amateur-radio operators swap and sell old "junk." Every summer the amateur-radio community holds hundreds of hamfests around the country. Starting off the season in April, is the mammoth Dayton (Ohio) Hamfest—literally the galactic magnet for amateur-radio buffs and the vendors who serve them. But there are also many local and regional bashes that are just as good qualitatively, only smaller.

I usually have time to attend only a few hamfests every year, but I at least try to make the Gaithersberg (MD) Hamfest. Although I've missed a few over the years, I've managed to break away for most of them. If you've never been to a hamfest, then try to make at least one this year.

The Happenings. There are several different activities at hamfests. Commercial vendors will be set up, many of

them offering bargain discounts on ham gear. I bought my Kenwood TS-130 at a hamfest for about 10-percent less than the same dealer sells it for normally. If a building or shelter is available, the dealers will usually, but not always, be inside.

Tailgaters (as they are called) are individual hams who want to sell or swap gear, parts, or just about anything else. The tailgating area is like one vast ham-radio yard sale. And there seems to be something for everyone at hamfests. If you are a fan of Marc Ellis' *Antique Radio* column then hamfests may be prime shopping grounds.

Although I'm not an expert on antique-radio prices, it seemed to me that of the four individuals or dealers who had antique radios for sale, only one of them asked what seemed like inordinately high prices...and true to the capitalist system, he didn't have the crowd that the other guys did.

A lot of people combine their hobby with a little business. My old friend and

school mate Norm Cohen of EHI Company attends a lot of hamfests on the East Coast. Sometimes he sells from his booth, at other times he roams and picks up one magnificent treasure or another. Norm has been 'festing for many years, and is one of the old hands.

While the bargains at a hamfest are a prime attraction for me, seeing old buddies is another factor that is equally important. But what about the bargains?

Bargain Hunting. The prices of used and new equipment, parts, and so forth vary all over the place from "you-gotta-be-kidding!" down to a quickly shouted "I'll take a dozen at that price!"

Last month we talked about resurrecting old transmitters in this column. At the Gaithersberg Hamfest last year, I took notes on the prices of some equipment for sale by tailgaters. Although they were at the low end of the price scale, they did give a reasonable indication as to what price range to expect.

One fellow had a pair of Johnson Ranger transmitters selling for \$90 each or \$150 for the pair. Another sold a Johnson Viking Valiant for \$125. I saw a BC-388/URR receiver (same as the Collins 51J3 but in military dress) for \$200.

If you are building an antenna tuner or linear amplifier, then the hamfest is the place to shop for your parts. But be careful to inspect the item before clunking down the bucks, because some busted junk shows up as well as new stuff.

Also be aware of the prices of new parts when shopping for used parts. I saw one fellow who tried to sell a high-voltage variable capacitor that is ideal for a linear amplifier or tuner, but he wanted nearly as much for the scuzzy thing as dealers get for the brand new article. Is there any wonder that he didn't sell it?

Others sold capacitors for ridiculously low prices. In fact, I bought a bagful of transmitting and low-voltage variable capacitors for a little more than pocket change. For example, I found, in good condition, a 440-pF, jeweled bearing Cardwell unit for \$3. Some of the dealers also offer good bargains. As a technical writer for magazines, I build almost all of the circuits that I use in my articles and column to make sure that they really



If you are a fan of Marc Ellis' *Antique Radio* column, then hamfests could be prime shopping grounds. Here are a few of the gems at a recent gathering.

work as advertised. As a result, I run through a mountain of electronic parts every year.

At Gaithersberg I spent \$100 at several dealer stands and came away with several hundred 0.001-, 0.01-, 0.1- μ F capacitors, scores of electrolytic capacitors (all new), scores of three-terminal voltage regulators, and enough red and green LED's to make a Christmas tree blush with envy. I estimate that I saved about 40% on the cost of those items if they were purchased individually.

On Display. Hamfests also attract interesting displays. MARS and the military often put on static displays of communications vans. Local Civil Defense and Red Cross communications units (often staffed by amateur operators) also have displays. But perhaps the most interesting are not formal displays at all, but rather the ingenuity and cleverness in the displays of fellow amateur operators.

For several years at hamfests, I've seen Bob Curry (KC3VO) and his motorcycle-mounted *kilowatt* mobile rig. Bob works for the engineering staff of one of the major broadcast-news



Norm Cohen of EHI Company with another of his magnificent finds.

organizations. He used his expertise to fashion a motorcycle-mounted mobile rig that includes a 1-kW linear amplifier and an AC generator to feed its gluttony for "juice."

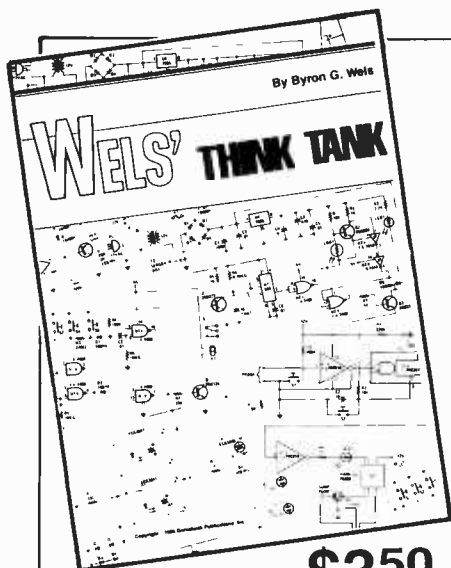
The *Curry Mobile* never fails to attract a large crowd at hamfests. As an old biker (Honda class) myself, I get a gleam in my eye everytime I see Bob's wonderful machine...only to have it dashed on the altar of family harmony. (My wife is a recovery-room, intensive-care nurse who takes a very dim view of motorcycles).

Some of the peripheral events at hamfests are also attractive. At many hamfests, a local volunteer-examiner organization will set up a time and

place to take various-level examinations for the FCC license. A few hamfests also have lectures and demonstrations for the technically minded. A few also have a wives activity, which in a traditional sense means non-ham wives of male hams. But with the larger number of female hams, at least some of that is changing.

