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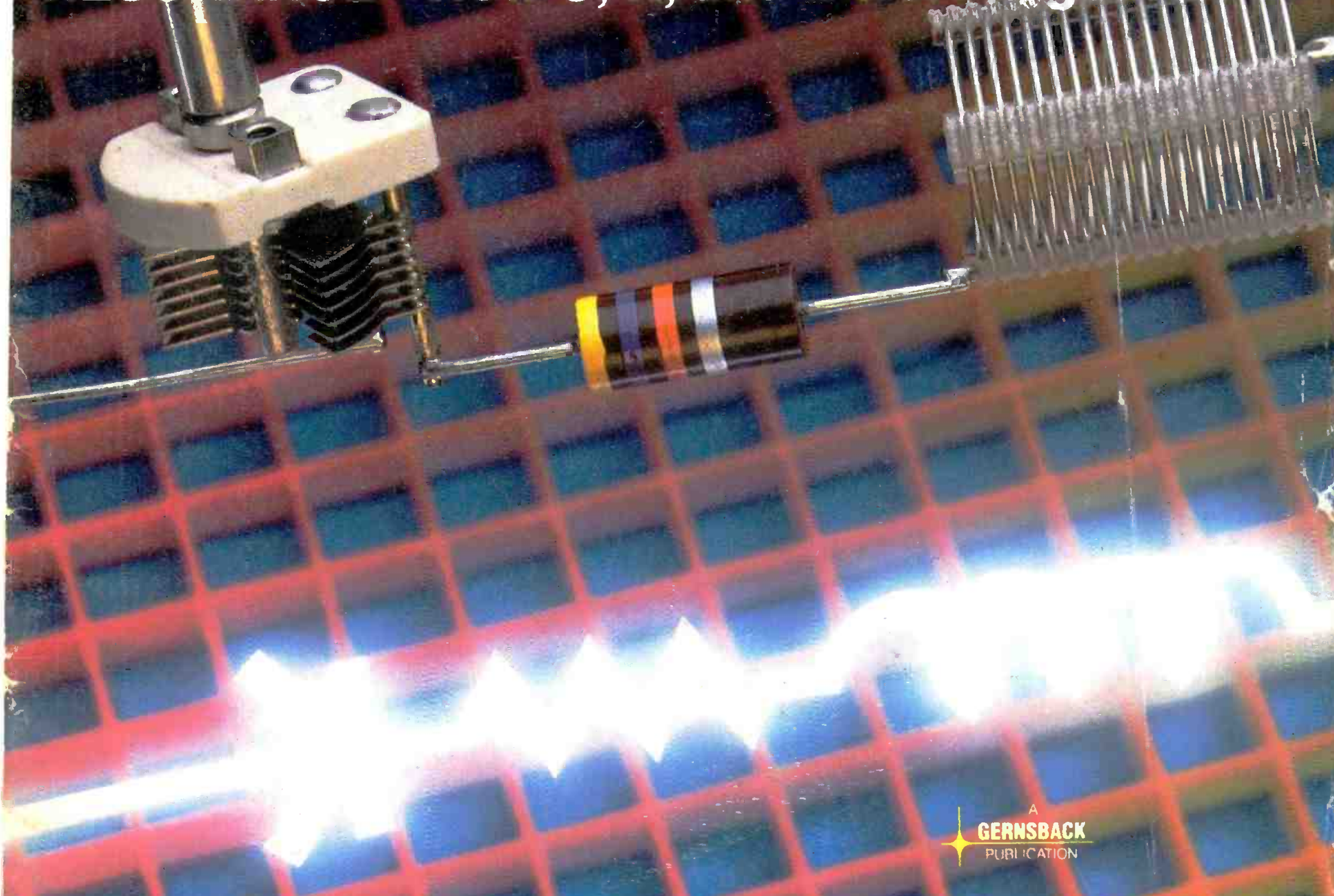

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March 1987

Data Storage—page 39

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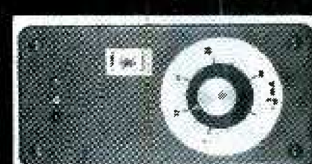
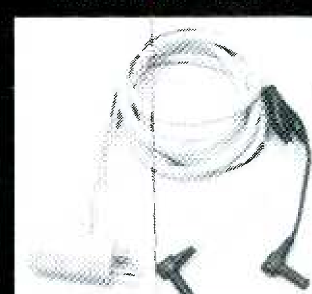


NiCd Charger—Page 65



Fluke LCA10—PAGE 70

Hands-on Electronics®

The Magazine for the Electronics Activist!

EDITORIAL PAGE

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Volume 4, No. 3

March 1987

The Ides of March are upon us!

It seemed as if it was only a few weeks ago that we were enjoying the surf of Long Island's south shore, detecting a chill in the air, and suddenly winter is almost over. It would have been wiser to watch the new issues of **Hands-on Electronics** pass by than look at the calendar.

The Great Computer Clone Contest is on, and manuscripts are beginning to find their way into our office. If you missed the last issue, I proclaimed there that the author of the best article published during 1987 will be rewarded with an IBM-clone personal computer. It probably will be very much like the one I'm using to write this editorial right now!

Why am I repeating last month's editorial? I want everyone to enter the contest. If I were to select the 10 best articles I ever edited, I would honestly say that more than half of those came from authors making their first attempts at submitting an article. So, beginners *do* have an equal chance against the pros who have been published.

So get to it. The winning entry may still be that blank piece of paper in your typewriter! And don't trust the calendar; the rest of the year may fly by and that great idea may still be a blank piece of paper.

Julian Martin

Julian S. Martin, Editor

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Mates Graphics

Cover photography by
Nick Kondis

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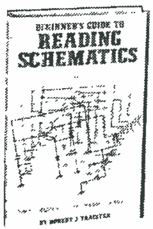

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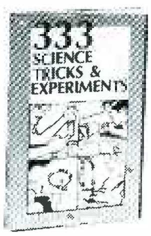

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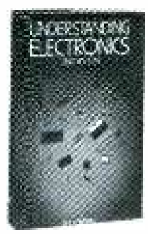

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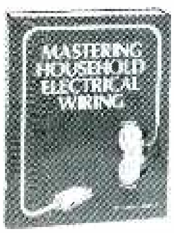

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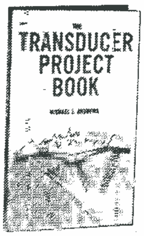

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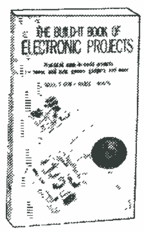

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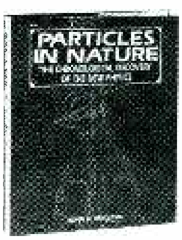

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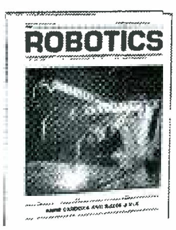

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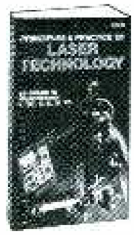

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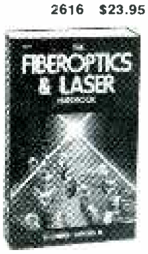

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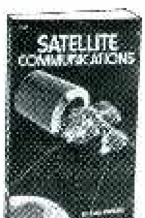

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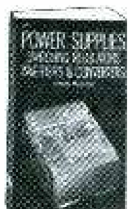

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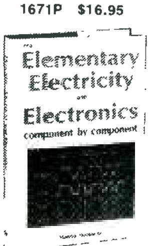

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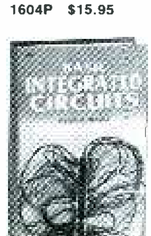

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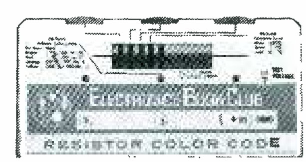

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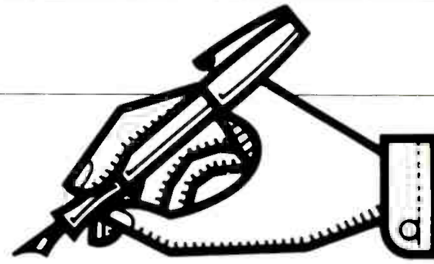

CoCo Coconut

This note is just to let you folks at "Hands-on" know that I did enjoy the "surprise" program in your November 1986 issue!

Although you folks never even mentioned the lowly little "Color Computer" excepting for the possible "etc.", I did manage to successfully convert Mr. Holtzman's "personalized Calendar" program to run on the CoCo.

For the life of me, I cannot understand why so many seem to ignore, degrade, and abuse the Color Computer. I have used most of the other breeds of personal computers, and even own a couple, but for power of an 8-bit unit (that thinks it is 16), what speed!. And the most complete BASIC of any computers in its class, the little CoCo excels them all. Yet, even you folks at **Hands-on** choose to ignore it.

If, perchance, any of your readers are interested in a CoCo compatible version of the program have them write me including a SASE.

Thanks again for a fine program.
A.S.H., Route 1, Box 198HHH, Deming, NM 88030.

We at **Hands-on Electronics** *would be more than happy to run articles on the widest variety of computers possible. Unfortunately, you can't print what you don't have. We've received little or nothing from our CoCo users. We know there are lots of you out there, so come on people, send in those articles!*

Resistance From Within

I did not put parentheses in my formulas for C and L in *Make Your Speakers Behave Like Resistors* which was published in your December '86 issue. Someone put the parentheses in, but in the wrong places. If readers try to calculate values with those formulas they will get confusing results.

Here is how the formulas should appear:

page 69, $C = 0.16/(R_e \times f)$
page 70, $L = 0.025/(f^2 \times C)$
page 70, $C = 0.025/(f^2 \times L)$

I used the form shown at the right when typing these formulas but without the parentheses. I can see how one could misinterpret them. I apologize for any inconvenience that may have caused.
David B. Weems, Newtonia, MO

Little Cat's Paws

For the past 3 years I have been interested in building a very-sensitive microphone. I am a photographer and interested in nature photography. In order to photograph animals I have to be able to find them, I reason that if I can hear them I can find them.

Basically, what I am asking is if you know of a low input-high output amplifier and kit forms of parabolic dish microphones, or any sensitive microphone like those I have described.

I am in the United States Army and am stationed in West Germany so I may have to pay additional postage which is of no great significance to me at this time.

Also, do you have any schematics on light amplification such as the Army's Starlight scope?
A.T. Mohler III, West Germany

Unfortunately, parabolic reflectors are tough to find. You may want to use a regular mike connected to a preamp and then to an amp. Dick Smith sells a mic preamp (cat f-4154) for $9.95 with a 55-dB gain. You can enquire about postage by calling 415/368-8844 in America. I would also take a look at the Super Strobe project in this magazine as it would be excellent for a sound-triggered flash if connected to the preamp.

There is a company that sells IR equipment that may have the light amp you want. Call 617/595-2275 in the U.S. for John J. Meshna Jr., Inc.

Good luck, and send us some shots of anything you may photograph with the Super Strobe.

Time Out

I am writing concerning errors in The TTL Timepiece construction project in your May/June 1986 issue. Firstly, on page 47 under "An Overview of The Circuit," you state "The count continues to a maximum of 12:59. On the next count, all readouts are zeroed and the sequence is repeated for the next half day." Actually the hours readout returns to 1 and the other readouts are zeroed, giving 24 hours in a day.

Second, on the power supply board foil pattern and parts placement diagrams, there are two common grounds. I corrected this by placing a jumper between the two grounds. One ground leaves U16 the other is at C3.

The third mistake is on the foil pattern and parts layout for the display board. The connections on the right side of DISP4 are out by one pin starting at pin 10 to pin 15. Pin 10 should not be connected.

Also, on the foil pattern and parts layout for the counter/display board, Pins 6 and 7 of U10 should be connected together. Pins 11 and 12 of U5 should be connected together. On U1, pins 6 and 7 should be connected. Also on U6, pins 10, 11, and 12 should be connected.

The last problem was getting the clock to run. In your article you state the most likely trouble spot is R3. I found that R3 should not be connected between pin 3 and pin 14 of U15. R3 should be connected between pin 3 of U15 and ground.

Once the above corrections were made the clock worked and has kept excellent time. To end on a positive note, I enjoy your magazine very much.
W.H.C., Guelph, Ontario

Thanks for the corrections, and I hope you weren't late for any appointments!

Video Switch

Here are a couple of hints for success in building the Video Switch (July/August, 1986 issue). First, be sure that your DC plug-in power pack delivers the required 9-volts DC when connected to the project. Some DC power packs can deliver up to 13-volts DC under minimal-load conditions. Next, you may have to wind L1 with as many as 11 or 12 turns to get the .15 μH. That is caused by differences in wire types, tightness of turns, and core tolerances.
J.K., Richmond, TX

Thanks for the coil winding tip. As for the power pack problem, the builder should not seek another DC power pack, should the unit he has put out too much voltage. A simple resistive bleeder network can fix that problem immediately.

LETTER BOX

Hi-Tech Weather Station

I'd like to install a hi-tech weather station in my home and back yard. I am an aspiring TV weatherman who wants to get his information first hand. Where do I go?

R.E., Conchas, NM

Don't go any further than your Heathkit catalog! One of our editors traveled Canada recently and whenever he stopped at a Canadian tourist center operated by the Mounties, the building displayed a Heath weather station so everyone knew exactly what the weather conditions were at that time. If the Heath Company is selected by the Canadian government, it's good enough for me. Look into it yourself.

Weird

I built the Stud Finder from the plans in the July/August 1986 issue of **Hands-on Electronics** and it works great! I discovered something that may be unusual. I ran the Stud Finder over an empty coffin and discovered that there are no nails, screws, or other metals used to make it up except for the brass handles. Strange!

B.W., New York, NY

Strange! B.W., what do you do for a living? (Get it? Living?)

Which Way Did They Go?

I was interested in buying a CB set so I visited my local newsstand in a 7-11 store to get a magazine on CB's, only to discover that there are none. Maybe I should say that there were none at that newsstand. I tried a few others (*newsstands, not 7-11's—Editor*) and had no success. Where did they all go?

W.T., Kansas, OK

They went to that happy newsstand in the sky that is currently being swamped with computer magazines. To be honest in my answer, I must say that after the big CB bubble-burst in the mid '70's, advertising support for the Johnny-come-latelies disappeared resulting in the financial collapse of almost all of them.

Speachless

As many of you may have noticed, the power supply leads for the Computer-Controled Voice Synthesiser *in the December issue, on page 59 Fig. 7, are labeled incorrectly. The lead marked +5 VDC is the ground, and vice versa. This also means that LED1 is upside-down and should be flipped. When these changes are made your computer will talk your head off!*

Rave Notice

I'm not much on sending rave notices to magazines; in fact, this is the first time I have ever written to an editor. Let me compliment you on finding and publishing the works of a magnificent writer/experimenter, Charles D. Rakes, who wrote the Circuit Circus column in the September/October issue of **Hands-on Electronics**. Mr. Rakes' subject selection, infrared circuits, was timely and opened the eyes and imagination of countless experimenters of which I am one!

Equally charming, if I may use the word, was the selection of the column's title—Circuit Circus. This guy Rakes is a *winner*. Keep his column coming our way and **Hands-on Electronics** will always be on the best-seller list of electronics hobbyists!

D.D., Painted Post, NY

Thanks for the kind words which we've sent to Charles Rakes. Everyone needs a pat on the back every so often except editors—we need it daily! We regret that Mr. Rakes column did not appear in the January, 1987 issue. In the last-minute rush to get Gadget Magazine included, we blew it! Sorry about that!

Ultimate Pendulum

The Ultimate Burglar Alarm project in the last issue (Sept./Oct., 1986) of **Hands-on Electronics** was nothing more than a simple motion-detector switch and locking relay. I was angry when I first saw it, but I mellowed quickly. It gave me an idea! I built a simple motion detector from a metallic, beaded chain held centered by gravity inside an ordinary frozen juice can. The can is mounted on the door of my workshop. I used the same latching relay circuit, except that instead of an expensive key switch I used a hidden toggle switch to disconnect the battery. An oversized doorbell is used as the alarm. Now my kids know that they are doing something wrong when they enter my shop. Somehow the sound of the bell has more authority than a dad's bellowing. Thanks for the ultimate pendulum!

F.W., Brooklyn Center, MN

I believe that for every project we present, the readers of **Hands-on Electronics** *conjure up several variations, that when built, hardly resemble the original project in diagram or application.*

Probably the most often repeated project is the crystal radio. That one is always welcome, because enterprising experimenters are forever coming up with a new or unusual way of making one.

Out of Sync

Fact card Number 17 has a misplaced arrow on it. The arrow indicating the 63.5-μs time displacement between horizontal sync pulses, should point to the front porch side of the left pulse. ■

New Products

Two-Way Radio Brochure

A full-color, eight-page brochure is available from Midland LMR that summarizes recent developments in the company's professional two-way radio systems and equipment. Among other subjects it details, are the latest advances in the Midland Syn-Tech line of advanced programmable mobiles, portables, and base stations available in all LMR frequency bands. It also discusses repeaters

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and accessories, as well as economical PLL-synthesized mobiles and portables, for less-sophisticated requirements. The brochure is available on request from Midland LMR, Marketing Department, 1690 N. Topping, Kansas City, MO 64120.

Digital Thermometer

A.W. Sperry Instruments, Inc.'s digital thermometer, the AWS DT-160 Digi-Thermo, is a pocket-sized digital thermometer, displaying many sophisticated and unusual features. In addition to its extendible temperature probe, the Digi-Thermo has a temperature sensor mounted on its front panel, which allows the user to switch between reading room temperature and probe temperature in seconds. The DT-160 has a built in clock that displays time when selected, and is programmable at two individual temperature limits, which trigger an audible alarm. The DT-160 has a built-in tilt-stand and spring clip that allows it to be placed in

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almost any location. The temperature range is 0° to 159.8° F (-19.9° to 71° C).

The DT-160 comes complete with a B-7 battery, 34-inch attached probe lead, a one-year warranty, and is economically priced at $45.00. For more information contact A.W. Sperry Instruments, Inc., 245 Marcus Boulevard, Hauppauge, NY 11788; Tel. 516/231-7050.

HP Power-Supply Catalog

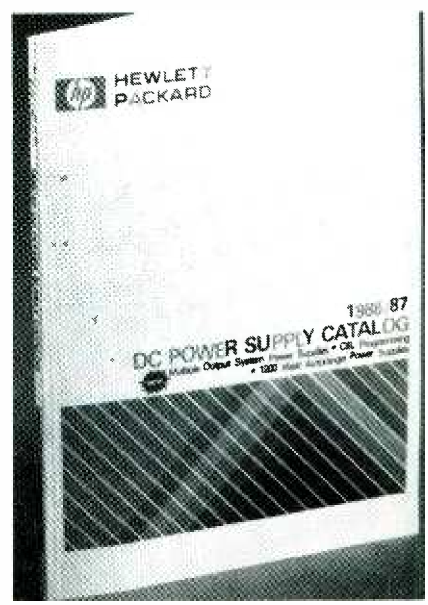
The 1986-87 Hewlett-Packard Company DC power-supply catalog is now available. It contains full, up-to-date descriptions of all manually-controlled and computer-controlled DC power supplies offered by HP, along with aids for choosing the correct supply for a given system or laboratory application.

Power supplies described in the 120-page catalog are grouped into three types: system power supplies, laboratory and industrial power supplies, and special-purpose power supplies.

The system power-supply section includes single- and multiple-output models offering up to 200 volts, or up to 120 amps output, and up to 1,000 watts, all on the HP-IB (IEEE-488) interface. Those units provide an extensive and easy-to-use programmable feature set, including read-back of actual output voltage, current, status, and many protection capabilities.

Programmers used to interface most of HP's broad line of DC power supplies to the HP-IB (IEEE-488) also are described. Additionally, a full range of laboratory models can be controlled with analog voltage or resistance signals.

The laboratory and industrial line of HP DC power supplies includes single- and multiple-output models, with ranges from 10 to 11,000 watts. This group consists of low-power, linear-regulated supplies for lab applications, high-power, SCR-regulated supplies for heavy-industrial applications, and hybrid topologies for a variety of other uses. Most of these supplies can be operated manually, programmed remotely with HP power-supply programmers, or by analog-voltage or resistance signals.



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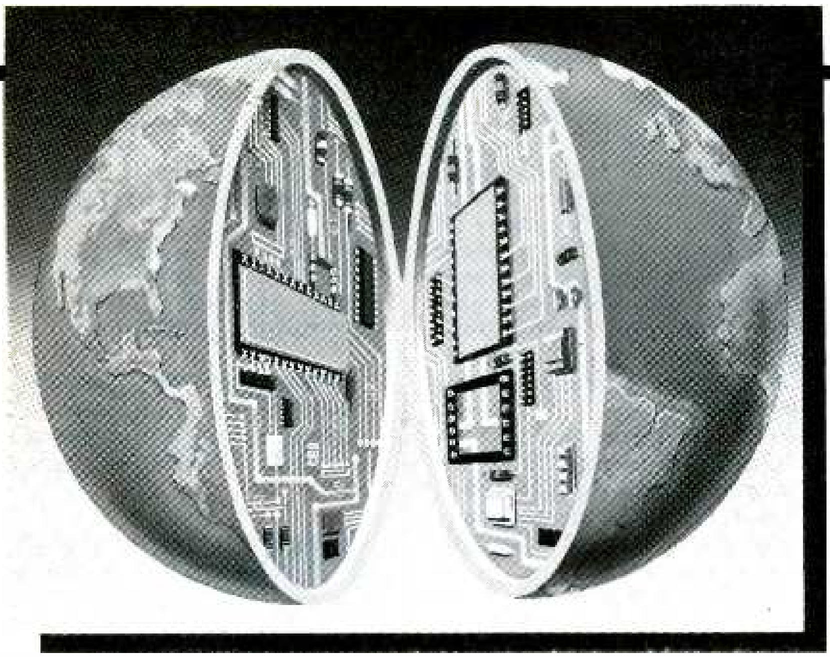
Power supplies in the special-purpose category exhibit one of two characteristics: bipolar/four-quadrant operation, or extra stability and precision. These supplies are optimized for many of the special needs of scientific research, component testing and calibration labs. Mail your inquiries to Inquiries Manager, Hewlett-Packard Co., 1820 Embarcadero Road, Palo Alto, CA 94303.

Wireless Remote Speaker System

Universal Security Instruments, Inc. have released their VX Series product, the V-8500 Wireless Remote Speaker Sys-



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- ☐ television/high fidelity service
- ☐ medical electronics
- ☐ broadcast engineering
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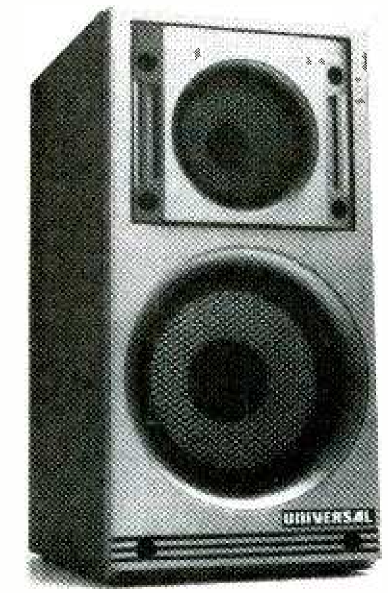

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tem. The V-8500 has a manufacturers suggested retail of $89.99 for the transmitter and speaker/receiver, and $59.99 for the optional add-on speaker system.

The V-8500 opens up a new way for a consumer to expand their sound environment throughout their entire household. The V-8500 operates by using household AC lines as a signal carrier, with a signal decoder built into the speaker. The signals then become available on any AC outlet. This allows the V-8500 to be connected to your stereo system, tape deck outputs, receiver audio outputs, VCR audio outputs, or even TV audio outputs (including projection TV's), and allows the audio signal to be received and listened to through the high-quality, full-frequency response V-8500 speaker system.

For more information contact Burt Cohen; Tel. 301/363-3000

Convertible Metal Detector

Fisher Research Laboratory has introduced a 3-knob metal detector that converts from handle mount to hip mount simply by sliding the control housing off the handle and onto your belt.

Competition hunters and shallow water treasure hunters have been asking for a convertible version of the top-of-the-line 1265-X. Not only does the 1235-X perform just about as well as the 1265-X, it's less expensive, lighter, and has features the 1265-X doesn't. For instance, the built-in frequency shift, which eliminates interference from nearby metal detectors, and the VCO push-button, no-motion pinpoint mode. The VCO circuitry responds to a target with increasing volume and pitch, making precise pinpointing a snap. Another unique feature is the drop-in battery compartments for two 9-volt transistor radio batteries. There are no wires or connectors to contend with, just drop the batteries in.

CIRCLE 82 ON FREE INFORMATION CARD

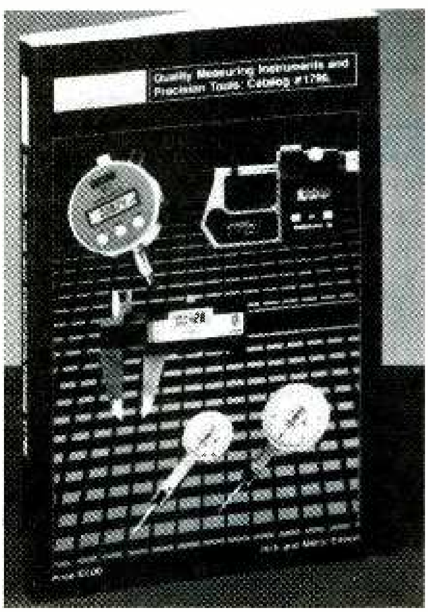
The 1235-X is a silent running, VLF-slow motion discriminator. There's no tuning control, no ground-adjust control, no threshold tone, and it simultaneously ignores ground minerals and trash, while it detects valuable targets.

Suggested retail price is $399.95. A free spec sheet is available from the factory. Write, Fisher Research Laboratory, Dept. HOE, 1005 I Street, Los Banos, CA 93635.

New Catalog

The Fred V. Fowler Company now offer their Catalog No. 1786, *Quality Measuring Instruments and Precision Tools*. Inside you'll find 448 pages of precision instruments—electronic, mechanical, and optical.

Digest-size to fit inside a toolbox or desk drawer, it features many items new to the Fowler line. With an emphasis on SPC, the catalog features a selection of digital electronic instruments with output capability, plus measuring machines and electronic measuring systems from Trimos and Sylvac.



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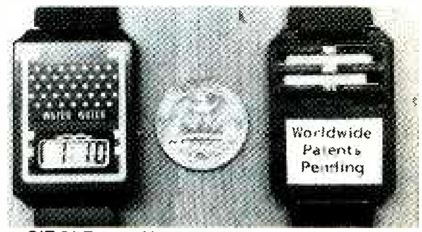
Additional items in the Catalog include precision tools (micrometers, calipers, indicators, gages, squares, rules, etc.), optical measuring instruments (magnifiers, microscopes, optical comparators, etc.), toolmakers' aids, shop tools, work holders (vises, sine plates, etc.), and more. Also included are a full color introduction and a master listing of service facilities for Fowler products.

The catalogue is available from Fred V. Fowler Co., Inc., ATTN: Department L, 66 Rowe Street, P.O. Box 299, Newton, MA 02166; Tel. 617/332-7004.

Wrist Watch Runs on Water

The first production models of a wrist watch that runs on water, were recently unveiled by a west Texas engineering firm.



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Based upon a 200-year-old technology, the Water Watch does not need a replacement button-battery, but rather needs only a few drops of water once or twice a week to generate electrical power.

The water battery consists of two or three tiny water cells. Each cell has copper foil on one surface and zinc foil on the other surface. There are small holes in the side of the watch case to allow water to enter. When water is added, an electrochemical reaction is set up between the copper and the zinc. This reaction produces the electrical power needed to run the wrist watch.

The Water Watch will run on tap water, soft drinks, beer, wine, fruit juice, or just about any water-based liquid. The only problem we've found is that the sugar in some of these beverages tends to gum up the water battery.

When you need to repower your wrist watch, just go for a swim, jump in the hot tub, wash your hands, or go for a walk in the rain.

Water watches are available for $20 to $30 in department stores and specialty shops.

Speed-Teaching Disks

Students seeking an *unfair advantage* in mastering academic concepts, should check out a line of high-powered, inexpensive courseware called Course-Master. Tailored to standard courses of study in primary, secondary, and college classes, the disks may be ordered by course-title. Course-Master provides interactive study drills in mainstream subjects such as English, history, science, social studies, humanities, and trivia. Special fonts and easy super/sub-scripting are provided

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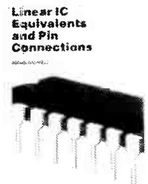

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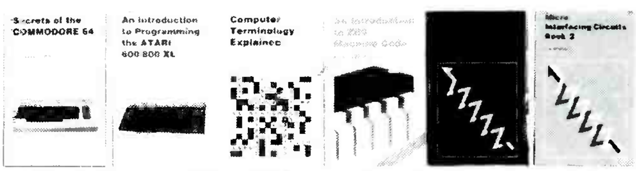

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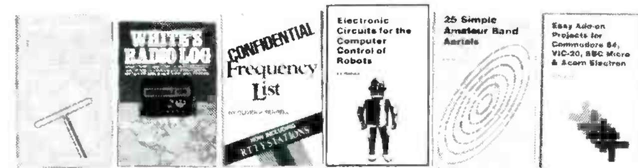

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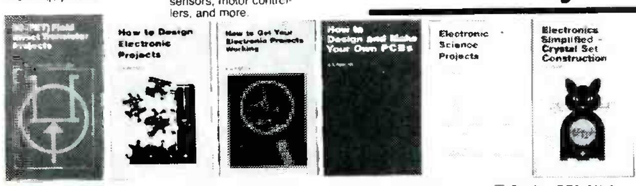
☐ BP134—EASY ADD-ON PROJECTS FOR COMMODORE 64, VIC-20, BBC MICRO & ACORN ELECTRON ..... $6.95. Picture digitizer, light pen, model controller and more.

Quality Paperbacks



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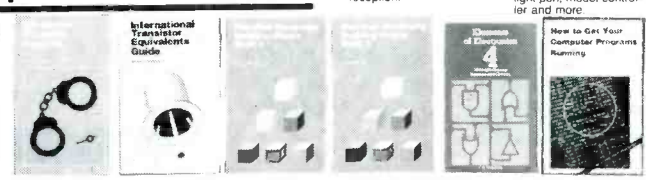

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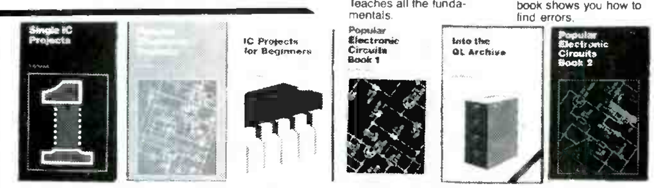

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☐ BP97—IC PROJECTS FOR BEGINNERS ..... $5.00. Written especially for the less experienced experimenter. Complete parts layouts and wiring diagrams.

☐ BP80—POPULAR ELECTRONIC CIRCUITS, Book 1 ..... $5.00. More circuits for hobbyists. Audio, radio, test, music, household and more.

☐ BP161—INTO THE QL ARCHIVE ..... $5.95. Presents the powerful database for the Sinclair QL. Step-by-step approach includes practical examples.

☐ BP98—POPULAR ELECTRONIC CIRCUITS, Book 2 ..... $5.75. More useful circuits. None of these projects duplicate those in Book 1 of this series.

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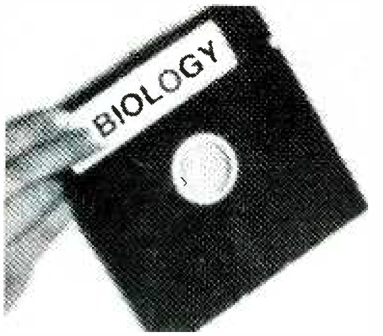

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for foreign language and math-science use.

Each Course-Master disk contains terms, facts, concepts, formulas, names, personalities, and definitions organized into meaningful units as required for specific courses. Designed by a behavioral psychologist for maximum learning utility and friendliness, Course-Master uses the long question, short answer structure, commonly found at the end of textbook chapters, for interactive drilling. Right answers are reinforced, wrong answers are corrected and re-presented until learned. The program is snappy, completely menu-driven, and the content can be edited by the user.

For the teacher, Course-Master prints word-match and fill-in quizzes on paper. Disks are priced beginning at $29.00. For more information, contact Compu-Tations, Inc., PO Box 502, Troy, MI 48099; Tel. 313/689-5059.

Low Cost Page Printer

Called the GQ-3500, Epson's printer comes equipped with 640K of memory to handle the full range of text and graphics functions needed by corporate and small business users, looking for quality printing and efficient throughput speed. And it offers user-replaceable consumables which result in easy servicing and low per-page operating costs.

Epson's laser features fast warm-up time (45 seconds) and first page printing time (between 22 and 25 seconds), with an overall speed of six pages per minute. Users have access to seven built-in fonts

CIRCLE 86 ON FREE INFORMATION CARD

available through an easy-to-use control panel. The printer's engine life is rated at 180,000 pages.

Epson's laser offers code compatibility, including emulation of line printer code sets and Epson's LQ dot-matrix series printers with ESC/P code sets.

Of course, this kind of performance costs, and it costs $2,495.

The GQ-3500 has the standard 470K of user memory, which provides the ability to print a half page of graphics at 300 dots per inch (dpi). An optional 1.5-megabyte expansion board allows users to print a full page of graphics at 300 dpi.

In addition to its extensive software code compatibility, the GQ-3500 includes a new page printer language, which is a further extension of ESC/P with added features allowing users functions such as high-level graphic primitives, forms overlay, and page formatting. Other well-known competitive models use memory intensive bit image graphics to perform the same tasks.

Epson America's Computer Products Division is located at 2780 Lomita Blvd., Torrance, CA 90505; Tel. 213/539-9140 or 800/421-5426.

Budget VOM

Beckman Industrial Corp. has introduced a four-function, analog multitester, with 16 measuring ranges, that retails for only $9.95.

The Circuitmate Model AM10 pocket-size meter, is designed to perform numerous quick circuit checks or to serve as a spare or backup meter. Expected applications for the AM10 are in homes, shops,

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automotive repair operations, schools, and other places where a low-cost electrical testing device is needed.

Features of the AM10 include a jeweled movement that provides accuracy of 4 percent of full scale, decibel readings on the AC volt scale, 2,000-ohms/volt sensitivity, two times scale overload protection, zero adjust for ohms and meter movement, and a mirrored scale.

The AM10 was designed to provide a low-cost alternative to larger meters and also as a backup meter for the service technician.

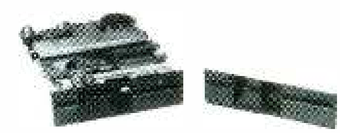
The AM10 case is made of UL-Listed flame resistant material. It measures 3.53" × 2.36" × 1.15", and weights only 4-½ ounces including the battery. The AM10 comes equipped with a test load set, battery, and an operator's manual.

Specifications include: DC and AC voltage ranges at 0–10, 10–50, 50–250, and 250–500-volts; DC accuracy of 4% of full scale; AC accuracy of 5% of full scale; AC bandwidth of 50Hz–1kHz; DC current ranges of 0–0.5, 0.5–50, 50–250-milliamps, at 4% accuracy of full scale.

For further product information, contact Beckman Industrial Corporation, 630 Puente Street, Brea, CA 92621; Tel. 714/671-4800.

IBM-AT Software Compatibility

Weltec digital, Inc. has announced the availability of a 1/2 high, 1.2MB floppy-disk drive, capable of giving the IBM AT compatibility to the PC or XT, without any alteration or change to your current drive controller card.



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Additional features include, brushless direct drive motor with a 30,000 MTBF, full interchange of diskettes between IBM-AT and PC or XT, as well as most IBM compatible systems, internal or external configurations, and ANSI and industry interface compatibility.

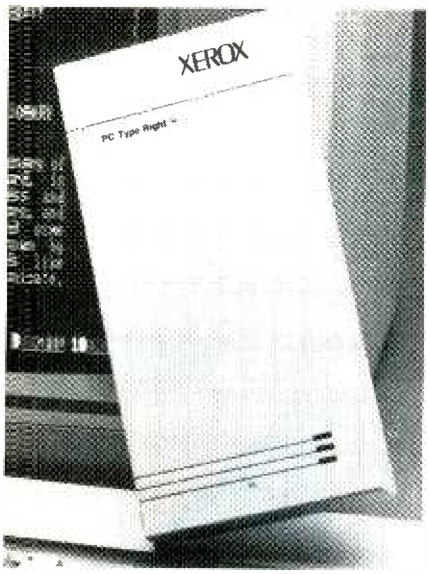
The unique floppy drive is immediately available, lists for $149.00, and is discounted to qualified OEMs, dealers, system integrators, and corporate multiple-end users. Drives come with a full one year warranty.

For more information, please write or call: Weltec digital, Inc., 17875 Sky Park North, Suite P, Irvine, CA 92714; Tel. 714/250-1959.

Xerox Spelling-Checker

Xerox Corporation announced an electronic dictionary for use with IBM and IBM-compatible personal computers that checks spelling as text is being typed. It can be installed in seconds and uses no random-access memory, disk space, or expansion slots.

PC Type Right checks spelling against a dictionary of 100,000 words in less time than it takes the typist to depress and re-



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lease the space bar. It includes a 1,200-word personal dictionary.

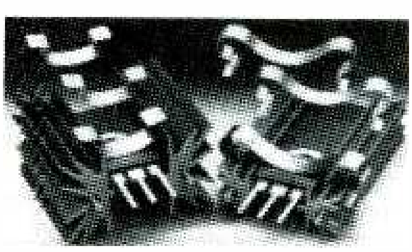
Typing errors are signaled by a *beep* tone. By receiving instant feedback of both spelling and typographical errors, users can improve typing speed.

PC Type Right is also one of the few spelling aids that serve people who communicate by electronic mail. It enables them to catch errors before they are transmitted.

Installation is simple. The computer keyboard is plugged into PC Type Right which, in turn, is plugged into the computer's keyboard receptacle. The unit works with IBM PC, XT, and AT personal computers, and IBM-compatible computers with detachable keyboards.

Those include the Xerox 6064 and 6065 personal computers, Xerox 6067 and 6068 word processors, and the ATT 6300 personal computer.

Suggested list price for PC Type Right is $199.95. It will be available nationally by November 1986 through Xerox and authorized Xerox dealers. Write to: Xerox Square 006, Rochester, New York 14644; Tel. 716/423-5078.



CIRCLE 87 ON FREE INFORMATION CARD

Mount Semiconductors Quickly

These extruded heat sinks feature spring clips. They make it possible to attach semiconductors to heat sinks very rapidly. You eliminate slow nut-and-bolt mounting, thus reducing labor costs.

The spring clip also improves thermal contact between semiconductor and heat sink. Vertically mounted, the heat sinks take very little PC board space. The spring clip for series 5334-36 adds virtually nothing to the footprint of the heat sink, also avoiding any interference with nearby components.

Series 5334-36 heat sinks can be furnished with spring clips on both sides, so that two semiconductor devices can be mounted—saving even more PCB space.

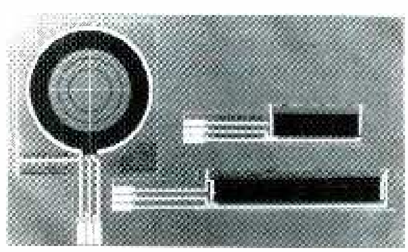
They come in three types: (standard) with two solid, tin-plated steel pins for solder mounting to PC boards; option LP, for more secure mounting to the board, using two No. 4 self-threading screws; Option SP, solderable pins provide .050" separation between PCB and heat sink to allow circuit traces to pass under the heat sink without risk of shorting.

The heat sinks run from about one to two dollars each in groups of ten, and are available from AAVID, Engineering, Inc., 1 Kool Path, Box 400, Laconia, NH 03247; Tel. 603/524-4443.

Circuit-Designer's Special

Interlink Electronics announces the development of a thick-film, linear potentiometer which provides a unique solution for a low-cost, very-low profile. Measuring only 0.015" high, the linear potentiometer may be integrated within a membrane panel or into any design where space is critical. The device uses Interlink Electronic's proprietary force sensing resistor technology to measure both the position of an object and it's pressure upon the surface.

The following electrical specifications



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are provided to enable the Interlink Linear Potentiometer to be integrated into various products: Maximum working voltage 1.5-volts; maximum DC current 1-milliamp; typical no-load resistance 10-megohms; typical resistance range 10-megohms to 1000-ohms.

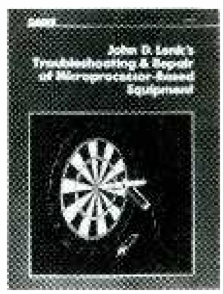
A linear pot kit for evaluation purposes is offered by Interlink Electronics for $30 ppd. The kit includes 3 formats of the linear pot, a sample electronic schematic for interfacing circuitry, and a data sheet. Contact Interlink Electronics, 535 E. Montecito St., Santa Barbara, CA 93103; Tel. 805/965-5155. ■

BOOKSHELF

John D. Lenk's Troubleshooting & Repair of Microprocessor-Based Equipment
By John D. Lenk

A simplified, practical system of troubleshooting for the many types of microprocessor-based electronic devices is described in *John D. Lenk's Troubleshooting & Repair of Microprocessor-Based Equipment*.

Concentrating on the basic approach to troubleshooting, the author included numerous procedures and *tricks* that can be effective in diagnosing, isolating, and locating faults in microprocessor circuits.



CIRCLE 71 ON FREE INFORMATION CARD

Written primarily for working technicians and field service engineers, it is also an excellent guide for students. Topics covered include: microprocessor test equipment; problems in troubleshooting microprocessors; troubleshooting a gate and IC; stimulus-response testing; V_{cc} and ground shorts from unexpected causes; flip-flop troubleshooting; register troubleshooting; current flow analysis; wired-and and wired-or troubleshooting; using the logic analyzer; step-by-step procedure of troubleshooting a VCR.

Retailing for $12.95, the book contains 250 pages and is available through bookstores, electronic distributors, or directly from Howard W. Sams & Co., Inc., Dept. R40, 4300 W. 62nd St., Indianapolis, IN 46268; tel. 800/428-SAMS.

dBase III Plus Handbook—2nd Edition
By George Tsu-der Chou

When pondering whether or not to buy a software package, it is often

CIRCLE 72 ON FREE INFORMATION CARD

wise to read some text to discover how useful it may be. This book is a worthwhile investment for such a purpose.

The text provides an introduction to database management principles and theory, plus detailed coverage of all dBASE III Plus commands and operations. Specific chapters cover: An introduction to the types of database, their structure, organization, indexing, and assigning key fields and data types; configuring your computer, preparing the system disk, and installing the program; defining the database structure, entering data, and displaying the contents of a database file; modifying the structure and contents of a database file; sorting and indexing a database; using memory variables, expressions, and functions; generating reports with the flexible reporting capabilities of dBASE III Plus, and writing command-file programs to automate database management applications.

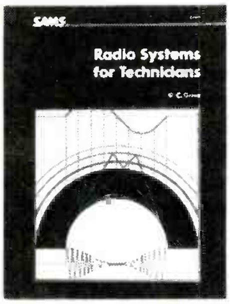
Computer users and micro managers who are contemplating the purchase of dBASE III Plus will find this volume useful in deciding whether the program meets their needs.

The 2nd edition of *dBASE III Plus Handbook* is a reference and learning guide to dBASE III and its upgraded version—dBASE III Plus. Those who have upgraded from dBASE III to dBASE III Plus will appreciate the comparisons between the two programs, including a complete appendix listing the differences between the two versions.

The book (510 pages for $19.95) is available in most bookstores and computer stores throughout North America. To order directly from Que Corp., call 800/428-5331.

Radio Systems for Technicians
By D.C. Green

In one complete volume, *Radio Systems for Technicians* discusses basic electronics concepts valuable to all technicians and hobbyists. Covered are such topics as: the principles of amplitude and frequency modulation; how to change the amplitude and frequency of a signal using modulators and demodulators; how to build and use transmission lines and aerials; radio-wave propagation and the use of landline and radio wideband systems;



CIRCLE 73 ON FREE INFORMATION CARD

the various stages, selectivity, sensitivity, and modes of operation of radio receivers and transmitters.

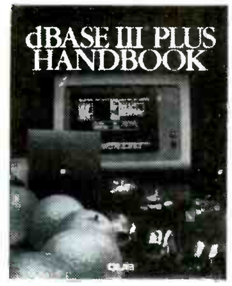
A 282-page soft-cover book, it retails for $12.95, and is available through bookstores, educational institutions, computer retailers, electronics distributors, or directly from Howard W. Sams & Co., Inc., Dept. R40, 4300 W. 62nd St., Indianapolis, IN 46268; tel. 800/428-SAMS.

Program Your IBM PC to Program Itself
By David D. Busch

Are you tired of spending endless hours writing program lines and subroutines? Does it feel as if you spend more time writing a program than using it? Then stop and let your computer do more of the work for you! Using this collection of plug-in programs you can harness the power of your IBM PC, PC JR, or compatibles for automatic software writing.

Sit back and watch your computer generate 40 or 50 lines of code without having to type in a single BASIC command! You will be amazed at how simple screen displays and menus will be to produce. Even graphic screens for visual presentations will be a snap. Your IBM PC will do the programming for you.