There are also a few hamfests that have contests that challenge ham's hobby skills. "Fox hunting" (hidden-transmitter hunting) is regaining its lost popularity. In such events, an amateur hides somewhere and the contestants try to radio-locate him or her. Those events can be quite competitive and ingenious. I can recall a bunch of hams in Norfolk, VA loading up the railroad tracks to make the signal appear to come from everywhere (of course, it didn't really work!).

Again we've reached the end of another column. But be sure to tune in next month, same time, same station. In the meantime, if you have any comments, suggestions, or tips that you'd like to share with your fellow readers, send them to *Ham Radio, Popular Electronics*, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■



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■ **THE THINK TANK** originally appeared in

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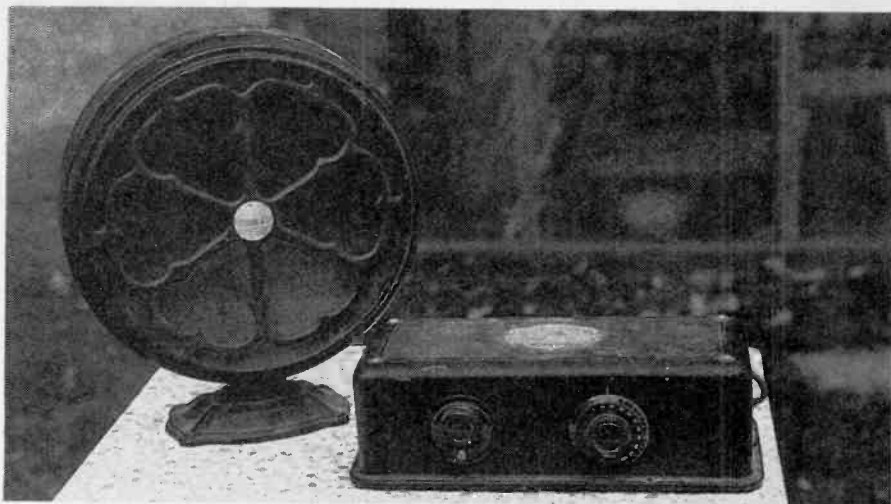
(Continued from page 83)

for the set, but the only supplier he's been able to find quoted a price of \$90.00 each. He's looking for a more inexpensive way to solve the problem. Can someone help him acquire the tubes at a lower price or to convert to cheaper tubes (or transistors)?

Finally, CW4 James R. Kale (205th Aviation Company, APO NY 09185-4050) is trying to help a friend put a Vietnam-war souvenir back in service. It's a military shortwave receiver of Asian origin and requires the following tubes: 1A2 (2 needed), 1B2 (1 needed), 1K2 (3 needed) and 2P2 (1 needed). Jim needs assistance in locating a source for these Asian tubes or (if possible) American equivalents.

A couple of readers have written me about the publication *Antique Radio Classified*. Charles R. Ball, Jr. (Snellville, GA) wanted to let the readers know how enjoyable and useful he has found it; E.C. Woodworth (Calgary, Alberta, Canada)—picking up on a mention I had made of this periodical a few months back—wanted more detailed information about how to subscribe.

I'm including this information under "Parts and Services" because I'd recommend regular reading of *Antique Radio Classified* as a good way to keep in touch with the resources currently available to antique-radio restorers. It's chock full of classified and display advertising placed by people looking to buy/sell radio-related items and services. Each issue also contains a number of short informational, and interesting articles relating to the antique-radio hobby.



Wanted: Battery-radio expert to help reader Dan Zeh fire up his Atwater Kent Model 35.

According to a statement published in the February, 1989 issue, *Antique Radio Classified* is published 12 times per year. U.S. annual subscription rates are \$19.00 (second-class mail) or \$28.00 (first-class mail). Air-mail subscriptions outside the U.S. are priced as follows: Canada, \$30.00; Mexico, \$28.00; other foreign countries, \$55.00. Surface-mail subscriptions to foreign countries are \$25.00, but—except for Canada—are not recommended because of long delays. To subscribe or obtain more information, write *Antique Radio Classified*, P.O. Box 2, Carlisle, MA 01741.

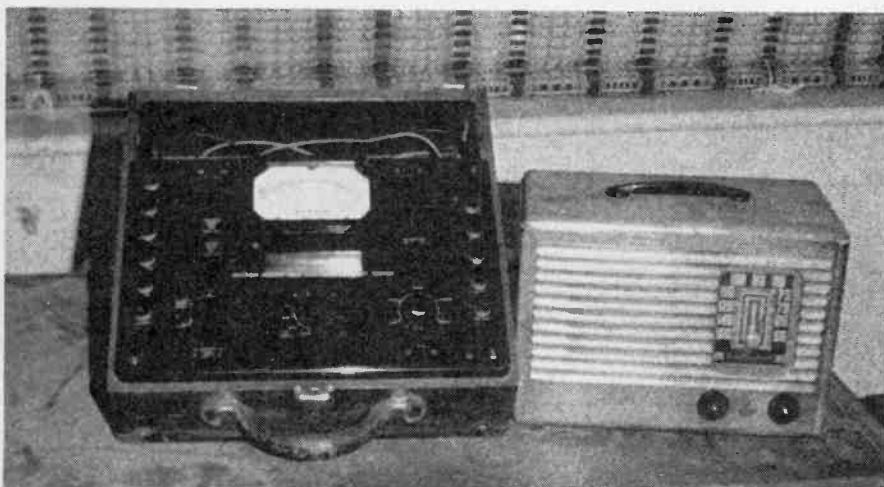
Many readers will also be interested in a 16-page booklet put together by Andrew Mooradian, 5 Priscilla Lane, Winchester, MA 01890. Titled *Olde Tyme Radio Services Directory, 1989 Edition*, the booklet contains a categorized listing of individuals and companies offering services of interest to the antique-radio hobbyist. Send \$2.50 to receive a copy postpaid.

Schematics and Service Information Needed.