For example, the screen-editor program allows you to draw on the screen any menu, title block, instructional screen, or other material that's needed in the program. Then by pressing the ENTER key, the screen just designed is transformed into



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program lines in a minute or less. Some of the other fascinating capabilities of the programs include: the DB starter, which constructs the skeleton of a database program, including the menus, the I/O modules, and the necessary ON...GOTO lines; and the proofer which finds misspelled keywords, mismatched parentheses, and other errors before runtime.

The guide features a total of 19 time- and money-saving programs that serious programmers will use again and again. And once they see how convenient those "automatic" programs are, they can begin using them to write even more software.

The book contains 141 pages, costs $33.95, and is available from Tab Books Inc., Blue Ridge Summit, PA 17214; Tel. 717/794-2191

(Continued on page 23)

Science Brief

SOUTH POLE SCIENTISTS SCAN UNIVERSE TO DETERMINE HOW GALAXIES FORMED

☐EXPLOITING THE UNIQUE ADVANTAGES of the South Pole, researchers during this austral summer (1986-1987) are seeking the answer to a fundamental question that so far has eluded scientists: How did matter in the universe form into structures such as galaxies and clusters of galaxies?

The scientists are trying to detect fluctuations—or *lumpiness*—in the microwave background radiation that permeates the universe. So far, measurements of that radiation have shown it to be remarkably uniform in all directions. However, theorists say that the radiation must contain fluctuations, which scientists call *anisotropy*, that describe the initial clumping of matter during the early formation of structure in the universe.

The researchers are optimistic about their chances, because they will be using newly developed instrumentation capable of observing fluctuations more than 10 times smaller than possible before—down to a few millionths of a degree, well below the limit of theoretical predictions.

If the challenging experiment is successful, the South Pole could well become the center of that area of cosmological research. If not, a drastically new theory will be needed to account for the formation of galaxies and clusters of galaxies, the spawning ground of stars.

Why Go South

The South Pole experiment is part of the 1986-87 U.S. Antarctic Program, which is funded and coordinated by the National Science Foundation (NSF). Approximately 255 researchers traveled to the remote continent at the bottom of the world to conduct 70 scientific projects in a variety of disciplines. This season marks the 31st consecutive year of U.S. activity in Antarctica.

The experiment is conducted by a team headed by Dr. Martin A. Pomerantz of the Franklin Institute's Bartol Research Foundation in Newark, Delaware. The team includes Drs. Mark Dragovan, Anthony A. Stark and Robert W. Wilson, all of AT&T Bell Laboratories in Holmdel, New Jersey.

In 1965, Dr. Wilson and Dr. Arno Penzias, also of Bell Laboratories, discovered that a background radiation permeated all regions of the sky—solid evidence that the universe started with a tremendous explosion of an extremely dense, hot and compact object. Those scientists were awarded the Nobel Prize for that discovery. During the explosion, called the "Big Bang," events occurred that dictated the present nature of the universe.

The microwave background radiation is a relic of the early universe—the remnant, cooled by expansion to a current temperature of 2.75° Centigrade above absolute zero from about one thousand billion billion billion degrees at the earliest epoch imagined by current physics. That all-pervasive radiation is an imprint of the structures that started to form about a million years after the Big Bang.

The best measurements to date of cosmic background radiation show that it is remarkably isotropic—uniform in all directions—with temperature fluctuations of less that 50-millionths of a degree Centigrade. That is just above the minimum fluctuations, or anisotropy, predicted by theories that describe the initial clumping of matter after its production following the Big Bang.

It Started at Bell Labs

The state-of-the-art instrumentation to be used at the South Pole was developed by Dr. Wilson's group at Bell Laboratories. A big problem was that radiation from the earth's atmosphere would override the microwave background radiation.

Two years ago, a U.S.-French team led by Dr. Pomerantz made far-infrared optical observations at the South Pole at wavelengths up to the millimeter region, where the intensity of the background radiation peaks and the new Bell radiometer operates. They confirmed that water vapor content and the "sky noise" at the South Pole is lower than at any other place on earth.

The one-meter radio telescope that the scientists are using can receive signals with wavelengths of about three millimeters. To attain the required sensitivity, the telescopes's receiver is cooled by liquid helium to 0.3° Centigrade above absolute zero which is −273.15° Centigrade. Because the telescope is located at the earth's axis, its site is fixed and the earth's rotation will provide 360° scanning each day—another unique advantage of South Pole site.

In the decade to come, the work of those scientists at the bottom of our world, along with the contributions of many other scientists under many differing flags, will compound a theory that may fully explain how we came to be here. What happened before the Big Bang? That's another question to which no answer can be found. ■

BOOKSHELF

(Continued from page 17)

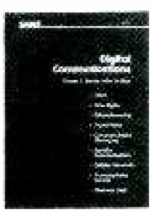
Digital Communications

Digital Communications is an in-depth text devoted to the new technologies in the communications field. It was developed as a comprehensive reference source as a result of the recent growth and significant advances in the communications industry.

Nine leading experts detail each subject with perspectives and overviews shaped by many years of experience. Their contributions reflect the most current and accurate information available in their fields.

Digital Communications focuses on the technological advances such as electronic mail, video teleconferencing, fiber optics, and voice/data integration and their implementation in business.

Each chapter of this hardbound text provides a tutorial, reference, or introduction to the sophisticated subject of digital communications.



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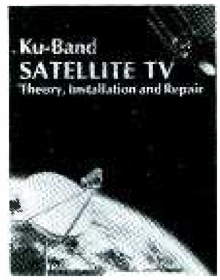
Topics covered include: fiber-optics transmission technology and system evolution, satellite communications, integrated services digital networks (ISDN), computer-based messaging, electronic mail systems, cellular networks, communications for command and control systems, digital coding of speech, video teleconferencing. The book retails for $44.95; is 448 pages; available through bookstores, educational institutions, computer retailers, electronics distributors, or directly from Sams by calling 800/428-SAMS.

Ku-Band and Satellite TV—Theory, Installation and Repair
By Frank Baylin and Brent Gale

Many people who didn't even know what a satellite dish was as of two years ago, now own one. If you are one of those owners, you know that the owner's manual only takes you so far. If you want to go farther, this text is for you.

Ku-Band Satellite TV—Theory, Installation and Repair is a source of information and explanations covering all aspects of worldwide Ku-band satellite television systems. The authors have taken great care so that



CIRCLE 68 ON FREE INFORMATION CARD

the interested layman will easily understand all the concepts.

The book begins with an exploration of the background of Ku-band TVRO's. It includes a detailed survey of frequency allocations for broadcast satellites in countries around the globe. Next, the underlying theory and practical aspects of equipment used to detect signals from orbiting spacecraft are presented in depth. Methods to design and size antennas for Ku-band TVRO's are outlined in Chapter 3. Properly selecting TVRO components follows in the fourth chapter, which also includes a study of scrambling and encryption methods.

Explanations of installing Ku-band systems and retrofitting Ku-band components onto C-band TVRO's is presented in Chapters 5 and 6. Next, a step-by-step examination of multiple-receiver systems and distribution networks is presented. In Chapter 8 existing North American, Soviet, European, Japanese, and Australian Ku-band broadcast systems are examined. A method to troubleshoot and repair TVRO's is presented in the last chapter. The basic types of test equipment are described in detail. The Appendices contain satellite TV equations, footprint maps for nearly all existing Ku-band broadcast TV satellites, a newly written satellite-finding program for any location on the globe, and lists of worldwide manufacturers and trade magazines.

This 386 page manual-costing $19.95 plus $2 shipping and handling, is available from Baylin/Gale Productions, Suite 103, 1905 Mariposa, Boulder, CO 80302.

Digital Communication Systems
By Peyton Z. Peebles, Jr.

Where can the highbrow data systems specialists turn to for information and theory on digital communications? They can check out this graduate-level text for the latest in data transmission theory.

Digital Communication Systems is a book that presents information on modern electrical communication theory as applied to digital communication systems. For the

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reader's exercise of the concepts, the book contains over 370 problems related to the theory. The text includes a logically developed, wide variety of digital essentials; sampling principles—theorems for nonrandom and random messages; practical sampling and signal methods; time multiplexing; baseband digital waveforms—optimum and nonoptimum quantization; companded quantizers; source encoding of digital messages; channel encoding

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fundamentals; waveform formats and much, much more!

Appendices present reviews of deterministic signals and networks, and random signal theory, as well as information on a number of specific mathematical topics.

The book is contains 425 pages, and retails for $39.95 from Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; Tel. 800/223-1360.

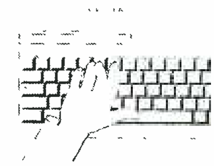
A Practical Reference Guide To Word Processing On the Amstrad PCW8256 and PCW8512
By F. A. Wilson

With the PCW8256 and PCW8512, Amstrad has now brought word processing within the reach of everyone. These machines are capable of manipulating letters and words in practically every conceivable way, and what can be achieved with them is probably limited only by the ingenuity of the user.

A Practical Reference Guide to Word Processing on the Amstrad PCW8256 and PCW8512 was written to complement the thick owners manuals. It offers much practical advice, simplifies many complicated procedures with specially developed "follow-the-arrows" charts, and also includes a comprehensive reference section.

The book retails for $14.95, contains 181 pages, and is available from Electronic Technology Today, Inc., PO Box 240, Massapequa Park, NY 11762.

Printed Circuit Board Precision Artwork Generation and



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Manufacturing Methods
By Preben Lund

We at **Hands-on** are often asked how to create circuit boards, but if our readers had this book, we would never be asked again. *Printed Circuit Board Precision Artwork Generation and Manufacturing Methods* was written to help printed-circuit board designers and draftsmen keep pace with critical new developments in PCB design and manufacturing, including computer aided design and drafting (CAD) and automatic testing equipment (ATE) and techniques. It also contains the latest, most effective methods for preparing PCB artwork to satisfy today's demanding board-manufacturing requirements, thus avoiding numerous production pitfalls, while cutting costs and saving valuable time throughout the entire artwork production and inspection process.

The hardcover book features 478 pages and sells for $39.95 (Order No. 10011), plus $5.00 for postage and handling (outside the U.S.A. $9.00). California residents add 6½% sales tax.

A new Educational Bulletin, No. 5010, describing *Printed Circuit Board Precision Artwork Generation and Manufacturing Methods* in detail is available free from any Bishop

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Graphics dealer, or by contacting Bishop Graphics, Inc., 5388 Sterling Center Drive, Westlake Village, CA 91359; Tel. 800/222-5808; in Alaska, Hawaii, and California Tel. 818/991-2600. ■

By BYRON G. WELS

WELS' THINK TANK

To Build or To Buy?

VERY OFTEN WE'RE HARD-PRESSED TO decide on whether to buy something we need or to build it ourselves. It's a decision that only an electronics experimenter has to make, because usually, we're the only ones that have that option. Our skills offer us that opportunity, and what makes the decision is that most of the time, we can pocket a good bit of change by building our own. But that is definitely *not* the only reason for making such a decision. Many times, we want the additional knowledge that is offered only by *rolling our own*; or we're curious about how things work; or simply crave the gratification of using our own hands and abilities to bring a project to life.

But there are times that basic economics dictate that we buy rather than build. Let's face it: If something is available for five bucks, complete, ready to plug-in-and-play, why spend seemingly endless hours and lots of cash to build it from scratch? There's no point (or sense) to re-inventing the wheel.

Humidity

What brought about the above lecture, was a letter from C.T., of Mauldin, SC. He wants to build a humidity indicator, but is experiencing some difficulty in getting a humidity probe. The one source that he'd managed to locate offered probes with a minimum billing of $100, plus freight! Being a dyed-in-the-wool electronics hobbyist, he won't give up. He still wants to build his own.

Well, I'm not certain of where you've looked, but would you believe a humidity probe for seven bucks? Under separate cover, I'm sending you the complete article on this subject, as it appeared in our sister publication, **Radio-Electronics** magazine. Sure hope that helps. Unfortunately, the schematic diagram is too large to reproduce here. But, if anyone else is interested in obtaining a copy of that article, send a check or money-order for $4 (which includes shipping and handling) to **Radio-Electronics**, *Reprint Bookstore*, 500-B Bi-County Blvd., Farmingdale, NY 11735. Oh yeah, the article—*Humidity Monitor*—appeared in the February, 1986 issue.

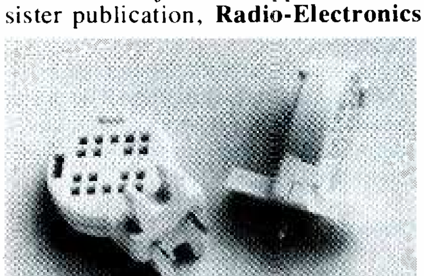

Fig. 1—At seven dollars, the humidity probe is a lot easier to buy than to build.

If you'd like to know how the probe works, here goes: It's actually a capacitor made of a dime-sized piece of plastic film, coated on both sides with an extremely thin layer of gold. Because the dielectric constant of the film alters with changes in relative humidity, so does the capacitance. The gold on each side of the film acts like one plate of a capacitor, and also provides electrical contact for the sensor-housing's spring-contact leads. The sensor measures only 0.6-inches diameter and 0.9-inches high. The capacitance ranges from about 115 pF at 0.0% relative humidity to about 160 pF at 100% RH. With a change of about 45 pF over the entire relative-humidity range, all we need is a circuit that can interpret that capacitance change in terms of properly-scaled voltage.

Timer

"I know that there are timer circuits all over the place, but I've specialized my hobby electronics to timers of all types. Have you a timer I might not have seen as yet?" P.J., Atlantic City, NJ.

Interesting, P.J. We've never before heard of anybody specializing so vertically! See Fig. 2 for an unusual timer using an SCR (silicon-controlled rectifier). That schematic shows an SCR whose conduction is controlled by a unijunction transistor (UJT). When capacitor C1 has been charged to a given point, it discharges through R1, which can be adjusted to provide different discharge rates, and therefore different triggering times.

When you first close S1, current flows from the battery-charged capacitor, C1, which bleeds off through resistor R1. When C1 is sufficiently discharged, transistor Q1 conducts and activates the SCR. That allows current to flow through the sonic transducer BZ1 (a piezoelectric buzzer, Radio Shack No. 273-065), causing it to sound.

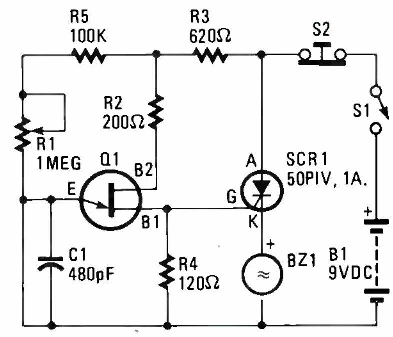

Fig. 2—This circuit uses a ECG6400 unijunction transistor for Q1. The piezoelectric buzzer, BZ1, is a Radio Shack 273-065.

To reset the timer, simply press S2, a normally-closed momentary-contact switch. R1 sets the time-delay rate. With the components shown, the lag rate is eight to ten minutes. Construction is simple, and perfboard can be used. The only caution is that the polarized components be connected with the correct polarities observed.

To test the unit, adjust R1 to the mid-range position and close S1. Reducing the setting of R1 should decrease the timing.

Don't hesitate to change the value of R1 to change the timebase. In fact, if there are specific time intervals you require, you can set those on R1 and then measure the resistance from the emitter (e) of Q1 and the junction of R1 and R5. Substitute a rotary switch for R1 and use several fixed resistors to determine the necessary time-bases.

Overvoltage Protector

"How can I keep a voltage spike from wiping out my voltage-sensitive equipment?" is the question put to use by M.R. of Sioux Falls, SD.

First, M.R., be aware that some equipment can tolerate overvoltage a lot better than others. Therefore, where it may be necessary to deliver a critical voltage value, it may also be necessary to provide overvoltage protection. Some devices contain circuits that automatically correct overvoltage conditions by dropping the supply voltage to a safe level. Other protection circuits react somewhat differently; when voltages exceed a preset value, the protection circuit removes power to the load altogether.

Figure 3 is example of the latter type of circuit. As shown, a silicon-controlled rectifier (SCR1, a 50-volt, one-ampere unit) is installed in parallel with the 12-volt line and connected to a normally-closed 12-volt relay, K1. The SCR's gate circuit is used to sample the applied voltage.

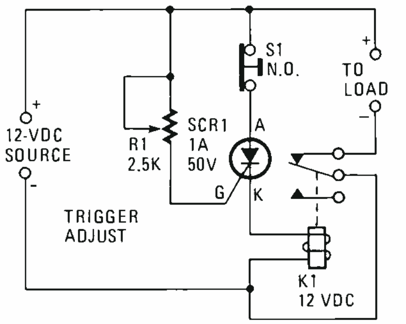

Fig. 3—Remember that switch S1 must be reset each time the unit is activated by a surge; if not, it will sit there doing nothing.

Note that the relay contacts are wired in series with the negative side of the 12-volt power source. As long as the applied voltage stays below a given value, SCR1 remains off and K1's contacts remain closed, thereby supplying power to the load. But, when the source voltage rises above 12 volts, sufficient current is applied to the gate of SCR1 to trigger it into conduction. The trigger point of SCR1 is dependent on the setting of R1. Once SCR1 is triggered (activating the relay), K1's contacts open, thus halting current flow to the load.

There is nothing particularly critical about the construction of the circuit; in fact, all the parts (and there aren't that many) can be mounted on a piece of perfboard, and dropped right into the same housing as the device to be protected. Or, if you're putting together a printed-circuit layout for some new piece of equipment, you can add the protection circuit to the power section of your project.

You can check the circuit's operation by connecting a variable power supply to the input of the circuit, and a suitable load to the output. The load should immediately be energized upon application of power. If, with 12-volts applied, the load device fails to function, adjust R1 until the relay disengages. After load operation has been verified (at 12 volts), slowly increase the supply voltage until the load device ceases to function. Once you've reached that point, you must then reduce the input voltage to the point where it no longer triggers the relay, and then press S1 (a normally-closed, momentary-contact switch) to reset. The load device should resume operation. If you do not hit the reset, the circuit will not allow power to again be applied to the load, regardless of how you reduce the setting of R1.

You should also be aware that while the schematic shown is designed for 12-volt operation, you can readily use it for any other range simply by adjusting R1. Of course, if you plan any drastic changes, by all means correct the values of the other components as well.

Proximity Alarm

"I need an indication of when something comes close to something. The fact of the matter is that I work at a large store and we've just about decided to close one of our parking-lot entrances because of disuse. The boss wanted to put a man on duty there with a hand counter to see how much use the entrance actually gets. I'm sure we can count electronically for a heck of a lot less cost than a full-time salary. Am I right?" T.J., Miami Beach, FL.

Of course you're right T.J. For a lot less than the cost of a day's salary for that man, you can build a circuit that can do the job—and hang around for future jobs, too.

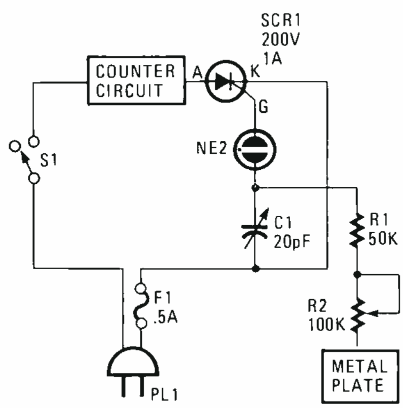

Fig. 4.—The metal plate in this schematic also serves as the return. You're going to have to adjust the plate's size to get optimum performance.

The schematic diagram in Fig. 4 shows a circuit built around a silicon-controlled rectifier (SCR1), which uses capacitance via NE1 (a miniature neon lamp) to trigger the circuit. A 20-pF trimmer capacitor, C1, functions as a sensitivity control, and is connected in parallel with a sensor plate. While the circuit appears to be incomplete, body capacitance in relation to the wiring in the wall, forms the other (invisible) connecting leg. A variable resistance (R2) in the sensor lead is included.

A great deal of surface area may be required to trigger the unit, and we suggest a large sheet of aluminum foil directly under where the cars will pass. However, it's extremely difficult to solder to aluminum; but the connection can be made by crumpling one corner of the foil and physically connecting it directly through lead wire to the circuit.

The actual counter can be an electromechanical type, or any of a number of LED types.

VOX

"I need a voice-operated switch that will give me a hand-to-spare when I'm working. Got anything suitable that I can use?" So writes T. L., of St. Petersburg, FL.

Sure thing, T.L., check out Fig. 5. That circuit causes a switching action whenever your voice, or any other sound (for that matter) is heard. Its operation is simple: The sound picked up by SPKR1 (which in this case acts as a microphone) is transformed into an electrical signal, and fed to transistor amplifier Q1. The output of Q1 is applied across coupling transformer T1 and used to drive the gate circuit of Triac TR1. TR1 is used to lend a latching affect to the action of the relay. (Recall the operation of the Triac—when triggered into conduction, it can only be stopped by interrupting current flow between its two main terminals, MT1 and MT2).

The entire circuit can be built on a small piece of perfboard, but take the precaution of keeping separate the high- and low-voltage portions of the circuit to prevent dire consequences should a short-circuit occur. None of the components are really critical, and intelligent substitution is of course, permitted. In fact, almost any PNP transistor will do nicely for Q1.

To test the circuit, connect the probes of any continuity tester (or the ohms setting of a multimeter) across the output leads of relay K1, and close switch S1. Insert the plug in a wall outlet. Set potentiometer R3 to about its mid-range position. Clap your hands near the speaker, and the relay should slap shut. If that doesn't happen, try humming into the speaker while adjusting R3 until the relay does close. When you stop humming, the relay should remain closed. To stop power to the load, PL1 must be removed from the 117-volt AC outlet. But if preferred, you can add a reset switch between one of the main terminals of the Triac and the power source.

The relay used in the circuit has a 117-VAC coil and contacts; thus it is geared toward high-power devices. But, if necessary, the circuit can be modified for low-power applications.

Door Opener

"I bought a motorized garage door many years ago, before all the electronics *fol-de-rol* became popular," writes J.B. of Austin, TX. "I had to trip a manual

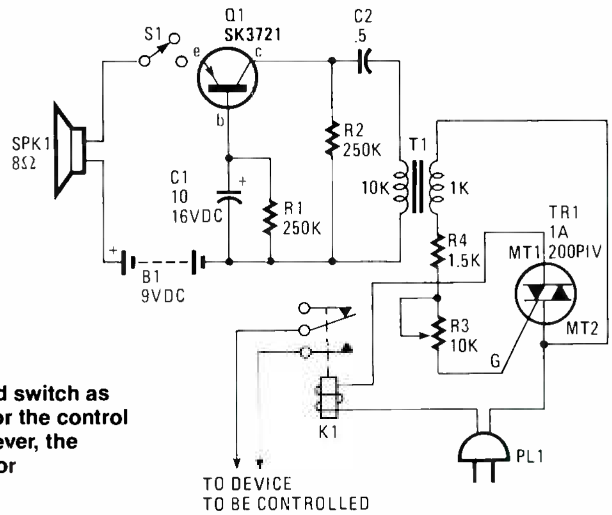

Fig. 5—The voice-activated switch as laid out here is intended for the control of high-power loads. However, the circuit is easily modified for low-power applications.

switch to make it work, but it was pretty classy back then, and it still works. But when the weather is inclement, I hate to get out of the car to throw that switch. Can I upgrade it now?"