Paul G. Bailey (201 S. Ivy St., Arlington, VA 22204); Detrola Model 425. Mark Soderlund (1614 11th Ave. N. #1, Fargo, ND 58102); Montgomery Ward Model 62-207. F.V. Bernauer (1503 Admiral Nelson Drive, Slidell, LA 70461); Philco Model 37-620. Brent Trumble (Cayuga Onondaga Area Occupational Center, 234 South St. Rd., Auburn, NY, 13120); Philco Model 90-90A. Bill Smith (Route 1, Box 50, S. Kent, CT 06785); Philco Model 16 with 80 rectifier. Jonathan Smith, CDR U.S.C.G. (Rt. 2 Box 1327, Ketchikan, AK 99901); RCA Model AR782. John E. Harrington, LCDR U.S.C.G. (127 Shubrick Rd., Monterey, CA 93940); Majestic Model 850. Sarge Barkett (R.D.2, P.O. Box 91, Hopwood, PA 15445) needs a dial-cord stringing diagram for a Philco Model 91.

This 'N That. Howard Sadlak has a number of 1930's and earlier tubes for sale, including the following numbers: ER-227, UX-227, UX-201A, CA-235, CA-171-A, UX-226, 24A, UX171, 42, 17A-3AX, 35, C-484, 201A, 2A5, CX-300A, and UX171A. Cost is \$5.00 each, plus 50 cents each for postage. Tubes are untested, but returnable if found to be defective. Howard also offers assortments of 25 old tubes for \$65.00 postpaid, but does not guarantee them at that low price. Write him about your needs (1106 3rd St., Bay City, MI 48708), including an SASE for reply.

Information continues to come in about our two Philco "mystery" items, which are mysterious no longer. Matt Undy (Clawson, MI) who, at 14, has to be one of the youngest readers to contact me, correctly guessed the func-



Here, Ken Sanderson shows off a couple more of his favorites: at left, a Weston Model 785 Industrial Circuit Tester; at right a 1940's wood-cabinet Emerson table model.

tion of the Philco microphone. Paul Flaughner identified the Philco mystery control and searched every cranny of the Cincinnati Public Library System to find an article he'd remembered reading about it in the Audel's Electric Library. The book was missing, but—as luck would have it—Eric Taylor (San Francisco, CA) had sent me a copy of the very same article last month.

Hank Gillis advises me to quit using methylene-chloride based finish remover to strip radio cabinets (see January, 1989 issue) and use Homer Formby's refinisher instead. Results are much more even, and there's a minimum of toxic fumes.

And, finally, G. Gillespie (Battle Creek, MI), thanks for the long and interesting letter about your lifetime love affair with electronics. Glad the grid-leak detector article brought back some enjoyable memories for you!

That's it for now. Until next month, let me hear from you! Address your correspondence to **Antique Radio, Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

CALENDARS UNLIMITED

(Continued from page 81)

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It's a Date! Calendars Unlimited was put to use immediately and proved its worth with equally as much zest. It even reminded me of my wife's birthday. While, it can't remind you of what you don't enter, it will print out everything you *do* enter in a manner that is useful and productive for your personal and business life. You can get a copy of Calendars Unlimited directly from Caddy-lak Systems, Inc., 131 Heartland Boulevard, Brentwood, NY 11717-0698; Tel. 800/523-8060. For more information contact the company or circle No. 119 on the Free Information Card. The program sells for \$49.95.

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THE TELE MONITOR

(Continued from page 34)

one listed, check the recorder schematic to ensure that the circuit is properly connected to the recorder.

Next, prepare a cable for connection to the mike jack. Again, you must select a plug that's suitable for mating with the jack of your recorder. The use of shielded audio cable is recommended. Solder the prepared cable to the appropriate circuit-board pads.

Once the board is assembled and the cables connected, clean the flux from the board, especially in the area of the modular connectors. Solder flux, when damp, is conductive and can cause erratic operation. Also check for misoriented or misplaced components, solder bridges, cold solder joints, and all the other construction errors common to hobby electronic projects.

You must also prepare or purchase modular plug-to-plug telephone cable (both ends terminated in modular plugs), which will be used to connect the circuit to the telephone line. Radio Shack sells them in varying lengths, with either coiled and flat cable. If a cable of greater length than is available is needed, it will be necessary to make your own. All of the equipment and material needed to handle that task is available from Radio Shack as well.

Preparing the Enclosure. Prepare the case according to the drawing in Fig. 4. A cutout is required for the modular telephone sockets, SO1 and SO2. Two cutouts can be made (one for

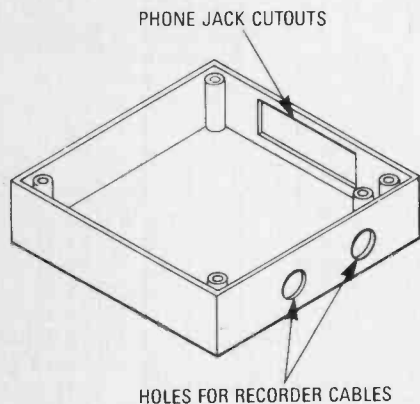
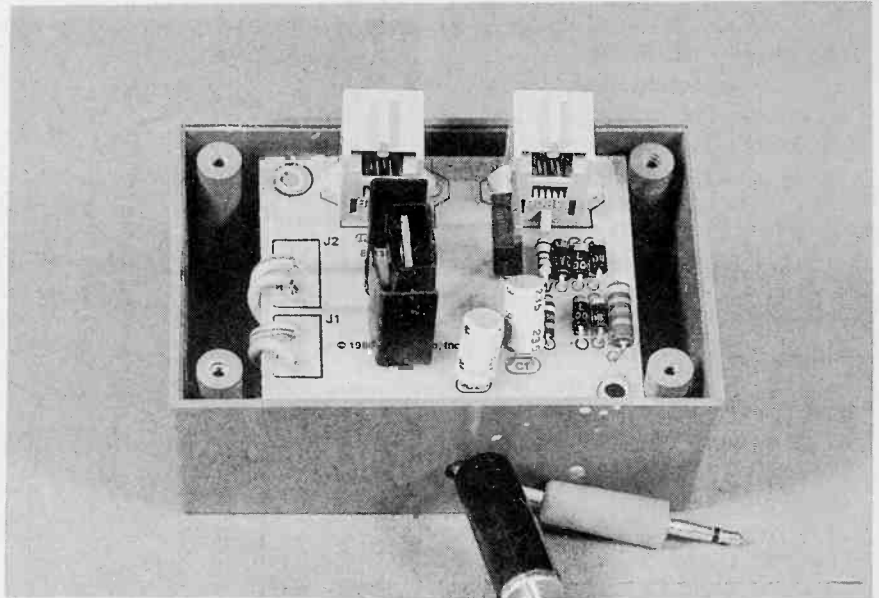


Fig. 4. The enclosure cutouts for the jacks and cables are shown. Note that the enclosure only has two posts for mounting the board. Align the board in the enclosure before cutting to ensure cutting in the correct location.



Here's the finished printed circuit board ready to be mounted in its case. Before mounting, however, it is necessary to drill holes into the side of the case for the cables that connect to the mike and remote jack if the recorder. Don't forget the cutouts to allow access to the modular telephone sockets.

each socket), or a single long one, as shown. A nibbling tool, available at electronic stores, is ideal for performing that task.

Make sure that you check the orientation of the board before making the cutout; the enclosure has only two posts for mounting the board. Position the board, component-side down with the two mounting holes lining up with the mounting posts to determine which part of the enclosure to cut!

Next, drill two holes for the recorder remote and mike cables. A $\frac{3}{8}$ -inch hole for each will be adequate. It is recommended, however, that a $\frac{3}{16}$ -inch hole be drilled and a reamer used to enlarge the hole to the desired size. Plastic is tricky to drill, and some plastics drill easier than others. The plastic used to make the enclosure listed in the Parts List will chip, crack, grab, or self destruct if you use large size bits. Drill speed is also important; generally, the slower the drill speed the better.

Checkout. There are a number of ways to check out the circuit. First, check the orientation of each component against the diagram and check all solder joints.

If you have a power supply capable of providing at least 50-volts DC, you can check the Tele Monitor without connecting it to the telephone line. Attach the power supply leads to the TIP and RING leads of the modular sockets. Connect J2 to the remote jack of the

recorder. Press RECORD and PLAY as you normally would to record. With the 50-volt DC power supply on, the recorder should be "off;" with the supply off, the recorder should be running.

If you don't have access to a 50-volt DC supply, it will be necessary to use the telephone line as your power source. As before, connect the circuit to the recorder. Install one of the modular plug-to-plug cable in one of the Tele Monitor sockets and the other end in the wall. Either connect a phone to the Tele Monitor or use another phone

TELE TRIVIA

The terms "tip" and "ring" originated from the telephone switchboard days when patch cords were used by operators to connect calls. The plug used to patch those calls is familiar to us as the $\frac{1}{4}$ -inch stereo phone plug.

The parts of the plug were (and still are) called tip, ring, and sleeve. Consequently, the circuits and circuit lead names took on the names of their physical representations on the plug, and remain that way today.

on the same line for the following test.

Pick up the telephone. The recorder should start; press "1" on the telephone to eliminate the dial tone, and speak a few words into the mouthpiece in a normal voice and hang up. The recorder should stop once you have hung up. Remove the remote plug from the recorder, rewind the tape, press play and then check the voice quality.

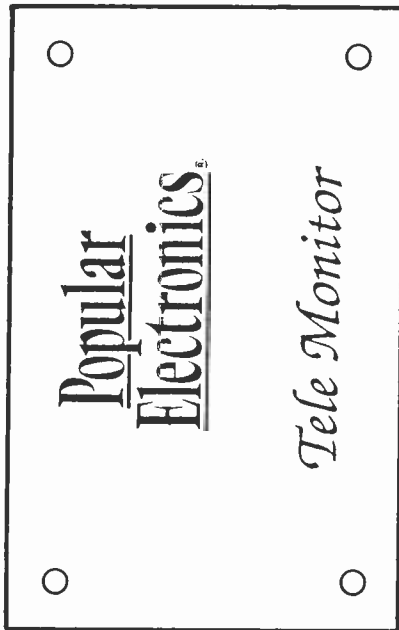


Fig. 5. This full size nameplate can be cut out and mounted on the front of the enclosure using double sided tape.

Final Assembly. Once the case is prepared and the circuit checked out, route the recorder cables through the proper holes, position the board in the case with the components facing down and the modular sockets lined up with the cutout. Secure with the two screws supplied with the enclosure. Mount the cover using the remaining four screws.

A full size nameplate is shown in Fig. 5. If desired, the nameplate can be cut out and attached to the lid of the enclosure with double sided carpet tape or rubber cement, thus providing a professional appearance.

If everything checks out, you are ready to monitor. Make sure the remote and mike plugs are connected, that the modular jack is connected to the telephone wall jack, press record and play and you are all set. Happy monitoring. ■



CIRCUIT CIRCUS

(Continued from page 90)

Several other games can be played with the basic wheel circuit by making a few simple modifications. The circuit can be turned into a coin-toss game by disconnecting pin 15 of U2 from circuit ground and connecting it to pin 7 of U2. Only LED's 1 and 2 are needed for the coin-toss circuit. When S1 is pressed and released, the two LED's will alternately flash on and off at a decreasing rate until the oscillator stops, leaving only one LED lit.

You can also turn the wheel into an executive decision maker by connecting pin 15 (reset) of U2 to pin 1 U2 for four options or to pin 6 for six options. To select any count up to nine, just connect pin 15 to the output pin that equals the number of options desired plus one. In other words, if you want three options, connect pin 15 of U2 to pin 10 (output 4) of U2. That programs the counter to reset and start over at that number.

The LED's for the decision maker can be arranged in any configuration desired with each LED indicating the decision for that position. ■

SOLDERING STATION

(Continued from page 65)

times over, not to mention the hours of troubleshooting and headaches.

The internally threaded soldering tip is conventional in style and size so that other tips that you currently own can be used in its place.

The core of the soldering iron, which acts as a heat source, contains enough reserve heat to allow you make one soldering connection immediately after another for continuous soldering. Forty successive connections were made; the last bit of solder melted as quickly as the first.