You sure can; take a look at Fig 6. That schematic diagram shows a circuit that can function with your existing system—once installed, all you'll have to do is hit the car's high-beam headlights to open the garage door.

That circuit, based on the MRD920 LASCR from Radio Shack, derives its power from a 9-volt battery. A momentary-contact switch, S2, is provided in the event that manual opening and closing is required. Relay K1 is a 9-volt type and relay K2 is a 117 VAC latching-type, (Allied Electronics no. 802-02777 or equivalent), which automatically latches with the first burst of current and opens on the second burst.

The gate lead of the LASCR is not used—a light source triggers the LASCR unit into conduction, causing current to flow in the coil of the relay. That, in turn, causes K1's contacts to close, thereby energizing K2 (closing its contacts) and operating the garage door motor. Garage door openers usually have a cutoff switch to remove power once the door is fully opened. Once the car is safely inside, and you're nice and dry, you can manually operate the switch to again close the doors.

The circuit can be built on a piece of perfboard, and the finished circuit should be housed in a weatherproof enclosure, mounted near the garage doors. The housing should contain an access hole (covered with a piece of clear plastic) to allow light to strike the LASCR.

To test the unit, close switch S1 and turn on your headlights. The garage door should open at once. To close the door, turn off the headlights and press S2. You'll find an unexpected battery life on B1, as it is only used during operating times.

Light Dimmer

"I once saw a circuit for a light dimmer using both a diac and a Triac. I'm now teaching a course in fundamental electronics in my local Adult Education program and would like to use that as a demonstration. Can you point me toward such a circuit?" H.M., Buffalo, NY.

Refer to Fig. 7. A Triac consists of two silicon-controlled rectifiers connected in reverse parallel and sharing a common gate circuit. When the gate circuit triggers the Triac, the unit conducts current in two directions (instead of just one, as is the case with SCR's), permitting it to control the conduction of alternating current.

Diac D1 provides a positive trigger voltage for the Triac's gate circuit.

The circuit is line-driven, and as such will output a 117-volt AC maximum through AC socket SO1. However, the maximum output is adjustable through potentiometer R2, allowing the circuit to provide much-lower voltages. The actual value delivered to the receptacle (SO1) is determined by the setting of potentiometer R2. R1 functions as a protective resistor to assure that the full line voltage is not delivered to the diac and gate circuit.

Capacitor C1 triggers TR1 when the breakover voltage of the Diac is reached. When TR1 fires, C1 discharges, and then recharges once through R1 and R2 until the next firing sequence. The Triac indicated in the schematic diagram is a 4-

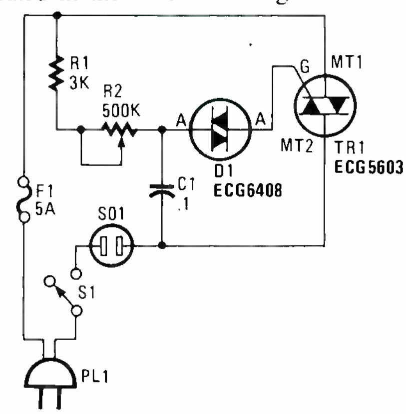

Fig. 7—This light dimmer demonstrates the application of both the diac and the triac. Potentiometer R2 controls the room light level.

ampere type, and requires heatsinking. You can build the entire unit on perfboard and mount it in a convenient aluminum box (which, with proper electrical insulation, can also serve as a heatsink).

The easiest way to test the circuit is to connect a lamp to SO1 and plug in the circuit. Place switch S1 in the on position and adjust the brightness with potentiometer R2.

Transmission Indicator

"Help me out," writes J.B., of Seattle, WA. "I'm a HAM operator, and know I'm not supposed to broadcast music. But I can't make everybody in the house keep quiet during the hours that I'm on the air. Can I make up a lighted sign to tell 'em when I'm on the air? And by the way, I do *not* want to dig into my new transmitter to do it. It's still under warranty!"

No sweat, J.B.! Check out Fig. 8. Everytime you hit the push-to-talk button, the light will go on. Just place the light (or several like it wired in parallel) behind a framed and boxed glass-plate with the letters "TRANSMITTING" or "ON THE AIR" in front of it.

If you've ever worked with crystal radios, the front end of this circuit will seem

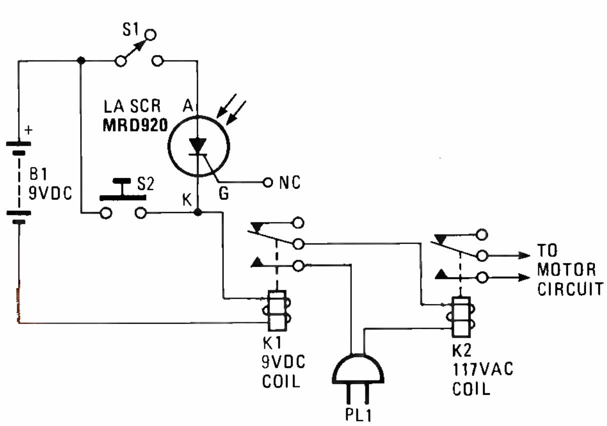

Fig. 6—You can easily upgrade the old switch-operated garage doors so that they can be opened just by hitting your car's high beams. This circuit makes it possible.

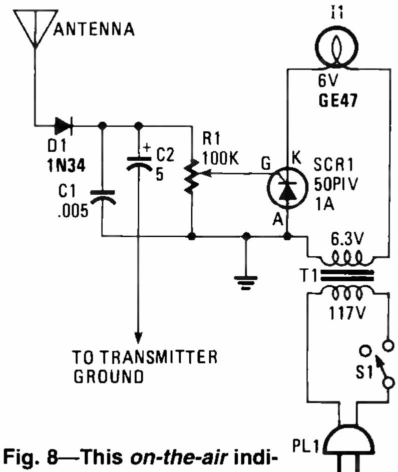

Fig. 8—This *on-the-air* indicator requires no digging into your transmitter. It operates when it detects radio-frequency energy.

familiar to you. The antenna (any random wire length) samples the output RF from your transmitter. That signal is then rectified (detected) by germanium diode D1, and used to charge capacitor C2. The DC output is used to trigger a small silicon-controlled rectifier (SCR1), which permits the current to flow through the small pilot lamp.

For lower-power applications, such as CB radio, the antenna will have to be close-coupled to the antenna. The power, incidently, is fed to the lamp through transformer T1. With a little modification, there are additional, practical applications for this circuit. For instance, if C2 is removed and the lamp replaced with a small, audible transducer, the unit can be used as a sidetone generator that will serve nicely as a CW monitor when you're transmitting in that mode.

The circuit can be assembled on a piece of perfboard. While the wiring isn't critical, it would be a good idea to keep the detector portion of the circuit separate from the power section. Couple the antenna closely; it might even dress this project up a bit to include a salvaged telescoping antenna from an unused CB rig.

Burglar Alarm

"Buying a burglar alarm system," writes K.L., of Omaha, NE, "is getting to be like buying a car. The price of the car is just the start. Then you get hit with all the options and accessories. Why don't you dip into your *Think Tank*, and see what you can come up with that I can build myself, and save?"

Sure, K.L. See Fig. 9. It kind of puts me in mind of the artist who sold a painting of a house, then a year later showed up at the customer's home with some yellow paint—he'd decided that one of the rooms in the painting should have the windows lit up! The key to the situation here, is exactly what sort of an alarm did you want?

Figure 9 shows a 6-volt buzzer and driver transistor powered from a small 6-volt battery. However, the buzzer could be replaced by a relay and used to power a heavy-duty outdoor bell or a siren from a 6-volt lantern battery, or an AC line that's been stepped down and rectified.

Using normally-closed magnetic-contact switches, you can protect all the openings in a home, and with foil tape, protect the glass as well. Looking at the schematic, you'll see that with all the switches in the closed positions, Q1 is biased off, and therefore does not conduct. When one of the switches is open, however, conduction through Q1 occurs and current flows through the emitter, through R2, and to the gate of SCR1. That causes SCR1 to conduct, triggering the alarm.

The switching sensitivity of the circuit is controlled through R1 (a one-megohm potentiometer) by varying the base voltage to Q1. The fixed-resistor, R2, ensures that sufficient drive is delivered to the gate of SCR1 when Q1 conducts.

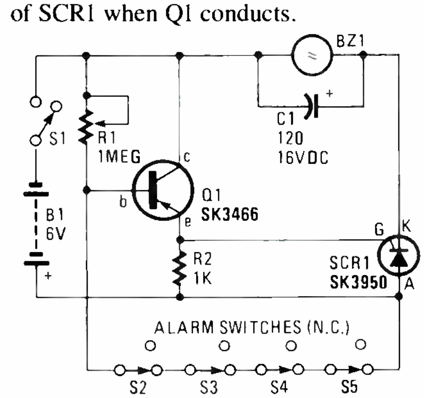

Fig. 9—Closed-loop, hard-wired burglar alarm system is shown here. It's a no-frills unit but it does the job.

To check the circuit's operation, make sure that all the switches in the loop circuit are closed, set R1 to its mid-range position, and close S1. If the alarm responds, you've either left a switch open, or you have to raise the setting of R1. Keep playing with that control, deactivating and reactivating S1 each time, until you can activate S1 without turning the alarm on.

At that point, test the system by turning S1 on, and then violate one of the magnetic window switches by opening a window. The alarm should sound.

Since the circuit draws a sizeable current when the alarm is activated, a good improvement would be to use rerchargeable batteries *and* a charging circuit. In that way, you'll know the batteries are always ready to work, and in case of a power failure, you'd still be covered.

Receiver Monitor

"I suppose a lot of people would envy me my job," writes D.L. of Jackson, MI.

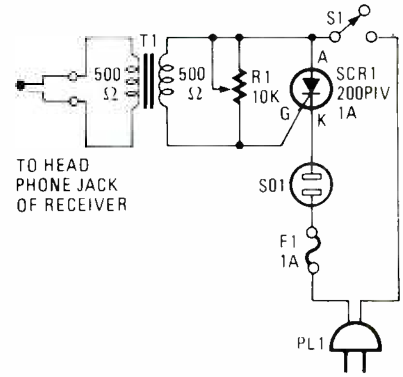

Fig. 10—This receiver monitor relieves you of the burden of waiting for an incomming signal. It waits, and signals when it hears something.

All I have to do is sit around listening to our shortwave radio with earphones on reading books and magazines. Nothing to do until a signal comes in—then I spring into action. But you'd be amazed at how fast, you can grow to *hate* those earphones! Isn't there something that I could rig up so that I could leave them off until a signal comes through?"

Look at Fig. 10, D.L. It was made for you. It's an alarm that plugs into the earphone jack on your receiver. Then when a signal (normally fed to the headphones) is detected and applied to the gate of SCR1, it conducts, sounding whatever alarm is connected to SO1. The signaling device can be an audible alarm or a lamp.

Keep in mind that the voltage at SO1 is DC, or to be more precise, rectified AC. If you employ a signalling or relay device it must be rated for DC. For example, a 48-VDC relay would work.

Variable resistor R1 functions as a sensitivity control so that background noises (QRM and QRN) won't trigger the alarm. Incidently, the circuit is also handy for use at a radio transmitting station. Connect the coil of a relay to J1 and set the unit up so that the relay is pulled in as long as the station is broadcasting. However, should the carrier be lost, even momentarily, the relay will release. The relay contacts can be set up to operate an alarm in that instance.

Well, that's about all the space we have this month—but before we say goodbye, here's a quick memory test for you. Take two, two-inch lengths of solid, insulated wire and twist them together tightly. Clip one end so there's no electrical contact, and strip the other ends for connection to a circuit. Now tell me what it's called, and what it's used for. We'll give you the answers next month!

If you need a particular circuit, and you're have a difficult time find it, let us know—we're happy to hear from you. Write to By Wels, **Hands-On Electronics** magazine, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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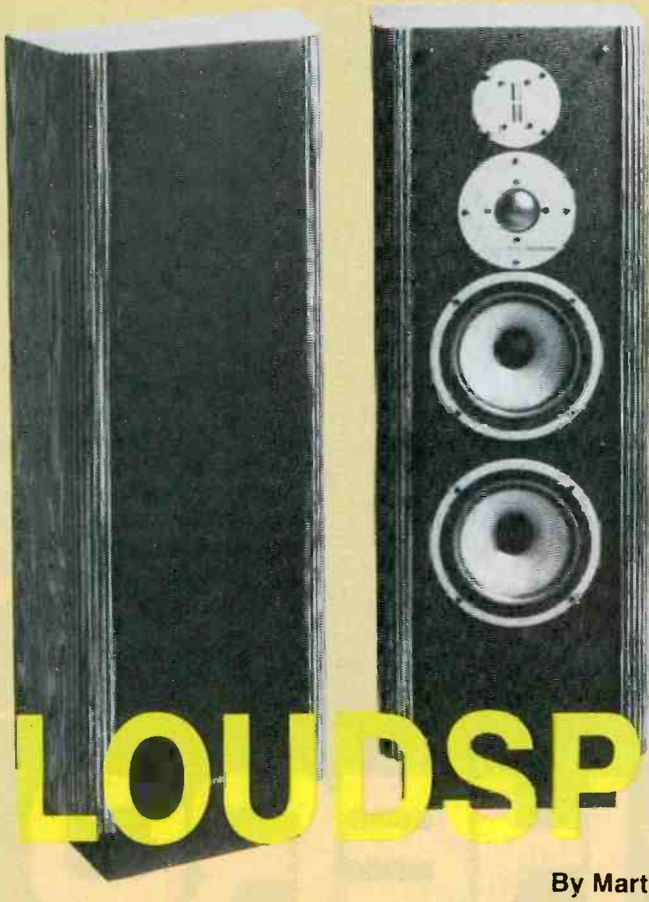


Darwin never realized that technology is just an accelerated hands-on form of evolution; loudspeaker technology today being one of the most accelerated forms of them all!

LOUDSPEAKERS

By Marty Knight

□WE ARE FORTUNATE ENOUGH TO LIVE IN THE AGE OF audiophile Utopia. Audio technology has reached a zenith of both complexity and quality, that few thought possible as little as ten years ago. From the lightest, most delicate arpeggio, to the screeching fuzz of a live rock performance, each musical nuance of man's expressive nature can be accurately reproduced.

Considered by most to be the simplest, the loudspeaker has proved to be the most difficult audio component to exalt to such lofty heights. Since the science of speaker design is based more on the physics of sound generation, rather than pure electronics, it is far more complex than most would assume. Thus the loudspeaker has traveled a long and twisted road to its present near-perfect status.

Currently available clarity is not to be confused with the electrifying and spectacular sound effects inappropriately associated with high-fidelity sound—exaggerated bass and over-accentuated treble. They are not signs of fidelity, but distortions of the original sound. If a reproduced musical performance is to be nearly identical to the original as possible, the creation of sound which is spectacular and sensational, must be left to the recording artist—not to the sound reproducing system. For an audio speaker system to have fidelity, it must not introduce new sounds of its own; it must unobtrusively reproduce the original performance.

Prodigal Speakers

The loudspeaker system is undoubtedly the weakest link in today's high-fidelity component chain. FM tuners and stereo amplifiers have reached a state-of-the-art zenith that leaves the audio purist with only fractions of small decimals with which to argue about improvement. The distortions of the turntable are no-longer perceivable by listening tests, even the once-lowly stereo phono pickup—audio's problem child during the past decade—has reached outstanding performance levels with future improvement for greater fidelity in sight. But there is no perfect loudspeaker! Musical instruments and electronic instrumentation have proliferated to such a degree in recent years that loudspeaker system design parameters have had to improve dramatically. Dynamic range is greater, frequency response is broader, dispersion wider, and power handling ability greater. To fully understand how manufacturers attacked the design problems in the creation of high-fidelity loudspeaker systems with the attending proliferation of design types, let's first check out how the loudspeaker generates the sounds we hear.

What's in a Speaker?

The basic dynamic loudspeaker (see Fig. 1) consists of a coil of wire (*voice coil*) suspended in the magnetic field of a *permanent magnet*. A non-magnetic, concentricly-corrugated support called a *spider*, holds the voice coil in the center of the magnetic field; and a soft, pliable material, called the *surround suspension*, supports the *cone*, on the loudspeaker's *frame*. Varying voltages from an amplifier connected to the voice coil generate a fluctuating magnetic field about the coil in step with an audio signal. The voice coil is moved in and out of the permanent magnet's field, again in step with the audio signal. The cone, attached to the voice coil, follows the coil's movement pistoning air back and forth, thereby generating sound waves almost identical to the original sounds that impinged on the microphone(s) used to

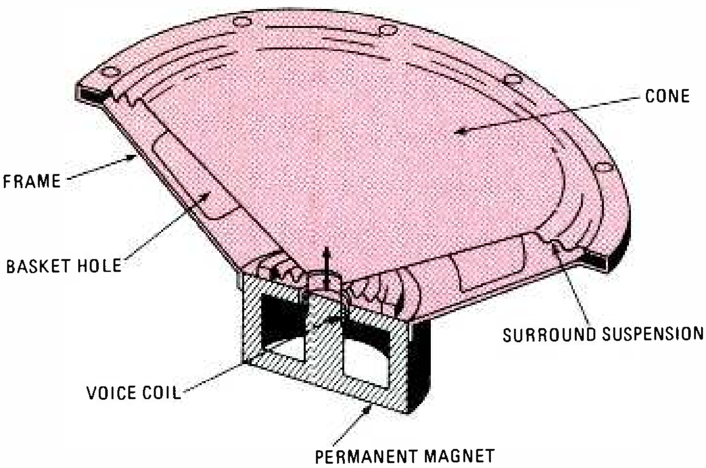


Fig. 1—The basket hole shown, is just one of several in the frame to allow free passage of air and sound from the back of the cone to the inside of the enclosure. The voice coil surrounds, and is surrounded by, a permanent magnet.


The electro-acoustic speakers require help from dynamic driver for their bass response. However, the more recent designs are able to reproduce the full spectrum of sound with respectable quality making use of several drivers.

record the live performance. Of course, the dynamic loudspeaker is a workhorse; while a microphone needs infinitesimal energy to operate, the loudspeaker produces tremendous sound power levels, that can fill your living room, an auditorium, or a ballpark.

Soulful Static

Dynamic loudspeakers are practically universal with one exception—the electrostatic speaker. Instead of relying on varying magnetic fields to drive a cone, electrostatic speakers use electron charges and metallic plastic sheets to vibrate in step with voltages. Here, our technology turns to the ancient Greeks who rubbed amber on cat's skin for the principle behind electrostatic loudspeaker operation—like charges repel, unlike charges attract. A plastic sheet held close to another sheet or metal plate will be repelled when like charges are on both elements; contrawise, they are attracted when the charges are opposite. An amplifier varies these electrostatic charges at high audio frequencies and produces sound.

The electrostatic marketplace is small but packed with quality. Infinity and Jensen use electrostatics for midrange and high frequencies. B & W electronics has an 11-element electrostatic with a woofer.

Of the two types of speakers, the dynamic type enjoys the greater preponderance of usage. The electrostatic system cannot deliver loud, low-frequency sound preferred by modern listeners. Thus, they're used for midrange and high audio frequencies in a sound system, and call on a dynamic speaker to handle the lows. But don't sell electrostatics short—full range electrostatic systems are now being designed and one is now in the marketplace. Quad's electrostatic does the whole thing without low-end help from a dynamic loudspeaker.

Sound in a Box

The loudspeaker enclosure is nothing more than a box containing the loudspeaker. However, both the enclosure and the loudspeaker must be designed for each other. To understand why, let's imagine a calm pool of water as a pebble drops into it. Ripples, like sound waves, radiate from the point of impact to the pool sides. At some arbitrary point, assume your ear is there to sense the wavelets. You "hear" pure "sound" from the dropped pebble until the wavelets bounce off the sides of the pool. Then you hear echos, interference, ambience, and noises not related to the original wavelets caused by the pebble. Place a speaker in a box and that's exactly what will happen. But, design the loudspeaker for the enclosure and fidelity is restored!

When the enclosure is sealed air tight as in the infinite-baffle and acoustic-suspension systems, the cavity completely absorbs the rear radiation of the loudspeaker. While the difference between the infinite-baffle and the acoustic-suspension systems might appear to be one of size (the infinite-baffle enclosure is much larger) there are subtle underlying differences. Referring back to the drawing of the


The infinite baffle speaker makes use of a cushion of air within the enclosure. Unfortunately, the system requires a great deal of space to provide linear cushioning.

relatively little space in a living room. It achieves this by making the corner walls of the room part of an intricately folded horn. Klipsch recognized that a room corner afforded an advantage which made possible the reduction in size of the horn while still providing a sufficient air column for low C on an organ. The advantage was that the three surfaces (corner walls and floor) have a mirror effect, producing reflections of sound waves and multiplying their effective length. The combination of a corner horn and the corner mirror effect, made it practical for the first time to build a loudspeaker system of moderate size which would audibly reproduce the lower octave and a half of the nine octaves we are able to hear.

The key attribute of the horn is its tremendous efficiency—about thirty times that of an acoustic suspension system! This not only means lower amplifier power but very small cone motion. The small motion minimizes all types of loudspeaker distortion. The price paid is size. The Klipschorn is 52-in. high, 31-1/4-in. wide and 28-1/4-in. deep and *must* be placed in a corner.

Reflecting On It

And finally, we have the Bose approach to sound reproduction. To solve the problem of wide frequency response with good bass reproduction, designers have always used a large speaker for reproducing lows, along with smaller speakers to reproduce mid-range and highs. In addition, they have employed a crossover network to route the appropriate frequency segment of the audio spectrum to a specific speaker.

Bose, however, developed special techniques to prove that multiple small speakers can reproduce the same range as single large speakers, without resonance or distortion. Bose employed a total of nine 4-inch long-excursion, wide-range speakers in the 901 system. Arranged in an in-phase array these speakers can move large amounts of air, which, along with the Bose electronic equalizer, accounts for the spectacular bass and clean mid-and high-range response. Since each of the nine speakers individually can handle 30 watts of audio power, the complete system is capable of operating at very high power levels (upwards of 270 watts), that may be required to reproduce low frequencies of sufficient volume. Bose recommends that amplifiers having a minimum of 20-watts power-output per channel be used. This is necessary to overcome the losses created by the equalizer and still have sufficient power output to recreate the dynamic range necessary to produce the illusion of natural reproduction. Of the nine speakers in the Bose 901 system, only one faces into the room. The remaining eight speakers, grouped four and four, drive against the room's wall at a dispersion angle of 120-degrees. The effect is unique—especially in stereo—because the sound appears to emanate several feet behind the wall. To obtain this virtual sound source, the enclosures need be placed only 12-18 inches from the wall.

The Footwork Begins

While the foregoing descriptions may have given you insight into the how's and why's of system design, no one can tell you what you will like and dislike. I dare say that there are as many different lists of advantages and disadvantages for a loudspeaker, as there are listeners—price being no exception. So, the best advice for anyone to follow is to get out there and listen for yourself. In the final analysis, the true quality of a loudspeaker system won't be measured with high-tech gadgetrey, but with your ears and brain.

Remember to bring your own music (preferably something indicative of what you enjoy and are familiar with) when going audio shopping. People often mistakenly believe that if a speaker can reproduce one type of music well enough, that all forms of music will seem equally as pleasing. That is a fallacy since different forms of music rely on different instruments, and thus, different portions of the frequency spectrum. Always test systems with the music you will most likely play on the audio system.

No matter what your musical tastes may be, always use music with both loud and soft passages to test loudspeaker systems. Some distortions can be masked by high volume. Be sure to play both the loud and soft portions of the music while switching between loudspeaker systems. Be sure to listen to the recordings in mono only since stereo sound can also mask loudspeaker distortions. With knowledge and your own musical taste as battle gear, you should be able to withstand any verbal or written onslaught a salesmen may hand you. ■

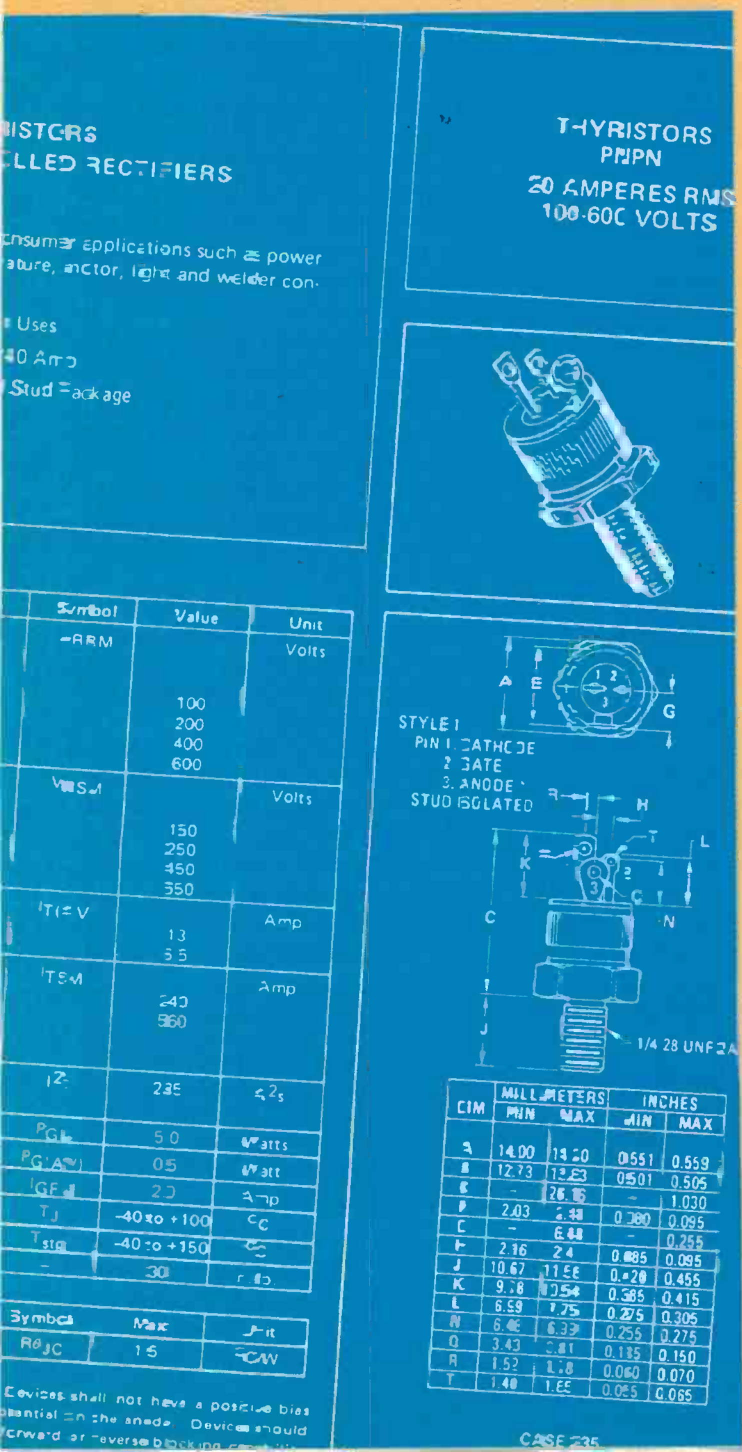
Even the once lowly car speaker has reached new heights in the age of audio fanaticism. They can produce sound quality to rival home speaker systems of just five years ago.

The three-way, acoustic-suspension loudspeaker with an electrostatic driver is now the audio wonderchild.

... SCR's, TRIACS, DIACS & QUADRACS

You've probably used them without knowing much about them, so here's some handy info

By Bob Grossblatt



WHEN SOMEONE GETS INTERESTED IN ELECTRONICS, there's a pretty-good chance that the first project they build is something like a light dimmer. It might be called a motor speed controller, variac, or any one of several other names, but no matter what label is put on the front of the case, the circuit was built around an SCR.

What are They?

The three initials stand for *S*ilicon-*C*ontrolled *R*ectifier, and because they're so easy to use, they're usually the meat and potatoes of introductory circuits. Unfortunately, they're also used without much of an explanation. The result is that most people know what they are and how to use them, but not everyone knows what's inside them and what makes them work. Since you can't do any really slick designing without thoroughly understanding the components in the circuit, let's take a look at some SCR anatomy. Once we've got a handle on that, we can dissect some of its relatives—diacs, triacs, and even a little known cousin called the quadrac.

An SCR is a complex part but, as you can see from Fig. 1, it's closely related to the common diode. As a matter of fact, probably the best and easiest way to understand the inner workings of an SCR is to think of it as a "programmable" diode. Regular diodes start to conduct when they're forward biased; just make the anode about a volt or so more positive than the cathode and bingo!—you've got current flow. Try the same thing with an SCR and absolutely nothing will happen.

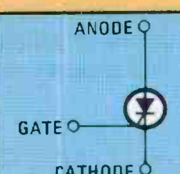


Fig. 1—As the symbol for an SCR indicates, it's very similar to a rectifying diode. It's built for use at high power, which makes it useful in circuits using household current.

Oh, if you raise the voltage high enough, the SCR will probably blow up, but unless you're working on a government contract, that's not too useful.

An SCR Impersonation

Even though the current-flow dynamics in an SCR are about the same as in a conventional diode, the differences are what makes the SCR such a useful part. One easy way to see exactly what the differences are is to build an SCR emulator. The circuit in Fig. 2 does the job very nicely. All you need is a relay, a pair of silicon diodes, and some resistors. The resistors aren't really needed to see how the circuit works but since it is only an emulator, it's a good idea to have something to keep current flow down to a predictable level.

There's nothing magic at about the choice of values for any

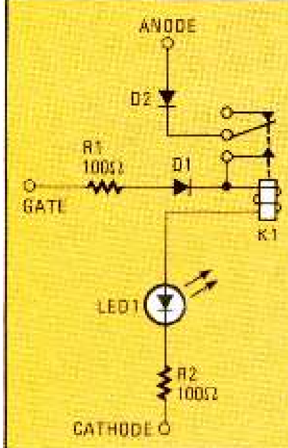


Fig. 2—This SCR-simulation circuit demonstrates the self-latching property of SCR's. Note that the relay is electrically, not mechanically, self-latching. Thus, the system shuts off only when current stops flowing through the anode.

of the components. You can use just about any latching relay you want to, but if you happen to have a 5-volt one laying around doing nothing—like I did—it's ideal. R1 limits the current flow through D1 and the coil of the relay. The precise value you choose depends on the sensitivity of your coil and the kind of diode you use. An offhand application of Ohm's law gave me a value of 100 ohms. You should do the same thing, but keep in mind that we're not talking about super-critical stuff here. Just about any resistor that's in the ballpark will do the job.

The circuit behaves exactly like an SCR. You can put any amount of voltage you want across D2 but nothing will happen until you let some current flow through D1 and energize the relay. As soon as the relay latches shut, current will flow through D2 and light the LED. What's important to notice is that, since the relay we're using will latch when the coil is energized, the gate current from D1 is only needed to turn the circuit on. You can disconnect power from D1 and the LED will still stay lit. The only way to turn off an SCR is to drop the positive voltage from the anode.

These are the two basic operating characteristics of any SCR and you should remember them. It takes a positive trigger voltage at the gate to turn the SCR on and a zero or negative voltage at the anode (with respect to the cathode) to turn it off. Now that you know about the theoretical side of the SCR, you might well ask how you can apply that to something a bit more practical. Well, since we started off talking about light dimmers, what could be more natural than using one for our example?

Who Turned Out the Lights?

Figure 3 is a typical light dimmer, or motor-speed controller, and as you can see, the whole thing is built around an SCR. One leg of the AC line is connected to the output and the other side is controlled by our friend, the SCR. But wait a minute. Before you run out and get the parts to build the circuit, let's see what's good about it and, more importantly, what's not so good about it.

You'll notice that we're stealing some of the AC being controlled by the SCR and using it, indirectly, to trigger the gate. Whenever the neon lamp fires, the SCR turns on and some portion of the AC shows up at the output of the circuit. The two capacitors, along with R2, work as a filter circuit for the neon lamp. They help to smooth out any glitches in the AC line that might cause a false triggering of the SCR. Control of the circuit is the job of R1, a 100,000-ohm potentiometer. If you use that circuit to control a lamp and slowly

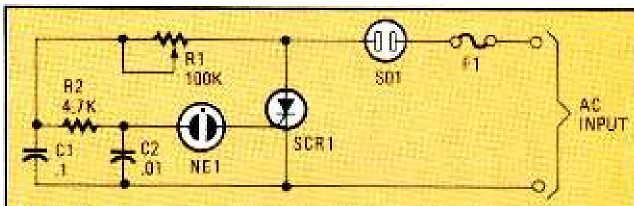


Fig. 3—The neon light (NE1) will flash when its voltage reaches a certain level in the proper direction. That, coupled with the fact that the SCR will conduct only in one direction, makes it an inefficient circuit.

turn the potentiometer all the way up, you should notice something interesting—the lamp doesn't get as bright as it would if you had plugged it directly into the wall. The reason is quite simple. Remember that the SCR is really similar to an ordinary diode, and since the AC is passing through it, what we're getting at the output is halfwave-rectified AC (pulsating DC). If we set the circuit to put out maximum voltage, we're only getting about half the AC at the output.

The pot is controlling the circuit by causing the neon to fire at different points on the AC waveform. By firing the neon as soon as the wave starts to go positive, the SCR will conduct for the entire positive half cycle of the incoming AC and we'll get maximum power from the circuit. As we turn R1 in the other direction, the neon will fire later and later into the positive half of the wave and, as you would expect, less and less power will show up at the output.

It's paradoxical that the main advantage of that circuit is also it's greatest disadvantage. You get pulse-width modulation free but the output is limited to about 50% of the RMS input voltage. What would make that circuit much more useful would be some way to keep the former and extend the latter. After all, if you really study the circuit, you'll realize we're wasting half the power we're using the SCR to control.

This, of course, sets the stage for the *triac*.

Triacs To the Rescue

Now that we know all about SCR's, we'll have no trouble getting a handle on triacs. As a matter of fact, the idea for something like a triac probably crossed your mind while you were reading the last couple of paragraphs.

Triacs eliminate the power wasting of the SCR by being able to conduct on both halves of the AC. They do that exactly the way you imagine they do—by having two back-to-back diodes in place of the SCR's single diode. This means they can conduct during both halves of the incoming AC—one portion takes care of the positive halfwave and the other takes care of the negative halfwave. Keeping that in mind, take a look at Fig. 4, the standard circuit symbol for a triac. What

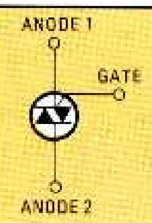


Fig. 4—The triac is superior to the SCR in that it allows current to flow in either direction. That is advantageous in circuits that require use of both sides of an AC signal.

you're looking at is a drawing of two diodes connected back to back. If you compare the triac symbol above to the SCR symbol in Fig. 1, you'll see that both schematic symbols tell you something about how the solid-state parts work.

(Continued on page 105)

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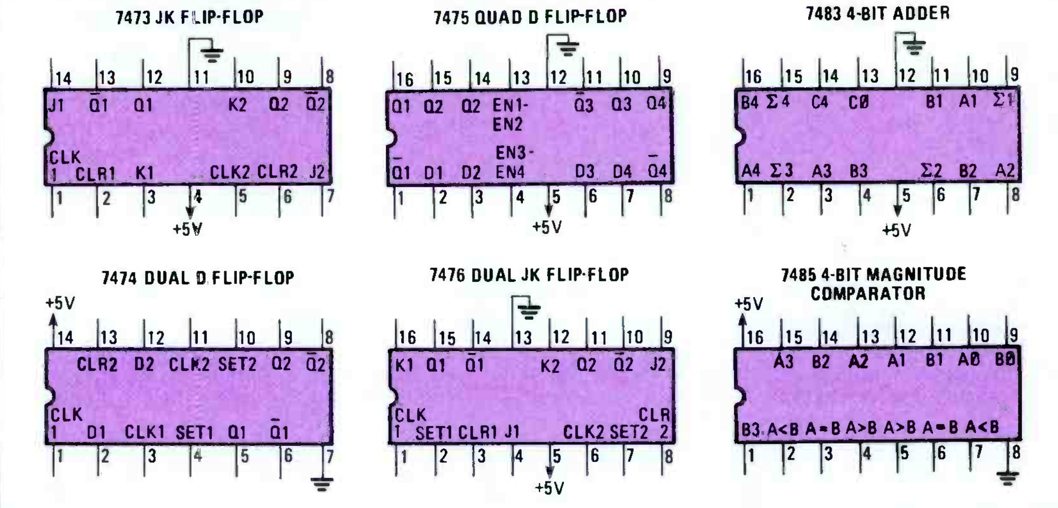

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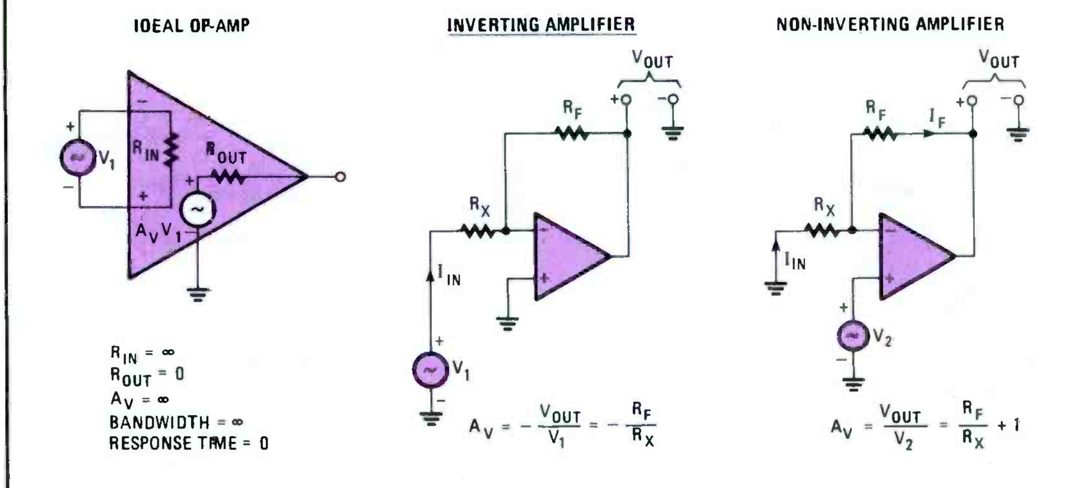

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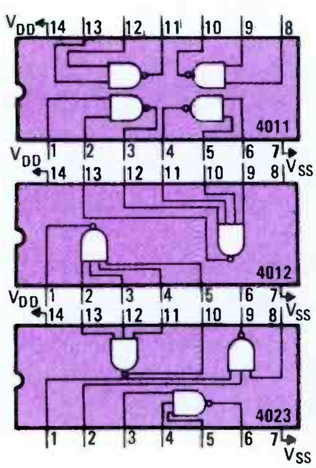


MAXIMUM RATINGS *(Absolute-Maximum Values)*

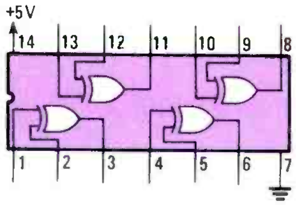
DC SUPPLY-VOLTAGE RANGE, (V_{DD})
(Voltages referenced to V_{SS} Terminal) .... −0.5 to +20V
INPUT VOLTAGE RANGE, ALL INPUTS .... −0.5 to V_{DD} +0.5V
DC INPUT CURRENT, ANY ONE INPUT .... ±10 mA
POWER DISSIPATION PER PACKAGE (P_D):
For T_A = −40 to +60°C (PACKAGE TYPE E) .... 500 mW
For T_A = +60 to +85°C (PACKAGE TYPE E) Derate Linearly at 12 mW/°C to 200 mW
For T_A = −55 to +100°C (PACKAGE TYPES D,F) .... 500 mW
For T_A = +100 to +125°C (PACKAGE TYPES D,F) Derate Linearly at 12 mW/°C to 200 mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR
FOR T_A = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) 100 mW
OPERATING-TEMPERATURE RANGE (T_A):
PACKAGE TYPES D,F,H .... −55 to +125°C
PACKAGE TYPE E .... −40 to +85°C
STORAGE TEMPERATURE RANGE (T_{stg}) .... −65 to +150°C
LEAD TEMPERATURE (DURING SOLDERING):
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10s max ...... +265°C

RECOMMENDED OPERATING CONDITIONS

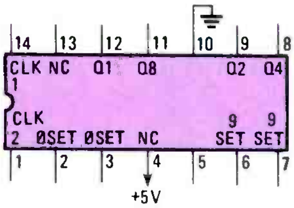
CHARACTERISTIC	LIMITS		UNITS
	MIN.	MAX.	
Supply-Voltage Range (For T_A = Full Package Temperature Range)	3	18	V

28 Hands-on Electronics FactCard — TTL IC's: 7486, 7489, 7490 7492, 7493, 7495

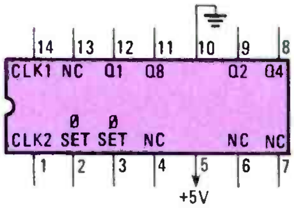
7486 QUAD XOR



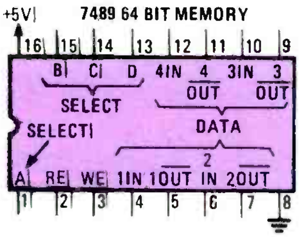
7490 DECADE COUNTER



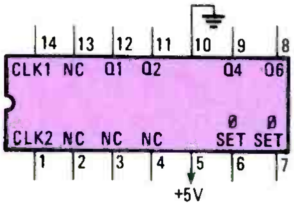
7493 BINARY (÷16) COUNTER



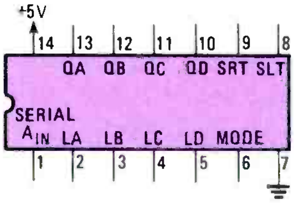
7489 64 BIT MEMORY



7492 ÷12 COUNTER

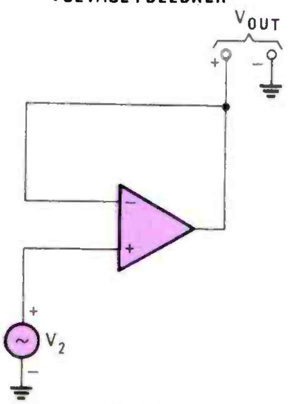


7495 4-BIT SHIFT REGISTER



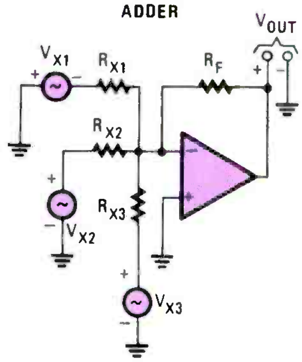
29 Hands-on Electronics FactCard — Op-Amp Circuits

VOLTAGE FOLLOWER



$A_V = 1$

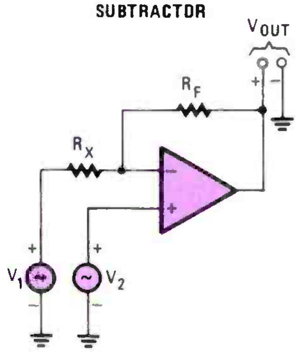
ADDER



$$V_{OUT} = -\frac{R_F}{R_X}(V_{X1} + V_{X2} + V_{X3})$$

$(R_{X1} = R_{X2} = R_{X3})$

SUBTRACTOR



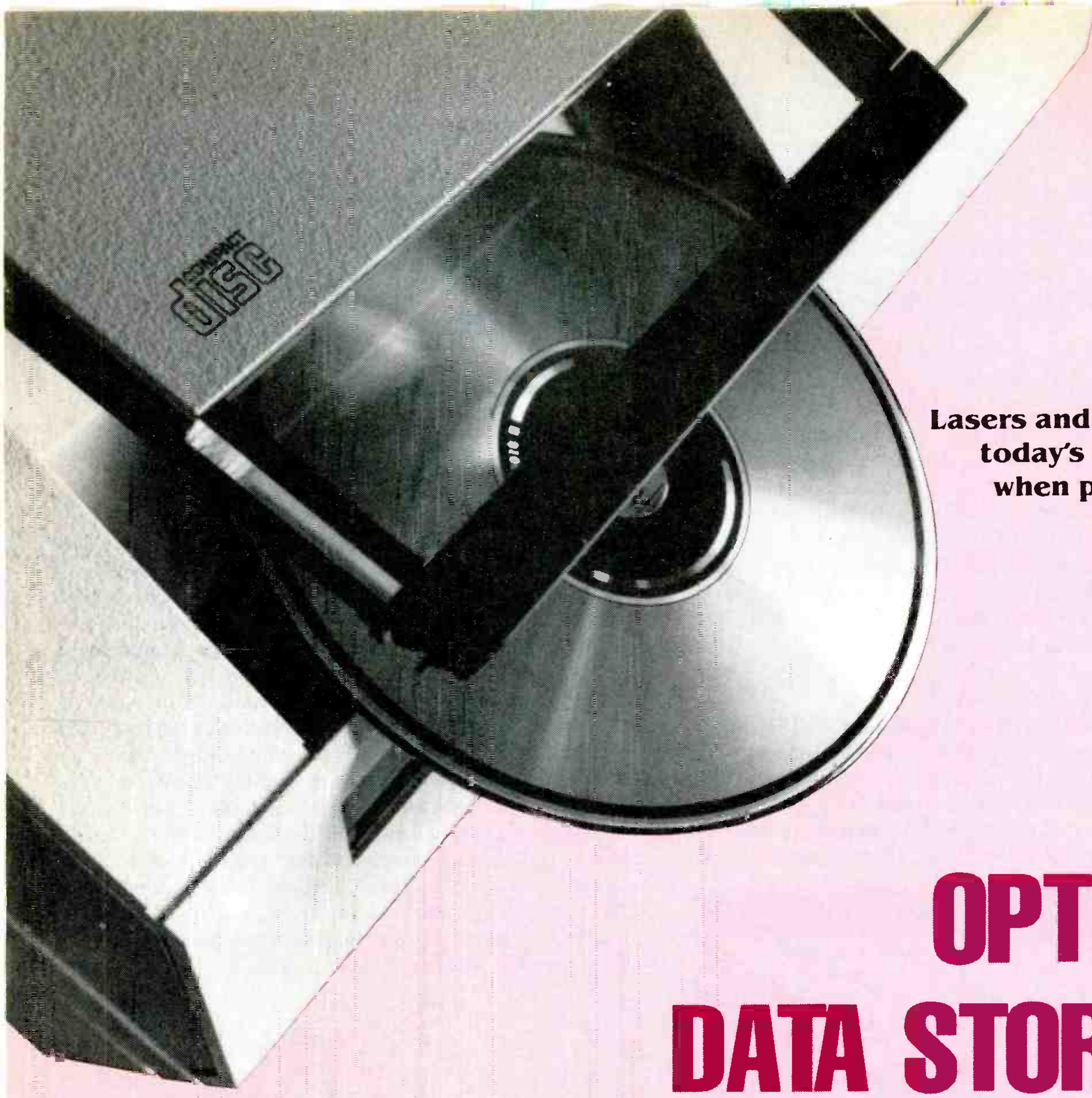
$$V_{OUT} = V_2 + \frac{R_F}{R_X}(V_2 - V_1)$$