Wrap up. Obviously the point to be taken here is that the Archer Model 64-2057 Professional Soldering Station is a handy device for the involved hobbyist. It requires little set up time, allows you to perform almost effortless soldering, and is low in cost even for experimenters who work on a table-top at home. Kit builders will find this soldering station a rewarding investment. For more information, visit your local Radio Shack Store or circle No. 120 on the Free Information Card. ■

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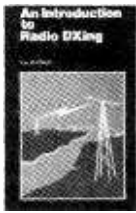
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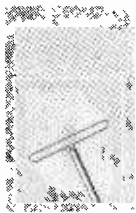
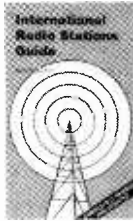
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AC BRIDGES

(Continued from page 64)

leg of the bridge). Their phase shift will be equal and opposite only if they would appear diagonally across from one another in the bridge diagram.

But the phase shift must be the same for both the left- and right-hand portions of the circuit. That is only possible at the frequency where the reactances of the active components are equal. Thus, the reactances of L1 and C1 in Fig. 6 must be equal to each other at the operating frequency.

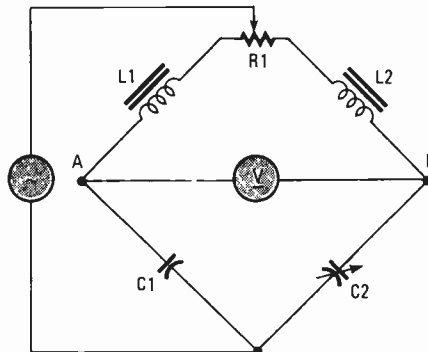


Fig. 7. Super-fine tuning would be necessary to balance this bridge, as almost all the components are active.

We can balance the bridge shown if we follow one further condition: If the reactance of L1 equals the resistance of R1, and the reactance of C1 equals the resistance of R2 at the operating frequency. So R1 must also equal R2.

Reactances of the capacitive and inductive elements can be found by using variable resistors for R1 and R2 and measuring the resistance after balance has been achieved.

Putting equal inductances and equal capacitances in the legs as shown in Fig. 7 is an easier way to produce a balanced circuit with inductance and capacitance in the same bridge. In that circuit, the phase shift in both left and right portions are equal at a specific frequency. A small change in either the capacitance or inductance in one of the legs will produce an AC output at points A and B. The circuit may be balanced by adjusting C2 instead of a balancing resistor.

Further Types. An all-inductor bridge circuit is shown in Fig. 8. By using a sensitive meter in series with a variable resistor, the output can be calibrated to any output range desired within the

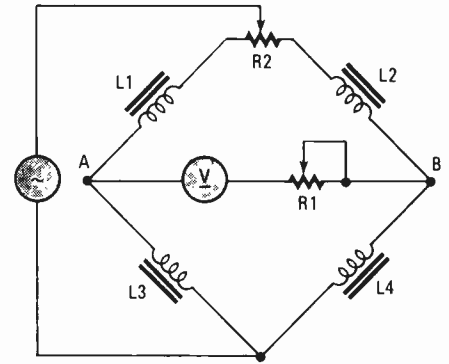


Fig. 8. By using R1 and a sensitive meter the output can be calibrated to any output range desired within the voltage limits of the bridge.

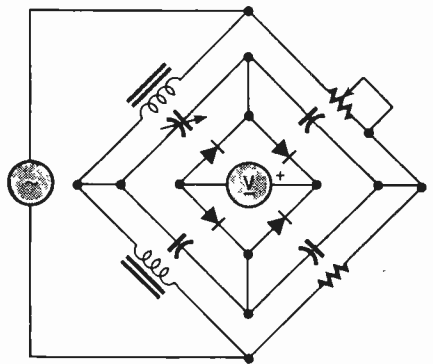


Fig. 9. If connected to a tank circuit as the source of AC, this circuit could tell you all its parameters.

voltage limits of the bridge. It is an excellent design for measuring the inductance of any inductor that is placed in the bridge.

The circuits described here by no means cover all the variations of bridge circuits. You can even have one bridge circuit inside of another bridge to measure the combined effects of more than two variations of the circuit, see Fig. 9. The bridge closest to the meter is a full-wave rectifier that shows you how to use a sensitive DC meter to register AC changes.

Of course individual legs can contain more than one component. While that makes things more complicated mathematically, the conditions for balance are the same: maintain equal potential at the nodes while paying attention to the phase.

Knowing about phase shift and what components have to match each other in the AC bridge is essential if you are to use the circuits to best advantage. A good acquaintance with the basics of the AC bridge circuit can solve a lot of your future design problems. ■

MATCHBOX CRYSTAL

(Continued from page 46)

need to be cut to length. Ferrite is quite hard and brittle, so about the only way to cut it is to file a groove right around the rod and then break it by hand. Trim the rod if necessary by rubbing it on a sheet of silicon-carbide paper (wet or dry), using kerosene as a lubricant.

Check that both pieces fit snugly lengthwise down the sides of the drawer part of the matchbox. If everything is correct, give them a wipe over with methylated spirits, then glue them in place with quick setting epoxy.

By the way, any type of round or flat ferrite rod will do, providing it is antenna-grade ferrite.

Accessories. The crystal set is now ready for testing, but first we need some accessories to complete the set-up. Number one on the list is a suitable pair of headphones, as we've described. Connect a pair of miniature insulated alligator clips to the headphone leads.

Next, measure out 15 meters of medium- or heavy-duty hookup wire for the antenna, and connect a miniature alligator clip to one end. You may wish to secure the other end to some sort of spool, so that you can wind the antenna up without getting it thoroughly tangled.

We made a spool from a section of a small tin can using two large metal-can lids (like from a car wax can) as flanges, and soldered the end of the antenna wire to it. A band of flat elastic keeps the wire in place when it is wound up.

For the ground lead, we suggest that you use a few yards of wire with a miniature alligator clip at one end, and a large jumper-cable type clamp at the other end, which can fit around the kitchen tap or a water pipe.

Initial Testing. Now for the exciting part. Connect the antenna, ground, and headphones, and temporarily attach a 100-pF capacitor to the A1 and E terminals. Check the coverage of the top end of the band with the antenna connected to the A2 tap, then the bottom end with the antenna connected to A1.

If you are missing some stations off the top end of the band, you will need to reduce the tuning capacitance. Conversely, if the low end is missing some stations, you must increase the



The Matchbox Crystal Set is tuned by sliding the tray up or down to change the inductance of the coils. A good ground connection is vital for correct operation of the crystal radio.

capacitance. A small assortment of capacitors will provide quite a variety of values if you connect them in series and parallel combinations.

Once the required capacitance has been determined, it can be made permanent, but make sure you use a low-loss type of capacitor. A loss factor of less than .001% at 1 MHz is desirable. The best capacitors for the project are polystyrene, silver mica, or NPO ceramic types specifically designed for RF work.

Finishing Touches. The ruggedness of your Matchbox Crystal Set can be improved by giving the lower parts of the solder lugs, and the area around them, a thin coating of epoxy. Use a slow-setting epoxy, and spread it thinly and evenly with a pointy instrument. It will flow out smoothly and set crystal clear if you warm it up a little while it is setting. A warm window sill in strong afternoon sun is ideal.

Put a little of the epoxy on the diode and capacitor as well, but don't bother to coat the coil windings—they are best held in place with a final coat of polyurethane.

Before you get out the polyurethane, stick some small pieces of sticky label material on the matchbox and label the terminals A1, A2, E, PHONES, and PHONES with your neatest writing. Don't use a spirit-based felt-tip pen—use drawing ink or similar water-based medium. Also, now would be a good time to draw a tuning scale on the sliding part of the matchbox, so that it can be protected under the final coat of polyurethane.

Calibration. We managed to draw

quite a comprehensive tuning scale on our prototype. That scale was hand-drawn over the first coat of polyurethane with drawing ink and a fine pen. The surface takes ink beautifully if it is pre-treated to render it slightly hydrophilic (i.e. to make it attract water). Just moisten a tissue with saliva (yes, that's right), rub it all over the first coat of polyurethane finish, and then wipe it dry.

If the cardboard is darkly colored, you can stick some white label material over it, or use one of the decorative white or silver inks available at most art-supply shops.

Next, consult a list of AM broadcast stations (in any recent "White's Radio Catalog" for example) and make a short list of all the stations in your area and their frequencies. Log as many of the stations as you can, drawing a light pencil line against the edge of the matchbox for each one. Draw a base line on the scale and measure the positions of all the station lines that are relative to it.

Next, plot a graph of those measured distances vs. the listed carrier frequency of each station. Carefully join the points to form a smooth curve. You can now read off the position of any intermediate frequency.

Use the graph to make a scale of frequencies in steps of 50 kHz. Transfer all the information with ruler and pencil onto the sliding part of the matchbox, and ink it in. If you make a mistake, it can be cleaned off with moistened cotton. Be careful of smudges—the ink takes a long time to dry on surfaces like cardboard.

Finally, give both halves of your crystal set a final coat of polyurethane all over, keeping the finish clear of the exposed parts of the solder lugs, of course.

Operational Hints. Although the circuit should be tuned by moving the ferrite rods in and out of the top of the matchbox, you can also tune in the same stations by moving the ferrite rods in and out at the bottom. The difference with that tuning technique is that the lower half of the coil will have a greater inductance, effectively moving the A1 tap up.

This will give you more volume, but less selectivity—the stronger stations will be noticeably louder, but some of the weaker ones will be lost altogether. Use whichever method suits your needs best. ■

AUTOMOTIVE NIGHT SAFETY LIGHT

(Continued from page 77)

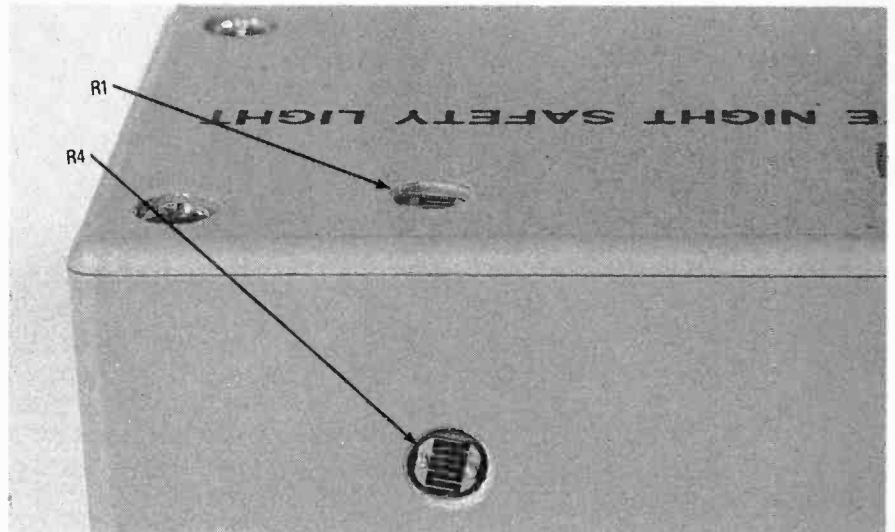
cover the faces of the units with epoxy. Each LDR should be mounted so that its face is flush with the surface of the case.

Installation. The best place to mount this device is on the rear window of your vehicle. It should be mounted so that R4, in the side of the case, looks out through the rear window. The daylight sensor should face upwards so that it will be unaffected by an approaching car's headlights.

If reflected light falling onto the daylight sensor does prove a problem, try mounting the sensor in a tube further down in the case. That would also shield the sensor from street lights.

Power for the unit must be derived from the unswitched +12-volt battery supply. The most convenient place to make that connection is at the trunk-light switch. Alternatively, you can run a lead through to the fusebox.

The ignition lead can be connected to any point that is switched to +12 volts by the ignition switch (for in-



Light-dependent resistors R1 and R4 are simply pushed into small holes drilled through the lid and side of the case. Note that R1 sits below the surface of the lid so that it cannot pick up light from an approaching car's headlights.

stance, to the accessories' supply line). The relay contacts are simply wired in parallel with the brake-light switch.

It's quite easy to find the brake-light switch. It's a pushbutton switch that is actuated by pressing the brake pedal. Install the wiring in a professional manner and terminate all leads in auto-

motive clip connectors (available in automotive accessory-shops).