30 Hands-on Electronics FactCard — CMOS IC's: 4011, 4012, 4023

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Quiescent Device Current I_{DD} Max.	—	0,5	5	0.01	μA
	—	0,10	10	0.01	
	—	0,15	15	0.01	
	—	0,20	20	0.02	
Output Low (Sink) Current, I_{OL} Min.	0.4	0,5	5	1	mA
	0.5	0,10	10	2.6	
	1.5	0,15	15	6.8	
Output High (Source) Current, I_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current, I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	μA

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMIT at 25°C (TYP)	UNITS
Output Voltage: Low Level, V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage: High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	4.5	—	5	1.5	V
	9	—	10	3	
	13.5	—	15	4	
Input High Voltage, V_{IH} Min.	0.5,4.5	—	5	3.5	
	1,9	—	10	7	
	1.5,13.5	—	15	11	



Lasers and computers, today's buzz words, when put together represent a formidable technology

OPTICAL DATA STORAGE

By Jeff Holtzman

WHAT'S PLASTIC-COATED, LOOKS LIKE A PANCAKE, AND holds the equivalent of 1500 floppy diskettes? It's called a CD-ROM, short for Compact Disk Read Only Medium, and it promises to revolutionize the way we deal with all sorts of information. A CD-ROM can hold any kind of data that can be represented in digital form—everything from an encyclopedia, to business data, to every surviving text written in ancient Greek before the year 700 AD.

In this article we'll take a look at the main features of several different kinds of optical storage technology (of which CD-ROM is but one). After that overview, we'll examine the CD-ROM in some detail: the compact disk itself, the player that holds it, the software that lets you get data from it, and several of the more interesting databases that are available now.

Optical Media

There are four basic kinds of optical-storage technology: WORM, Erasable, CD-I, and CD-ROM. The first two are "writable;" in other words, with the right hardware, you can not only retrieve information from the disk, but you can store it there as well.

The WORM

WORM stands for Write Once Read Mostly. As the name suggests, you can save information on the disk and read it back at any time. It's like a floppy disk, however, information on a WORM cannot be erased. That may seem like a disadvantage—but in some applications (like accounting), it's actually an advantage.

A WORM drive currently costs about $5000, and a WORM disk costs about $100. Each disk can hold between 100 and 200 megabytes of data.

Unlike some of the other technologies we'll discuss here, WORM technology is not likely to become popular in the mass market. It is too costly, and the drive capacity is too low. That's not to say that it's useless, however. It can provide a large business with a fairly high-density storage medium until the more advanced technologies become available. In addition, hardware and software designers can begin the process of perfecting their wares on that stop-gap technology.

Erasable Optical Media

Mostly just a gleam in designers' eyes, the Erasable Optical Disk (EOD) is really the next major step in the evolution of information-storage technology. The reason is that the EOD can be written to, read, erased, and re-used many times. In addition, compared to the CD-ROM, the EOD is much faster. And like the CD-ROM, but unlike magnetic materials (like the floppy disk), the EOD is reproduced by a stamping process that is much like that used to produce vinyl records. However, it is likely that a decade will pass before general-purpose erasable optical disks see widespread use.

CD-I

Another optical technology that is somewhat closer to seeing the light of day is CD-I, for Compact Disk Interactive. It is envisioned as a multi-media means of presenting all sorts of information. Using disks similar to the CD-ROM, CD-I will provide music, sound, graphics, and simple animation, as well as text. Unlike the CD-ROM, which requires use of a personal computer, CD-I will be self-contained; and it will be mass-marketed as a stand-alone consumer item, much like a VCR or TV set. It will have its own viewing screen, keyboard, and mouse or joystick interface. You can think of CD-I as a combination video game and MTV.

CD-ROM

The optical-storage technology of today is the CD-ROM. It holds a fantastic amount of information: 550 megabytes, enough to contain the text of an entire encyclopedia with room to spare. A laser is used to burn information on the disk, and another laser is used to retrieve that information. Reading the disk requires a CD-ROM player; players currently cost

Toshiba's XM-2000 CD-ROM drive has an audio output for special applications. It can interact with an IBM-PC or any computer with an SCSI interface. Disks are loaded in front.

about $1000—although that price will drop rapidly, as CD-ROM's gain in popularity. Several of the biggest American and Japanese electronics and software design firms (Sony, Hitachi, Toshiba, 3M Corp, Apple Computer Inc., Digital Research Inc., Microsoft Corp., etc.) are working hard on developing standards for CD-ROM players and the software used to get information from the CD-ROM. Currently, there are few CD-ROM databases available; but that situation is changing rapidly.

Disk Format

As shown in Fig. 1, the disk itself measures 120 mm in diameter, and is about 1.2 mm thick. It is physically identical to the compact disk used in high-fidelity audio systems. Unlike magnetic medium (both floppy and hard disks), which

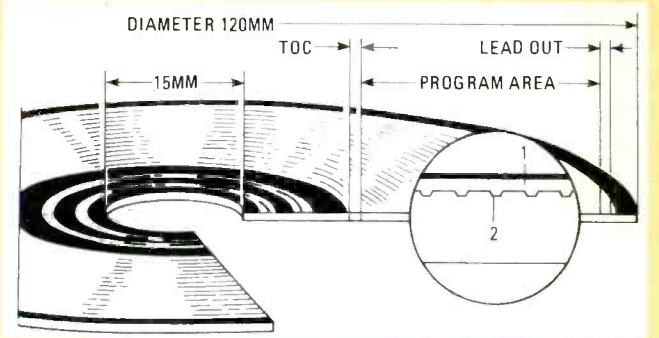


Fig. 1—Like the audio CD, a CD-ROM is a disk that is 120 mm in diameter, 1.2 mm thick, with a 15 mm spindle hole. The surface of the disk (2) is covered with a polycarbonate plastic that makes it impervious to many kinds of damage.

have data arranged in concentric circles called tracks, the CD-ROM contains a single spiraling track of data. See Fig. 2. The spiral measures about three miles in length, and there are about 16,000 turns per inch. Each sector of data contains about 2000 bytes, and takes up a space about ¾ inch long.

Information is digitally encoded on the disk in a series of pits and lands, as shown in Fig. 3. Pits are burned into the disk by a laser; the spaces between pits are called lands. Pits and lands represent, in a rather convoluted manner, the series of binary 1's and 0's that make up digital data. We won't go into how separate bytes are represented, but we will say that each eight-bit byte of data actually requires 14 bits on the CD-ROM. The extra bits function to detect and correct for errors. In fact, it is claimed that a CD-ROM has a maximum non-recoverable error rate of 1 bit in 10 quadrillion (10^{19}). Of course, a high-precision optical system is used to read data from the disk. See Fig. 4.

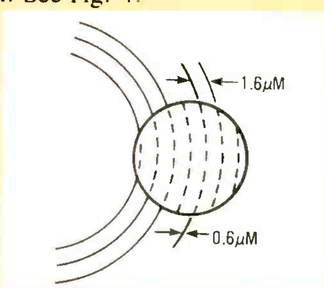


Fig. 2—Floppy and hard disks arrange data in concentric circles, but the CD-ROM arranges data in a single spiral track. Each "groove" along the spiral is 0.6 μM wide and adjacent grooves are kept at a distance 1.6 μM apart.

Cost and Data Format

The cost of physically preparing a CD-ROM master disk is about $50,000. Depending on the quantity manufactured, individual pressings cost between $5 and $50 apiece. That $50,000 doesn't include the cost of generating the database or of converting it to the most efficient form for CD-ROM use. What's efficient for one media is not necessarily efficient for CD-ROM. It is fairly simple to create an indexing (or directory) structure for quickly locating a desired piece of information on magnetic media (floppy and hard disks). But because the data on a CD-ROM is contained in one long spiral, locating individual items can be a lengthy process. Therefore, in order to reduce *seek time*, much care must go into planning how data is stored on the disk. In addition, special detailed indexes are created and stored in several places on the disk.

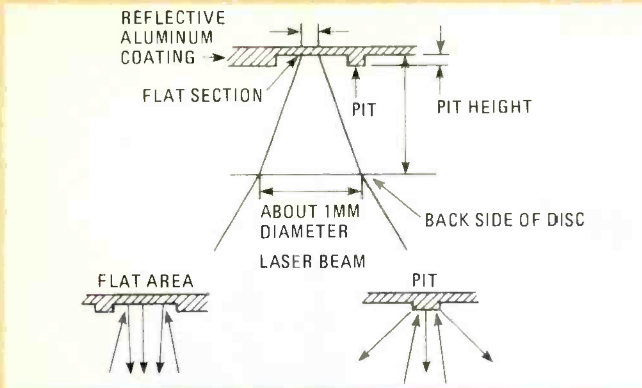


Fig. 3—Data on a CD-ROM is encoded in pits and lands that are burned into the surface of the disk. It is the change from pit to land (and land to pit), rather than the pits and lands themselves, that represent the binary 1's and 0's.

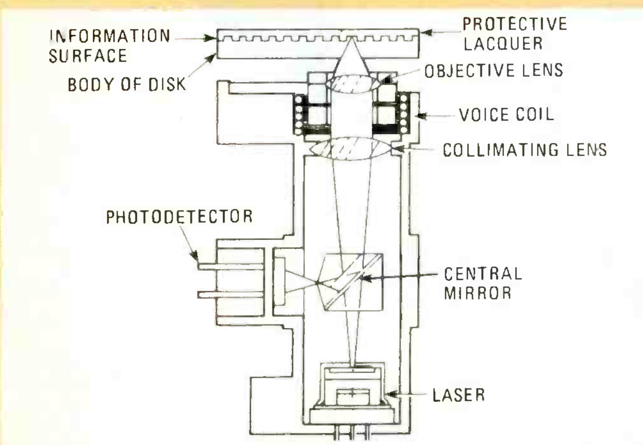


Fig. 4—A high-precision, laser-based optical system is used to read data from a CD-ROM. The central mirror is partially transmissive, so that the source laser can pass through it, be reflected by the disk, and then be reflected by the mirror to a photo detector for processing.

For example, the text of the CD-ROM form of Grolier's *Academic American Encyclopedia* occupies 60 megabytes. The index, which includes every occurrence of every word in the entire encyclopedia, occupies an additional 50 megabytes. But with the text and the index together only 20% of the CD-ROM has been used!

Applications

Most currently available CD-ROM's are usable only with IBM-PC's, although a few are available for other machines (like the Apple II). To work with any given CD-ROM, you'll need a computer, an interface card, low-level software to interface the hardware, and high-level software that allows you to search the database, print and save copies of your findings, and so on. Although the disks themselves are identical, the low-level software must be custom-tailored to a specific computer, and the high-level software must be custom-tailored to a specific CD-ROM application. Before laying out any of the green stuff, make sure that the CD-ROM you want to use can run with your player and PC.

Groliers

The most famous (and the first mass-merchandised) CD-ROM is the Groliers' Encyclopedia we discussed above. It will run on several different players, but requires and IBM-PC. The package includes everything you need to scan the encyclopedia, both to look up a specific subject and to browse. When researching a subject you can combine key words in various ways to narrow your search. For example, you could search for articles containing both the words "resistor" and "capacitor," but not containing the words "integrated circuit."

Phillips is the leader in (and inventor of) CD-ROM technology. Shown here is their CM 100 drive, a top-loading unit.

When you find a subject that interests you, you can look at an outline of it, or the full text. You can save either to a standard ASCII file, to be included with a report or other document.

The Grolier CD-ROM is fairly inexpensive (about $200), and its easy-to-use software sets a standard that other CD-ROM makers must emulate.

We had a chance to operate the Hitachi CD-ROM, and found its access speed and storage capability to be most impressive. It does not require much foresight to predict a time when CD-ROM technology will become indispensable.

PC-SIG

If you're involved with personal computers in any way, you've probably run across public-domain software. PC-SIG (the Personal Computer Special Interest Group) is an organization that collects and distributes that type of software for the IBM-PC. Their offerings currently reside on approximately 500 floppy disks, although more are added all the time.

Recently, PC-SIG released a CD-ROM that contains their entire collection. Their indexing structure is not implemented as well as Groliers', so, to find programs of interest to you, you'll probably have to consult the printed listing. When you do find what you're looking for—and you're bound to find something interesting, with so much available—making cop-

(Continued on page 101)

HEADPHONE REPAIR

It often takes very little effort or expense to put new life into defective stereo headphones.

By Homer L. Davidson

☐BECAUSE THERE ARE ONLY A FEW PARTS THAT CAN BE defective, most headset problems are very simple to troubleshoot, and making the repairs yourself might take no more than 60 minutes. And not only does making the repair yourself save big bucks—most audio service shops have a minimum fee of $15-$25—the headphones won't be laid up for weeks waiting to be serviced.

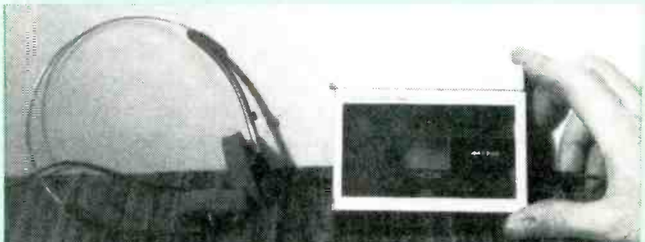
As far as needing special tools are concerned, unlike other audio devices which need some rather sophisticated test equipment, headphone repairs require only a small soldering iron, a screwdriver or two, a pocket knife, and an ohmmeter when you need to make a continuity test. In fact, you can often substitute a continuity-tester made from a battery and a small test lamp for the ohmmeter.

Many Different Kinds

While stereo headphones originally were available primarily through stereo (high-fidelity) dealers, today, stereo headphones can be purchased at most shopping malls and flea markets, as well as at electronic retail and parts stores. They are available in many different models and price ranges: You can purchase a bargain pair—usually at a local flea market—for $4.95 on up. On the other hand, true high-fidelity, or professional quality headphones suitable for at-home listening, may vary in price from $39.95 to $149.95.

While the average frequency response for "high fidelity" headphones is usually 20 to 20,000 Hz, the lower priced, better-quality models often have a frequency response of about 50 to 15,000 Hz, which happens to be the frequency response for most FM stations. In fact, both kind are considered to be *full range* headphones because, assuming equal distortion and sensitivity, it's questionable whether the average listener could distinguish any difference between a headphone response of 20-20,000 Hz and one of 50-15,000 Hz.

Most stereo full-range headphones have an impedance in the range of 8 to 50 ohms. Many of the headphones used with what are called *personal* or *Walkman-type* AM-FM radios and cassette players are around 32 ohms, while boom-box and large players generally employ headphones having an impedance of approximately 8 ohms. (Just for your interest, the old-time, pre-transistor radios and crystal receivers required headphones having an impedance of 500 to 200 ohms, or higher.)



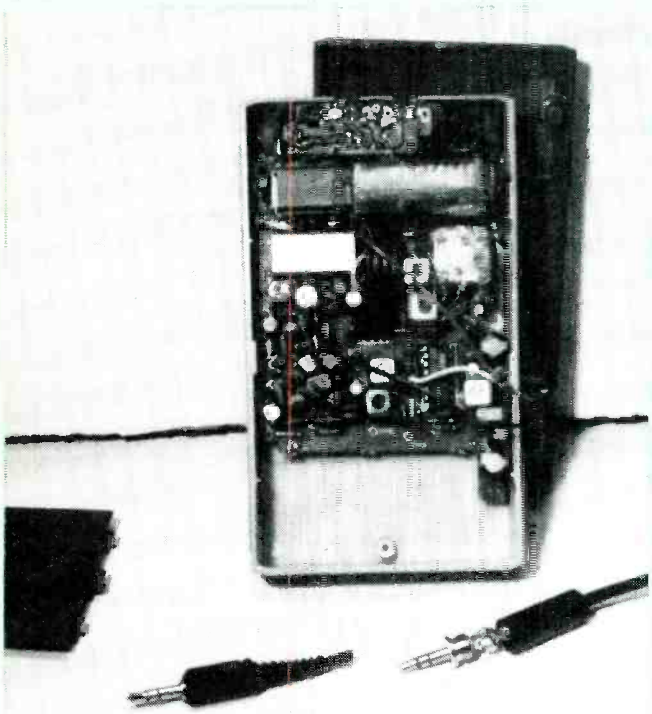
The impedance of the new headphones may vary from 16 to 32 ohms, compared to older headphones which had a typical impedance in the range of 500 to 2000 ohms, or higher.

Noisy Plugs

Sometimes you'll hear noise that sounds similar to radio static whenever you touch or move the headphone's cable. The noise is often caused by tarnish on the headphone plug's contacts—the tarnish actually functions as an insulator. If you can move the plug around in its jack and make the noise cut in and out it's a safe bet that the problem is tarnish, which can be removed from the plug's contacts with a paper towel that's been saturated with contact-cleaning fluid.

Defective Cord and Plug

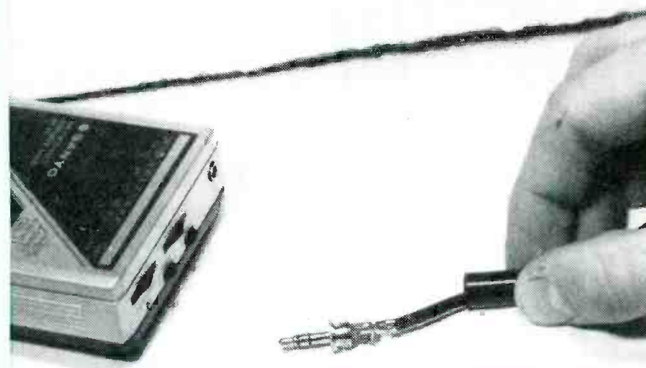
Suspect a broken cord, plug, or jack when one side or both earphones appear erratic or intermittent. For example, the sound level may cut up and down, then fade out. Determine if the right or left earphone is defective. If both are erratic, suspect a broken cord or poor connections at the male plug at the end of the headphone's cable. Wiggle the cable wire close to the male plug and near each earphone while listening to music. You've discovered a break in the wire when the sound cuts in and out. More often than not, the wire(s) in the cable break right at the plug, or where it enters the earphone's case; rarely is there a break in the middle—between the plug and the earphone itself.



Often, the cord's wire breaks close to the stereo plug. Simply cut off the cord and replace it with a universal type. Always solder each connection; don't just twist it.

If there appears to be a break in the wire at the plug, cut off the broken cable at least one inch in back of the molded rubber plug. Uncover the two separate cable wires—one from each earphone. Separate the outside shield from each cable. (The outside shield or braided wire is common to both headphones.) Instead of two independent shielded wires—one for each earphone—there might be three separate wires, with one wire serving as the common connection (ground) between the left and right earphones. (The common ground is usually found in the budget-priced headphones.)

Obtain a stereo phone plug from any electronic supply or parts store. Whether the plug is a full-size *phone* type, or a *miniature-phone*, or a *subminiature-phone*, a stereo plug will have *three* individual metal rings, as contrasted to the monophonic plug which has only two metal rings for contacts. Slip



Notice that there are three metal rings on the stereo plug. The ground (common) wire(s) connects to the rear terminal, or the solid metal piece.

the new plastic plug cover over the headphone cable. Solder the shielded or common wire to the largest, or outside terminal. (The common or ground connection is the first metal ring area on a male plug—the part called the *sleeve*.) Connect and solder the remaining two wires to the plug's small terminals—the connections called the *tip* and the *ring*.

Broken Junction

You may find a break in the cable where the wires connect at the cable junction—where the wires from the left and right earphones come together. To repair a break at the junction, remove the outside fabric material to get at each wire. Some flexible cable or wires are wrapped around cloth threads (tinsel wire) and are difficult to solder because the wire often burns before the solder takes. To make sure you get the connection right the first time, apply a coating of *rosin core* soldering paste (not acid paste) to the tinsel wire(s) before you try to make a solder connection. Once you have tried and failed, it's usually too late to use soldering paste.

Wrap a layer of plastic tape over each wire, and then one complete layer of tape over the spliced area.

Defective Earphone Unit

Check the headphone's wires for a break between the plug and the individual earphones by using two sewing needles and a VOM or DMM (Fig. 1). The needles are used to provide a connection to the wires without having to cut through the wire's insulation, or through the wire itself. Simply push a needle through the insulation and into a wire. If you jam a needle into the wire just where the wire enters the earphone, the wire can be checked for continuity from the male plug to the needle by connecting an ohmmeter between the needle and its matching contact on the plug.

Suspect a defective earphone unit if the continuity of each wire is normal to each needle. Often, only one earphone is defective and the resistance of the normal earphone may be compared with the defective one.