Finally, the enable switch can be installed in any convenient place on the dashboard. An automotive-style push-to-make/push-to-break switch (but don't choose one with a pilot lamp) is the best type to use here. ■

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SAWTOOTH GENERATOR

(Continued from page 61)

single fixed frequency range is required, delete the switch altogether and mount the required capacitor on the board with the rest of the components.

The use of a 500,000-ohm potentiometer as the FREQ. ADJ. control (R12) sprang from my needs, which may be at odds with your requirements. Try experimenting with the values of resistors R3, R4, and R12, as well as the bank of range capacitors connected to switch S2 in order to tailor the operating frequency of the circuit to your needs. Remember that the clock frequency must be 256 times the desired sawtooth frequency.

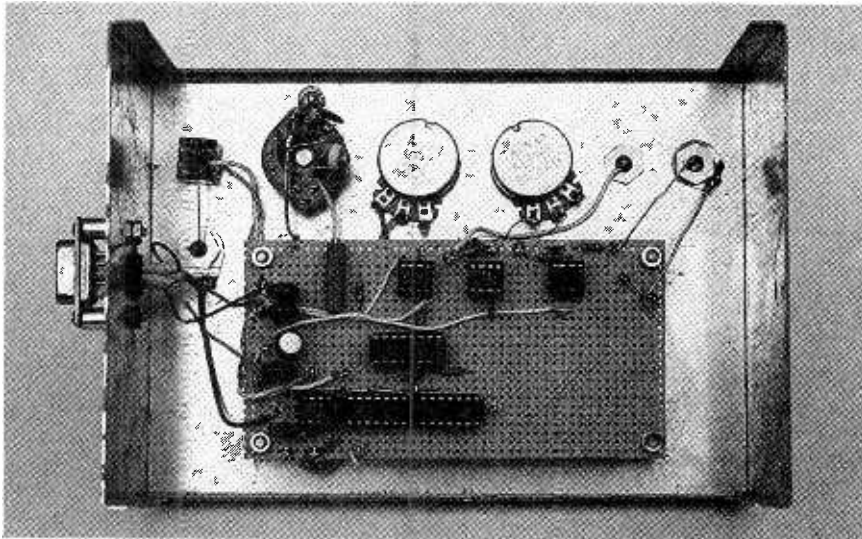
All controls for the circuit—with the exception of the OFFSET NULL trimmer potentiometer (R7), which is used to can-

the circuit from an external source, the power supply (shown at the bottom of Fig. 2) can be eliminated, which will result in a cost savings.

In the prototype, power is fed to the circuit through a 9-pin D-type connector that's mounted on the side of the enclosure. However, any connector that you may have on hand will suffice. The D connector was mounted, on stand-offs, to the side of the enclosure, and wires were run from the D connector to the circuit board through a hole in the enclosure.

To prevent short-circuiting the power supply (if the edge of the cabinet happens to strip the insulation from the wires) it is a very good idea to place a grommet in the hole to cover any sharp edges.

If the circuit fails to operate as expected, check for proper wiring between the IC's and the discrete



Here's is the Digital Sawtooth Generator mounted in a metal chassis. Note that no power-supply components are included in the prototype unit. Power is delivered to the circuit through a 9-pin D-type connector (on left). Four wires are needed in such an arrangement for the +12 volt, -12 volt, +5 volt, and ground connections to the circuit.

cel any accumulated DC component in the waveform—are mounted off the board. In my case, R7 turned out to be useless, but it is possible that any given collection of IC's will have a large enough DC component to warrant R7's inclusion. It is recommended that R6 and R7 be initially deleted (unless you have the parts on hand), and installed only if a problem is detected later on.

Originally, the Digital Sawtooth Generator was designed to be used in conjunction with a universal power supply capable of delivering all of the necessary voltages to power the circuit. If, like me, you decide to power

components. Also check for solder bridges, cold solder joints, the continuity of the wiring, etc. If you fail to locate the problem, check the voltage applied to the IC's and for an output signal. Occasionally an IC may be damaged in transit, or rendered useless due to mishandling.

Well, that's about all there is to it. The Digital Sawtooth Generator is easy to build, and is well-behaved. In addition, it can be modified by the user to generate just about any waveform. You can expect to see more and more digitally synthesized circuits in test equipment and communications equipment in the future. ■

VIDEOGAME SWITCH

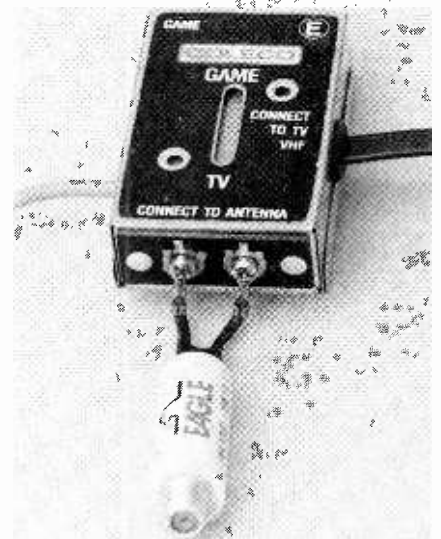
(Continued from page 36)

tween the console and the modified switch, connections between the TV, antenna, game, optional VCR, and the switch remain the same, so connect the switch as you had it before. Plug the power cable from the switch into the console and you'll be ready to test the unit.

Select the game channel on the TV and leave the game off. The correct TV program should be displayed. Insert a game cartridge (if used) and switch the game console on. The game display should appear immediately on the TV. If you switch the console off, the TV program should reappear.

Trouble Shooting. If the game and TV displays do not appear as stated, make sure that the game is plugged in and outputting the correct voltage. Check to make sure that the correct TV channel has been selected.

If those tests turn up nothing, connect test leads to the new console jack and check for about 5-volts output when the game is switched on. If zero or very



From all outside appearances, the game switch looks the same with the exception of the missing slide post. Don't worry about that, you'll never miss it.

low voltage is present, the supply leads might be reversed, D1 might be incorrectly installed, or R1 may be of too small a value.

If the TV channel cannot be displayed even when the game is switched off, the +5 volt wire is connected to a point before the unit's power switch, causing the relay to be always activated. ■

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EXECUTIVE DIVERSIONS

(Continued from page 72)

Another competent game-playing alternative to the PC is the Tandy/Radio Shack Color Computer 3, which comes with 128K of on-board memory (internally expandable to 512K). An 8-bit machine, it includes two joystick ports, and it can support external 5.25-inch disk drives. Like the Commodore 64, it can be hooked-up to a color TV set for display, though a color monitor may also be used. The computer can produce images up to 640 × 192 in 4 colors, or it can produce 320 × 192 graphics using 16 out of the available 64 colors.

The "CoCo," as the machine is affectionately dubbed by an army of loyal fans, is blessed with a good deal of third-party game software and is well supported by the manufacturer, with its countless stores nationwide. Recent deep price cuts have made the CoCo quite competitive with its major rival, the Commodore 64.

The classic Atari 8-bit computers, such as the 400, 600, 800, and 1200 series, and the newer 65XE and 130XE computers, carry on the Atari tradition of excellent game graphics and sound—the name "Atari" coming from a term used in the Japanese game "Go" that means "I'm going to attack you." A great deal of game software is available for Atari machines, though the introduction of new software for them has been hobbled in recent years by the market domination of the Commodore 64 and more recently, the IBM PC and Atari ST.

Introduced by Atari's new management team in 1985, the Macintosh-like Atari ST (which uses the 16-bit 68000 microprocessor) has proved to be a superb, "knock your socks off" graphics-and-sound oriented game machine, and one that is suitable for small-business use as well. The 520ST (520K RAM), 1040ST (1040K RAM), and the new 2MB Mega ST (expandable to 8MB) use the Graphics Environment Manager (GEM) developed by Digital Research. With GEM, you can control your computer through its world of icons—trash cans, file cabinets, calculators, etc. GEM makes it seem as if your computer is simply an extension of your desktop.

In addition to 512 possible colors and excellent graphics (resolution of 640 × 400 mono, and up to 640 × 200 color), the Atari ST offers a built-in

sound-effects generator and a built-in MIDI interface for composing and playing computer-synthesized sounds and music. All of those features combine to make for a game-playing computer that rivals even the fanciest arcade machines.

The Commodore Amiga 500 is an exceptionally versatile "dream computer," comparable to the Atari ST, that is equally at home in the office as it is in the home. With its 16-bit Motorola 68000 central processor, the Amiga has lots of number-crunching power. But the machine excels at any and all applications involving graphics and sound; some enthusiasts claim that the word "Amiga" really is an acronym standing for "AMazing GAME machine" rather than the Spanish "female friend."

The popularly priced Amiga 500 has 512K RAM (expandable to 1MB) and three custom VLSI (Very Large Scale Integration) chips that provide the computer's outstanding capabilities for animation, graphics, and sound. Key features include arcade-quality 4,096-color graphics, two mouse/joystick ports, four-voice digital stereo sound, multitasking capability (you could conceivably play two games at once), and even left- and right-audio outputs for driving a stereo-sound system. Consequently, the machine is especially suited to highly animated games with special sound effects. The even more powerful Amiga 2000 and the newly announced 2500 also are offered by Commodore, and they boast memory expandability to as much as 8MB. Those new computers' strength lies in their suitability for memory-gobbling desktop-video applications, but the upscale Amigas can indeed be very formidable game machines. And they also can be configured to run IBM-PC software.

Summary and Suggestions. In the last two months, we've surveyed the computer-game scene, with special focus on the IBM PC. We've discussed some of the advantages, disadvantages, and limitations of the PC as a game machine; surveyed the world of PC game software; discussed the ins-and-outs of public domain and shareware software as well as on-line gaming; and suggested some practical game-machine alternatives to the PC.

The bottom line is that your PC's logo does not have to stand for Impossibly Boring Machine. ■

The Electronic Industries Association/Consumer Electronics Group has recently completed the first in a series of videocassette training tapes.

EIA/CEG ANNOUNCES COMPLETION OF NEW "BASIC CAR AUDIO INSTALLATION" VIDEO TAPE

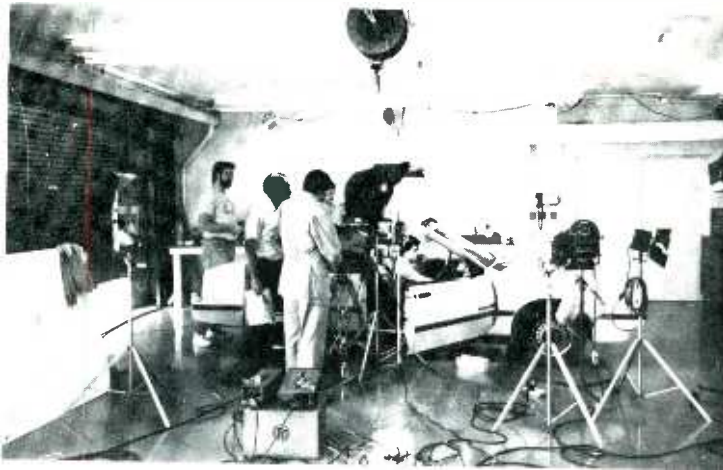
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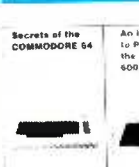
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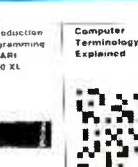
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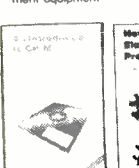


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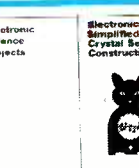
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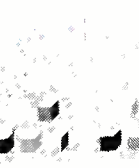
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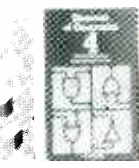
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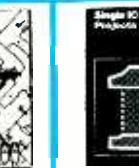
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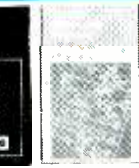
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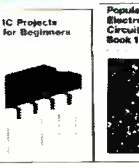
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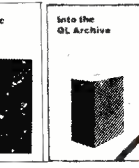
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