Sometimes, the earphone may be damaged—actually burned open—by excessive volume. This is possible because an earphone is essentially a miniature dynamic speaker, consisting of a magnet, a diaphragm, and a coil attached to

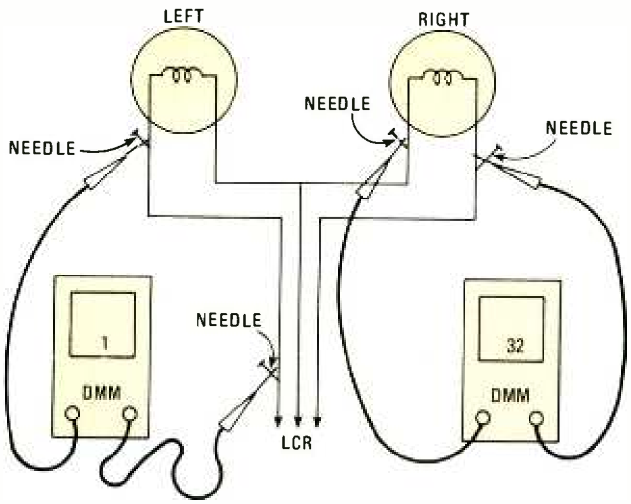


Fig. 1—The earphone coils and their wires can be checked with the low range of a VOM or a DMM. Needles jabbed through the insulation provide a direct splice-free connection to the wires for the test leads.

the diaphragm. Excessive volume overheats and burns out the coil. Remove the soft, rubber, foam cushion from the front of the earphone if the wire is broken where it enters the case or if the phone is suspected of an open condition. For low-cost headphones, pry off the plastic lid with a pocket knife to get at the earphone's speaker-coil and connecting wires. The foam ear pad and plastic lid may be glued together after repairs are made. If the polyurethane foam covers are torn or worn, you can get replacement covers at local Radio-Shack stores (33-374).

Check the continuity of an earphone's speaker-coil by using the ohmmeter's low range (Fig. 2). The average resistance should be around 8 ohms. You may find the resistance "reads" much lower than the rated resistance (impedance) when measured using a pocket VOM, but with a DMM the actual impedance almost equals the measured value.

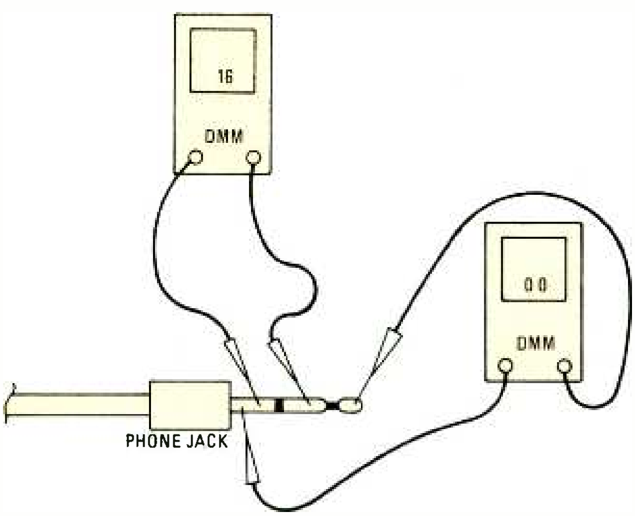


Fig. 2—Both the continuity of the cable and the individual earphones may be checked with the ohmmeter. The DMM resistance measurement may equal the headphone's impedance. A zero resistance means the channel is open.

Try to locate the wires from the cable that are soldered to the earphone's coil. Inspect the soldered connections. Sometimes, the coil's ultra-fine wire breaks off right at its connection.

Make a resistance measurement of both earphone coils: the measured values should be very close. (Always check the resistance of each earphone at the male plug after repairs.)

An adapter will convert a miniature or subminiature stereo plug to the larger standard phone plug, to which it is easier to make connection when using test probes.

Substitute

If a VOM or DMM is not handy, and you can't measure the resistance of the earphone coils, temporarily tie or clip the suspected cable wires to the good earphone plug connections to determine if it's the earphone or the wires that are defective. Clip a small speaker to the earphone leads for audio tests. Turn the radio or cassette player on to locate the dead or open earphone. An erratic or broken wire may be located with the same kind of test.

A *mushy* sound out of one earphone may indicate a defective integrated-circuit or transistorized power amplifier, or a defective cone in the earphone's *speaker*." A defective earphone may be located by reversing the earphone leads at the male plug. If the same earphone is distorted, suspect a defective cone. Check the amplifier circuit if the suspected earphone is normal when the wires are reversed..

When one defective earphone is located in a low-priced headphone, it may prove cheaper to purchase another set than to try and locate a replacement earphone.

But if the headphone is an expensive model, first try to repair the headphone. Higher-priced models may contain a complete self-enclosed earphone unit, which is cheaper to repair than to replace.

Trouble at the Jack

While a headphone's stereo plug is often a cause for erratic or intermittent operation, the jack can also be troublesome. If you get erratic, intermittent, or noisy operation and the plug checks out OK, wiggle the male plug at the radio or cassette player's earphone jack and notice if the problem appears or persists. Sometimes, you'll hear sound if you push *sideways* on the plug, indicating a "worn jack."

If the problem appears to be the jack, check it carefully no matter how good it looks. Often, a hairline crack isn't noticed unless the jack is closely examined. Since epoxy won't adhere to many kinds of plastic, it doesn't pay to even try to repair a jack unless you've got a lot of time to waste. Simply order a replacement jack from the radio or cassette manufacturer, or the service depot. ■

AFGHAN AIRWAVES

When the vandal hordes from the Steppes are burning your country, shortwave radio is your only contact with the civilized world.

By Gerry L. Dexter

☐NIGHT COVERS THE TROUBLED LAND OF AFGHANISTAN. IN remote villages, in valley camps, in hidden mountain redoubts, groups of Afghan *mujahidin* (holy warriors) sit cross-legged, eating bread and drinking glasses of tea half-filled with sugar. A transistor radio is tuned to the *BBC*'s "Pashto Service" news broadcast, or the *Voice of America*'s "Dari Service". But once the news ends, the dial is flipped back to the Afghan government's *Radio Kabul* for the music, not for the news.

Although the Kabul government attempts to jam foreign broadcasts, they apparently get through nonetheless. Journalists who have traveled with the *mujahidin* note again and again how frequently the *mujahidin* tune in the voices from abroad. The guerrillas and, indeed, those not directly involved with the resistance, have an insatiable curiosity about what is happening around the world. And they listen to foreign stations to get news about Afghanistan since the foreign radios, if they report anything at all on the subject, will have something closer to the facts than will the government's *Radio Kabul* mouthpiece.

The Afghanistan conflict is the same as any other in two respects: Propaganda via radio plays an important role; and that role is largely ignored in news reports and by reporters who manage to get inside the country. References to broadcasting are minimal, usually offhand, and frequently inaccurate when it comes to who is behind the various broadcasts and even proper names of the stations involved.

This Red Wasn't Santa

Radio's role in Afghanistan's current agony began with the Soviet invasion on Christmas Eve, 1979. Communist leader Mohammad Hafizullah Amin, who had displeased Moscow both with his increasingly independent course and his mishandling of an already in-progress resistance to his government, was replaced by Moscow's hand-picked Babrak Karmal. Before the invasion and the coup which resulted in the death of Amin and several of his family, Karmal had already recorded the announcement of the coup and his assumption of power. The message was broadcast on Christmas Eve over a fake *Radio Kabul* operating close to the frequency of the government station from a transmitter in or near Tashkent, in Uzbekistan SSR (USSR). The real *Radio Kabul* blithely continued with its normal programming and made no mention of the coup until the next morning.

The Soviets pulled another fast one, too. In order to make it as easy as possible to take over the facilities of *Radio Kabul*, the Afghans on station there were talked into draining the fuel out of the tanks being used to guard the building. Two days earlier, some elements of the Afghan military had their communications equipment sabotaged just before the invasion was scheduled to begin.

The *mujahidin* have still not been able to set up a united opposition front; there are too many factions with viewpoints too dissimilar. The half dozen or so main groups based in Peshawar, Pakistan have loosely organized into two groups, one radical and one more moderate; and the hundreds of smaller groups within Afghanistan give their allegiance to one or the other only when and to the degree that it is convenient. Perhaps as a result of that situation, clandestine resistance broadcasting hasn't grown to the degree one might have expected. The number of voices that ride the anti-

Much of the Afghan-resistance radio equipment is provided through Paris by RFK volunteers, such as Olga Svintosa (whose antenna is concealed in boxes) and Bruno Bucher (whose transmitter is concealed in an old, worn suitcase.)

Afghan airwaves are nowhere near as many as those beamed at Iran or those in Central America.

Early Resistance

The earliest Afghan resistance radio is said to have been set up within Afghanistan by Gulbuddin Hekmatyr's *Hezb-e-Islami* in 1979. Hezb is an extremely radical group reported to have connections with the Muslim Brotherhood and to favor a Khomeini-style Islamic republic, though one led by a Sunni Moslem rather than a Shi'ite as in Iran. Just which station it was, or is, we don't know. It may no longer exist; it may be one of the stations operating now for which no backers have been identified.

The Paris-based French Human Rights Committee was the guiding light behind the organization of *Radio Free Kabul*. RFK was actually a loose network of transmitters rather than a single transmitter. At least 11 of them were in use at one time, ten low-power, limited-range FM transmitters and one low-power shortwave. Volunteer French technicians accompanied the transmitters as they were smuggled into Afghanistan, where the *mujahidin* were taught how to use them.

Programs, including material created and performed by Afghan artists and entertainers who had fled the communists, were recorded in a studio in Peshawar and then smuggled into Afghanistan for rebroadcast. Some of the programming was designed for the occupation forces, so it was not surprising that Moscow complained about the station, claiming that it was funded by the CIA. Actually, private American aid does go to the station through the New York-based Freedom House, and the American Aid for Afghans, based in Portland, Oregon. The exact state of RFK's operations inside the country at present is unknown, although some sources report that some of the transmitters have broken down.

Radio Free Kabul may have evolved into The Voice of Free Afghanistan, which is supported by the Paris-based Society for the Preservation of Human Dignity and Freedom. The station has been expanding its broadcast hours and frequencies on shortwave. It operates out of studios in Peshawar, although the location of the transmitters is uncertain. The current schedule is 0130, 0730, 1130 and 1515 UTC on 3200, 3800, 4200, 5200, 5800 and 7200 kHz. Two other broadcasts, said to be intended for North America, are at 1200 and 1600 UTC on "16 and 25 meters." Although the station is sometimes heard in Europe, there is no known reception of it in North America.

The main *mujahidin* moderate group, the Islamic Unity of Afghan Mujahidin (not to be confused with the Islamic Unity fundamentalist group!) is the sponsor of the Voice of Unity-Radio of the United Muslim Fighters, the only Afghan resistance station that can be heard fairly regularly in North America. Its broadcasts are on the air from 1530-1630 UTC on 11490 (and less often heard on 9555 and 9795). For the DX-minded, the station does issue a QSL card, but getting one can be an adventure in frustration. Letters to the announced address of P.O. Box 294, 1061 Vienna, Austria will, 99 times out of a hundred, be returned to the sender by the Austrian Post Office. Only on rare occasions does a letter get through and a QSL card result. **Hands On**'s DX columnist, Don Jensen, has theorized that the Austrians have placed a "watch" on mail destined for that post-office box and automatically return letters mailed to that address. Bureaucratic slip-ups may be the reason for the occasional letter reaching its destination.

Although the *mujahidin* are several lifetimes removed from Western civilization, their weaponry becomes more modern as they acquire captured Russian arms, such as the assault rifle held by the freedom-fighter on the left.

The U.S. government has its hand in broadcasts in support of the resistance. Nearly two years ago, Congress directed that a "Radio Free Afghanistan" be created, but the end result turned out to be a program rather than a separate station. The *Radio Free Afghanistan* broadcasts are part of the US-supported *Radio Free Europe/Radio Liberty* network which, with the exception of the Afghanistan program, broadcasts exclusively to the USSR and Eastern Europe. The programs for Afghanistan began on a limited basis with the intention to expand them at a later date. That hasn't happened, probably as a result of the financial problems facing the RFE/RL service.

The 15-minute programs are aired six times a week, half of them repeats, at 0200 UTC on 9555, 9725, 11770 and 11815 on Wednesdays, Fridays, and Sundays, and at 1300 on 11865, 15115, 15435 and 17725 on Tuesdays, Thursdays, and Saturdays. The programs are in the Dari language, most of them beamed from RFE/RL transmitters in West Germany.

Meantime, the Afghan government's *Radio Kabul* (Radio Afghanistan) plays a central role in the propaganda and disinformation campaign. It, and the other Afghan media, are closely supervised by the Soviets. In fact, some 60 percent of the *Radio Afghanistan* broadcasts come from transmitters within the USSR rather than from Afghanistan.

Shortwave broadcasts are in local languages such as Baluchi, Pashto, Dari, and for overseas listeners, in Russian, English, Arabic, French and German. English is aired at 0900-1030 on 4450 kHz (from the USSR), 6085, and 15255 and 17655 (both from the USSR). Also at 1900-1930 on 9665 and 11880 (both from the USSR). Other *Radio Afghanistan* frequencies include 3965 (USSR), 4740 (USSR), 7200, 11805, and 11820. Most of the Afghanistan transmitters are 50 KW, while those in the Soviet Union are 100 KW. The

(Continued on page 102)

NUMBER 133

GADGET

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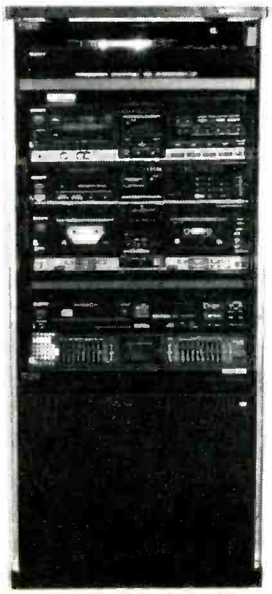
What's Inside . . .



Sony DD-100 Boodo Khan Stereo Cassette Player

Walk This Way

BOODO KHAN STEREO CASSETTE PLAYER (DD-100). Manufactured by: Sony Corporation of America, Sony Drive, Park Ridge, NJ 07656. Price: $219.95.
TV/FM/AM RECORDING WALKMAN (WM-F202). Manufactured by: Sony Corp. Price: Not available.
TV/FM/AM STEREO CASSETTE PLAYER (WM-F80). Manufactured by: Sony Corp. Price: $129.95.
TV/FM/AM AUTO REVERSE STEREO CASSETTE PLAYER (WM-F55). Manufactured by: Sony Corp. Price: Not available.
STEREO RADIO CASSETTE PLAYER (RX-SA80). Manufactured by: Panasonic Co., 1 Panasonic Way, Secaucus, NJ 07094. Price: $139.95.

What was once a dramatic breakthrough in small-size, high-fidelity portable sound reproduction is nowadays just a part of the electronic entertainment landscape. The scores of thousands who enjoy *Sony*'s *Walkmans* and competitor miniature stereo tape systems probably give as little thought to the "miracle of personal stereophonic sound" as they do to running water or the telephone. In today's fast-paced consumer whirl, that's the welcome fate of a successful electronic innovation.

Taking a product for granted indicates a degree of acceptance that even Madison Avenue can't (quite) engineer. Still, manufacturers and marketers inevitably mess with success, introducing variations and updates and personal stereo products are no exception. On a recent trip to Hong Kong, our publisher brought back a catalog with no fewer than 20 different *Sony Walkmans* described and illustrated. Also brought back were a couple of models not imported to the U.S.

(Continued on page 5)

Midget Medium

POCKET TELEVISION (TV-70). Manufactured by: Casio, Inc., 15 Gardner Rd., Fairfield, NJ 07006. Price: $129.95.

It's tiny TV time again—tinny sound, indistinct image, improbable accessories, but still they roll off the assembly lines. Epson, Citizen, Panasonic, Sony, Seiko, Sanyo, even old-line Zenith and Magnavox and comparative newcomer Goldstar, all have entries in the mini-TV consumer sweepstakes—and, of course, *Casio*.

As with Citizen, Epson, Seiko and Panasonic, *Casio* relies on LCD technology, liquid crystal display image delivery, as opposed to the conventional TV's cathode-ray tube. Aside from continuing development of a promising technology, LCD systems offer two concrete advantages over miniaturized CRT units.

LCD technology makes possible extreme compactness (an important selling point) and uses up batteries at about half the rate of down-size CRT units. *Casio*'s *TV-70* certainly has the slim lines of an LCD TV. With its lid closed it's only a half-inch thick. Its over-all dimensions make it easy to slip into a shirt pocket or handbag.

Of course, the *TV-70* also shows its LCD origins in another important aspect, the mediocre quality of the image and picture it delivers. That more than incidental flaw is LCD TV's chief drawback. But the technology is improving, as indicated by this *Casio* black-and-white set.

When the *TV-70*'s lid is popped up, light hitting a translucent LCD picture tube projects a 2" image onto a horizontal mirror, delivering an unflickering, if dull, picture. The more light passing through the lid's LCD element, the sharper and brighter the image delivered, which to our way of thinking eliminates at least one of the attractions of the tiny TV. With an LCD pocket set, there can be no hiding under the covers to watch a late-night program. If you're a parent, of course, this may make the *TV-70* an attractive gift for your youngster.

Sound is delivered via an earphone, power comes from three AM-4 batteries (good for four hours of viewing), there's a volume and brightness control on the unit's right side and the combination "on" and "VHF/UHF" selection switch on the left. With the exception of optional AC or car power adapter options, that's pretty much *TV-70*'s simple story. Compared to other LCD pocket televisions reviewed in the past, this *Casio* indicates solid, if unspectacular, progress in delivering an image.

Casio's continued interest in the LCD technology is likely to be reflected this year in some new products, including a further approximation of the "panel TV," a larger, almost flat unit.

Besides novelty appeal, the market for all these mite-sized tubes is mainly among sports fans. Increasingly at sports events, some spectators will be peering into their palms between plays, following some other televised contest via a personal TV. For such secondary purposes, *TV-70* will do nicely. The image is sharper than on earlier *Casio* models, steady and comparatively distinct.

With further development, these LCD sets may even catch up with the miniaturized CRT competition. By then, perhaps, the tiny CRT models may be compact enough to erase the LCD size advantage—Sanyo's new "beam index" 30TV1 certainly indicates progress in that direction (see January's GADGET for further details).

Regardless of which tiny TV technology finally comes out on top, the rivalry makes for an interesting consumer electronics contest. And the improved picture of the *TV-70* makes it a closer race to call than some gadgeteers might have thought.—G.A.

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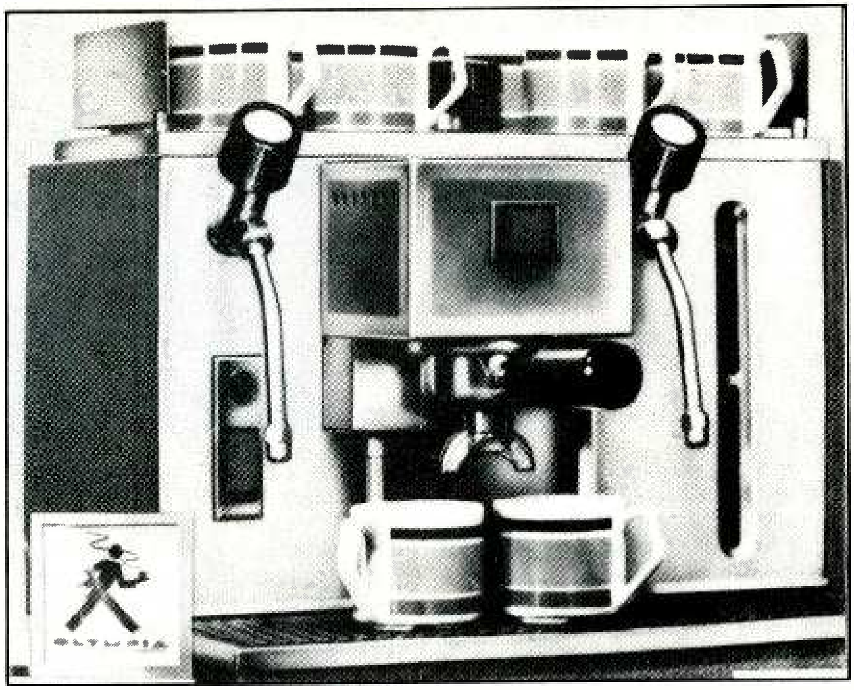
Steam Power



OLYMPIA CAFFAREX. Purchased from: Zabar's Deli & Gourmet Foods, 2245 Broadway, New York, NY 10024. Price: $500.

According to New York's Chock Full O' Nuts Coffee, Americans currently down some 28 gallons of Java each year. Given the consumers who, because of health concerns, have stopped drinking the stuff altogether, the number of us drinking more than 28 gallons each year must be considerable.

Since Chock Full ("the heavenly coffee") isn't in the espresso business, the company doesn't bother to report how many of those gallons are consumed in the form of that rich, dark, strong brew and associated beverages. But given the gourmeting of America, we'd imagine that espresso consumption is substantially up. Probably not enough to justify a $500, Swiss-built, commercial-style *Olympia Caffarex* in every coffee-drinking household, but enough to explain why one of New York's leading purveyors of fine culinary items would carry one.

Actually, after living with the *Olympia* for a week in the GADGET office, the notion of shelling out $500 for this machine didn't strike us as altogether absurd. First of all, it's a sturdy and essentially simple device.

Beneath the *Olympia*'s sleek, early-'60's *moderne* cabinet are a tank to heat water for coffee, tea and the like and a boiler producing steam for beverages like cappuccino. On the front of the machine are the controls; a steam vaporizer, two simple gauges indicating water levels, a hot water spout outfitted with a piston head and a second hot water spout. If the *Olympia Caffarex* sounds as if it requires a degree in steam engineering to operate, your reaction is similar to ours when we first saw this hissing, steaming beverage machine.

After plugging in its 220-volt cord, a lighted power switch mounted below a pilot lamp is turned on. Within eight or nine minutes, the pilot lamp goes off. At this point, the directions say the steam vaporizer should be opened briefly which brings the pilot lamp back on. Once it goes out for a second time, the *Olympia Caffarex* is ready to brew.

A filter holder, with a one- or two-cup coffee filter (both supplied with the machine) filled and inserted, is screwed into the main water spout pistol head. A cup is placed on the machine's metal rack (removable for cleaning, as is the spillage pan underneath it) and a button above the spout is pushed.

A loud hissing and sputtering—jarring enough to be disconcerting the first time it's heard—indicates water is being forced through the ground coffee and into the cup via a double-headed spout on the filter holder's bottom. The result is rich, fragrant espresso, the equal in our tests of any we've been served in a restaurant. To turn off the coffee flow, the spout's button is pushed a second time.

To heat milk with the *Olympia*, it's poured into a supplied, small plastic jug. This is placed under the steam vaporizer with the spout just under the surface of the milk. The vaporizer is opened fully and with a loud whoose, the milk is heated and frothed via steam. As the directions caution, "as soon as the foam begins to form, it is necessary to lower the jug in order to keep the end of the vaporizer just under the foam." The machine's second water spout is used to "obtain hot water for tea, grog, etc."

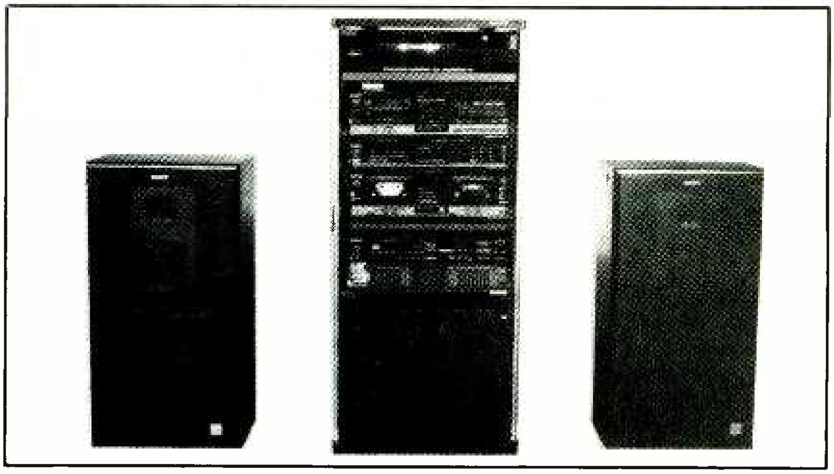
Maintenance is basic. The various taps have to be kept clean and the tanks occasionally flushed. For the main piston-head tap, this requires that hot water periodically be sent through the filter and filter holder when they're empty of coffee. The boiler should be treated either with white vinegar (the directions suggest filling the boiler to a third of its capacity with a mix of ⅓ white vinegar and ⅔ water) or decalcifying tablets. These procedures, and an occasional wiping with a damp cloth, should keep the *Olympia Caffarex* churning out espresso indefinitely. Besides the milk jug, two metal coffee filters and the fitted filter holder, the unit is equipped with a funnel, a coffee measuring spoon, an instrument for tamping down the coffee and a container into which used grounds are deposited.

Despite all the hissing and steaming, the *Olympia* doesn't require any special precautions. Both tank and boiler are filled via caps on the machine's top. The boiler's cap, according to the instructions, should never be unscrewed without first letting off the steam via the vaporizer. The filter holder, the first time it's used, should be heated by briefly running some hot water over it. Likewise, if it's hot, it should be cooled under some cold tap water.

In the fractured English of the directions, the *Olympia Caffarex* "enhances the standart [sic] of your cocktail cabinet which will be the envy of your guests." These are the same people, it's also promised, who "will be amazed" when "the genuine cappuccino is ready." Besides impressing all these people, the manufacturer boasts, "this little miracle machine does it all in less than no time," making it, "just the machine for discotekes [sic], trade and offices."

Whether it's also just the machine for you depends on how important good coffee, in its espresso form, is to you. For some people, the *Olympia Caffarex* would be a luxury worth its price tag. One, we judge, which would last a lifetime.—G.A.

Stereo Stack



STEREO COMPONENT SYSTEM (SEN-600). Manufactured by: Sony Corporation of America, Sony Drive, Park Ridge, NJ 07656. Price: $2,000.

A couple of years back, "rack systems" became the big, new noise on the stereo retailing front. To understand why, it's necessary to backtrack a decade or so to the era of component stereo. First came the "hi-fi," a single unit record player with enclosed speakers and a tuner.

By the 1960's, all the kids who'd grown up in houses with "hi-fi" systems revolted against the conventionality of it all by becoming do-it-yourself stereo connoisseurs. Pulling together their own systems by mixing and matching components—turntable, amplifier, tuner and speakers—according to their own budget and the reputations of various manufacturers. No stereo music consumer worth his or her subscription to *Stereo Review* would have been caught dead buying or owning a system made up entirely of the same brand components.

It was apparently retailers who first noticed a turning away from this activist consumer stance. For reasons undoubtedly studied and analyzed by stereo marketing experts, today's buyers are partial to single-brand systems. Enter the rack system, including the *Sony SEN-600* which GADGET bought, built and tested.

Right out of the box, one reason for rack system consumer acceptance suggested itself. What used to be three components and a pair of speakers has become something more elaborate. The *SEN-600* includes, besides the glass-fronted cabinet it's housed in, an amplifier (TA-AX530), tuner (ST-JX430), cassette deck (TC-W530), turntable (PS-LX431), compact disc player (CDP-40) and graphic equalizer (SEQ-430). The system speakers are *Sony*'s APM-615/615AV. Other complicating factors include remote control and the system's video equipment applications. Coming from the same manufacturer, the intimidated consumer at least can be sure the components will all function together.

Perhaps ironically, the toughest assembly job connected with the *SEN-600* was its rack (SU-S530). Although the first line of the instructions say, "you will need a medium size Philips head screwdriver..." GADGET found that to be an understatement. Better you should have a powered or ratchet screwdriver. *Sony*, for its part, should supply Philips head screws which won't disintegrate even as you struggle to tighten them. Especially as the cabinet's pressboard construction makes a tight screw imperative. We also suspect that taking the rack apart for moving more than once or twice would render it as rickety as a cardboard box. But, *Sony* isn't in the furniture business anyway.

In general, we found the set-up instructions for the *SEN-600* easy to follow. This aspect of the system seems to have been especially carefully thought out. Illustrations in the manuals make clear exactly which connection is being discussed, while the coding of the system's power and remote control connections make assembly as easy as a child's connect-the-dots puzzle. Building the system's rack, at first with a hand screwdriver, took over two hours. Once the components themselves were out of the box, system set-up took less than an hour.

With the system assembled, we began to think that maybe the '60's generation of stereo component buyers were right. There were aspects to this single-brand system not at all to our liking.

For example, the amplifier's function controls and indicators are badly configured. The switches for turntable, tuner, CD and tape deck aren't exactly aligned with their respective signal lights mounted above. A quick glance to check whether the function desired is on, especially after hitting the switch, can be misleading. A small point, but that's the sort of control design glitch we expect giant consumer electronic companies to design out of their systems.

In using the tape deck, we were never able to figure out how to mute its audio when dubbing tapes at high speed. It's great to have a double tape deck for just that purpose, but who wants to listen to the whine of high-speed recording?

Also, we confess to being slightly ignorant in the ways and means of graphic equalizing. While it's fun to fiddle with the levels—it makes you feel kind of like a recording engineer—the main attraction for many buyers is probably the display panel with its bar graphs of sound in action. If a consumer wants the buying ease of a single-brand system, is he or she the kind who's likely to be jumping up and kneeling in front of the system making adjustments for various recordings and tapes?

Finally, there's the system's sound. Using the *Sony* speakers, it sounded both muddy and indistinct. If we were buying the *SEN-600* for our own use, we'd certainly bypass the speakers for products from another manufacturer.

The performance of the components thus far unmentioned—the tuner with pre-set station capabilities and the digital CD with the by-now standard capabilities—was perfectly acceptable, if unexceptional. But, these judgments may just be the result of a lifetime spent listening to cheap or beat-up systems.

What really struck us about the *Sony SEN-600* rack system, a representative example of the very newest trend in consumer stereo, was its resemblance to an earlier era of home music entertainment. Assembled it doesn't look like the home hi-fi of the pre-stereo past; those were usually put together in a horizontal configuration.

Instead, with its record cabinet on the bottom and turntable at the top (accessible via a lifting lid), the rack looks to us something like the cabinet-model phonographs of the teens and twenties, minus of course both the hand crank and the 78 rpm speed. Is this yet another example of back to the future?—G.A.

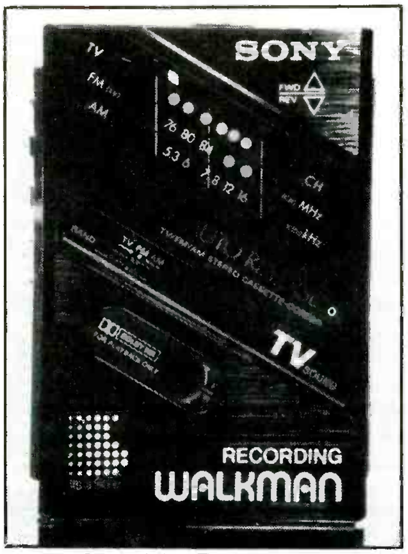
PERSONAL STEREOS

(Cont. from p. 1)

Sony's latest marketing-technical brainstorm, very much meant for the U.S. market, is the *Boodo Khan Stereo Cassette Player*, named for Tokyo's most prestigious concert hall. The company hails the *DD-100* as a "new concept in personal stereo," in that the unit and its accompanying headset aren't designed for walk-around listening. Quite the contrary, the "acoustically sealed" headphones carry the warning: "When wearing the headphones do not operate any motor vehicle, do not ride any bicycle, do not even walk outside." Being "acoustically sealed" against the outside world has its drawbacks, but as long as you stay put, the *Boodo Khan* delivers something approaching the ultimate in small-size stereo sound. The system's high fidelity is clearly more than a product of its headphones.

In fact, we used the headset with other personal stereos as well as using standard *Sony* earphones with the *DD-100.* Neither combination delivered anything like the fidelity of the *Boodo Khan* system. *Sony* gives credit to the cassette player's "special Dynamic Optimum Loudness circuit," responsible for boosting "low frequency (bass) ranges to achieve 'concert hall' realism."

Beyond its advertised fidelity and sonic realism, the *DD-100* is a basic playback unit; no auto reverse and five simple controls—fast forward, rewind, play, stop and a volume setting. Just about the only frill is double jacks for use with two headphone sets. This



Sony WM-F80 Stereo Cassette Player

"new concept" from *Sony* reverses the original ambulatory rationale for *Walkmans*, bringing the product full circle.

Sony's *WM-F202* is a *Walkman* of a type more popular in Japan than in this country. This particular model isn't available officially in the U.S. Nearly unmarketed here, *Walkmans* with "TV sound" may become more important as stereo broadcasting becomes the norm. If you've just purchased a monaural sound TV, you could always enhance it by listening via *Walkman* stereo. Currently, daytime TV addicts seem the major market.

The *WM-F202* is equipped for VHF TV channels 1 through 12, has auto reverse, Dolby noise reduction, a three-position interference suppression switch (for use when recording from the radio or TV bands) and a separate tiny microphone and accompanying mic stand.

One particular achievement of this model is its arrangement of controls and indicators in what is a very small area. The tape direction indicator is a model of clarity, while the dispersal of no less than eleven separate controls is little short of ingenious.

The *Walkman WM-55* (also not imported to the U.S.) seems to be the non-recording version of the *WM-F202*, as it has the same other capabilities and features. This one is also configured differently, with the tape compartment and band indicator horizontal, instead of the *WM-F202*'s diagonal arrangement. Presumably, this unit is aimed at the market segment with no interest in recording, or in paying extra for the capability.

Yet another TV sound *Walkman*, this one purchased in the U.S., the *WM-F80* is equipped with a five-band equalizer, making its users ambulatory sound engineers. Actually, in testing this unit, the equalizer did seem to make some marginal sonic difference.

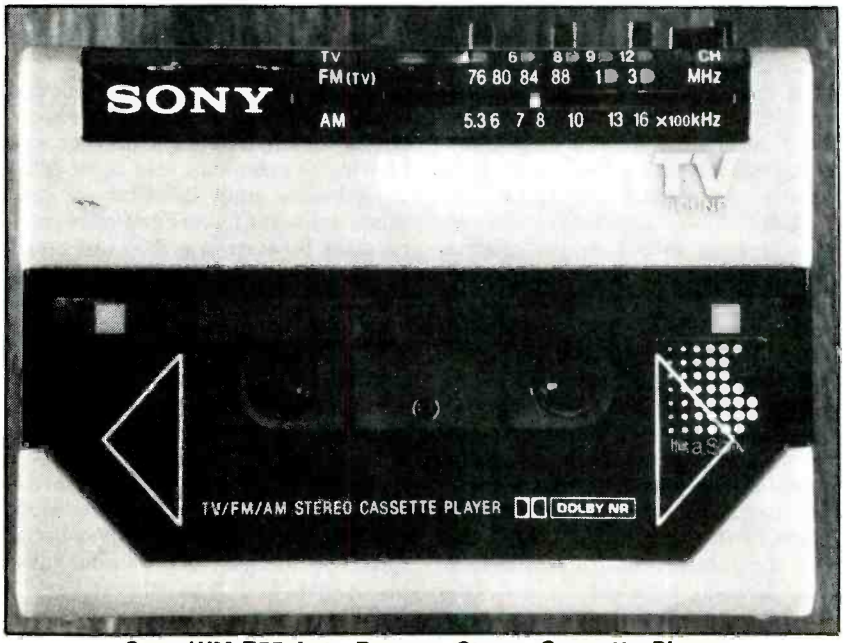
Some self-recorded tapes, distorted

Panasonic RX-SA80 Stereo Radio Cassette Player

because of another system's improperly adjusted graphic equalizer (leftover from another GADGET test), sounded a bit clearer with the five bands set at various levels. Likewise, using the *WM-F80*'s TV capabilities, daytime TV's soap opera promotion spots sounded a trifle less hysterical—or is that giving credit to the wrong *Walkman* capability? The *Walkman* also revealed that the host of TV's "The Price is Right" has a habit of sucking in air at the end of sentences. Now *that's* sonic realism.

This non-recording *Walkman* comes equipped with auto reverse, Dolby, "local sensitivity" (which limits interference from strong broadcast signals)

(Continued on page 6)



Sony WM-F55 Auto Reverse Stereo Cassette Player

PERSONAL STEREOS
(Cont. from p. 5)

and all the controls necessary to make the user master of his or her own personal stereo fate.

Sony may have established this product category, but others were quick to flatter its ingenuity in the most sincere fashion possible. *Panasonic*'s *Stereo Radio Cassette Player (RX-SA80)* offers the design refinement of a pre-setting function for its AM/FM radio bands and a rather elegant LCD station indicator with quartz synthesized tuning. There's also Dolby, auto reverse and the intriguing "ultra phonic mode," apparently a less complex mimic of a graphic equalizer.

The *Panasonic* pre-set tuning system will memorize six FM and six AM stations, a capability which requires six pre-set buttons and a "memory" function. As far as we could tell, unless consumerist pride requires the *Walkman* label, the *Panasonic*, with its features, is easily the equivalent of the *Sony* products with theirs.

Frankly, after checking out five different small tape players and recorders over a short period of time, our minds were awash in "features," "capabilities" and perceived or imagined differences in audio quality. No wonder the glossy audio magazines turn this kind of comparison over to their computers.

Our suggestion, if you're planning to purchase a personal stereo tape unit, would be to allow the sales person to show you only two or three different models. Most importantly, be clear on which features—recording, non-recording, TV sound, radio reception, graphic equalizer, radio channel pre-sets—you want before you walk into the store. Features, not quality comparison, are the soundest basis for a purchase decision.—G.A.

Mondo Combo

TELEVISION/VIDEO CASSETTE RECORDER (L950). Manufactured by: Lloyd's Electronic Corp., 180 Raritan Center Parkway, Edison, NJ 08818. Price: $899.

Gadgetical logic can be a misleading thing, especially in the world of mass consumer behavior. For GADGET newsletter, *Lloyd's TV/VCR* combo *(L950)* seems an eminently practical home entertainment device. But in talking about the product during our tests, we discovered a lot of consumer resistance.

Price was a common objection. Why buy a single TV-VCR unit when video recorders and televisions purchased separately wouldn't cost significantly more? What happens if the VCR dies before the TV, or vice versa? And what about flexibility, being able to arrange your VCR and TV to fit available space or to conform to typical use of the two?

Flexibility seems a bad rap. The 13" *L950* we looked at, in former years it would have been described as a "table model" TV, takes up much less space than the same size TV and a separate VCR unit. As for price, *Lloyd's* appears to have priced this combo a bit lower than might be expected. The price figure quoted here is the suggested retail tag; at least one catalog is offering the *L950* at $699.

Of course, at this price, the *TVCR* (as *Lloyd's* has dubbed it) is a simple one. The *VCR* offers fast-forward, automatic playback repeat, automatic rewind and simple programmability. "Fourteen days/one program," meaning that for a period of up to two weeks, the user can set the *TV* and recorder to turn on at the same time each day. The *TVCR*'s timing functions demand a clock, so that's also been included. There's also an "instant record" feature which we thought was a nice extra.

With the touch of one button, mounted under the *TV* screen, the *VCR* can be engaged to record immediately for 30 minutes, useful for capturing that game highlight or news program report a viewer might suddenly want to have on tape. But there are no fancy editing capabilities or sophisticated stop action controls, freezing a video picture without any degeneration of image. There aren't any on-screen programming directions or information, no built-in character generator or "picture-in-picture" capability.

The *TV* is basic, too, non-digital, non-stereophonic audio. It's cable ready (a phrase fast becoming meaningless, when it's not confusing), but the tuning is via the kind of electronic system which means a laborious session of close adjustment when the set is first used. Given the simplicity of both halves of this duo, it's not a big plus that the remote control is full-function, meaning both the *TV* and *VCR* are fully controlled from the infra-red remote system.

As for possible failure of half of the *TVCR*, the company offers the same limited warranty for both TV and recorder; parts are covered for a year and labor is provided for 90 days. The picture tube itself is guaranteed for two years.

Maybe what we like most about this product is that it represents one more choice for the consumer, another way of bringing video into your home without intensive study of electronic consumer guides or feature and price comparisons between brand X and brand Y. Careful consumerism isn't a bad practice, of course, but sometimes it's nice to walk into a store and make a quick purchase. That flexibility and freedom are supposed to be part of life in the contemporary consumer republic where we vote with our purchasing dollars.

Besides the *L950* we looked at, available in 13", 19" and 22" screen models, the company offers an *L940* in the same trio of sizes with "8-hour playback capability." We doubt the *Lloyd's TVCR* will sweep the marketplace, but we're kind of glad it's available.—G.A.

Getting Graphic

FOUR-COLOR GRAPHIC PENWRITER (RK-P200C). Manufactured by: Panasonic Co., 1 Panasonic Way, Secaucus, NJ 07094. Price: $269.95 to $349.95.

Among its several attractive features, not the least is the *Penwriter*'s name, a moniker which better describes these devices, situated somewhere between a typewriter and a PC printer, than earlier labels. When Brother International introduced its version of this functional hybrid to the consumer market three years ago, they were called "type-a-graphs." *Penwriter* seems a more refined name for these ingenius printing and plotting devices.

Refinement, in fact, is much of what the *Panasonic RK-P200C* is about. The graphs it produces are slightly finer in detail and execution than the Brother device's output. Its range of features and capabilities also suggest progress in the design of these multi-purpose printers.

The *RK-200C*, and its more advanced *Panasonic* counterpart, the *RK-P400C*, are adaptations of existing technologies to create a new entry into the evolving typewriter-PC printer-graphic device market. Graph plotting is its most spectacular function, but it also has applications as a standard typewriter and as a low-cost PC printer of acceptable quality and speed. According to its specifications listing, the *Penwriter RK-P200C* prints out at 6.5 standard characters per second.

What seems to have been joined here are the technologies of graphic plotting (the four-barrel pen-holder is borrowed from such devices as the seismograph and the so-called lie detector); relatively basic computer memory (2K, which translates into 1140 characters of total memory stored in nine different files or "phrases") and the electronic typewriter, from which the *Penwriter*'s 45 characters and 23 function keys, in their arrangement and design, are adapted.

Either battery- (six 9-volt "flashlight" batteries) or outlet-powered, the *Penwriter* offers four colors (red, black, green and blue), nine character sizes and the traditional trio of graph forms, likewise in three sizes—pie, bar and line styles. The user enters data into the *RK-P200C* via the device's 16-character LCD, and the device translates numerical information into crisp, sharp graph displays.

The LCD functions as control central for the *Penwriter*, with instructions, queries (i.e., which graph, which size, etc.) and data display, for confirmation or correction, all shown here. Four key function controls, text (referring to text memorization, editing and entry), printing, color and typing mode, are at the right side of the keyboard. A code key at the right side of the space bar activates various command keys (coded in blue) which otherwise function as part of the more-or-less standard keyboard.

In our initial encounter with the *Penwriter*, we found the various routines and command series both tedious and easy to mis-sequence. But, as with any electronic memory device, after a few practice sessions they were painlessly memorized. *Panasonic* has also engineered in a number of steps which in most functions allow graceful exit from a misplaced command.

One refinement here didn't impress us, the *RK-P200C*'s optional method for correcting printing. Along with the four color pens, the unit can be equipped with a four pen "correction" set.

In place, of course, the correction set derails the *Penwriter*'s four-color capabilities. But in our use of these correction pens, we found them to be not altogether perfect in wiping out a misprinted word or letter. Clearly meant to be used primarily in ordinary typing, the system's drawbacks seem a result of trying to pack too much into an already impressively multi-functional device. The correction pen system seems a compromise which, at this stage, doesn't work as well as the rest of the *Penwriter*'s systems.

Despite its unconventional printing method, however, the *Penwriter*'s characters are clear and crisp enough to pass for ordinary typewriter characters. Perhaps not "letter quality," but its output misses that designation by only a hair. But, what "letter quality" typewriter will print vertically, in two directions as well as horizontally?

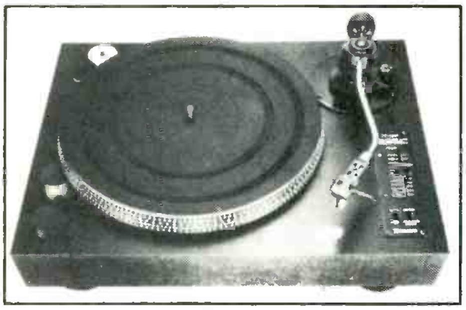
Getting back to the *Penwriter*'s graphic functions, each group can contain as many as a dozen sets of data. Input is possible for numerical data of up to eight digits. In comparative graphs, up to four groups (each containing 12 sets) can be printed out. The *Penwriter*'s index and reverse index controls, in the graph mode, are used to display data to be deleted or to confirm the information before entry into the graph's data base.

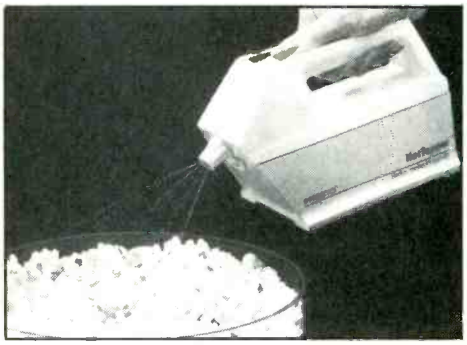
For use as a computer printer, the *Penwriter* must be connected via an interface adapter (RP-K100) offered as an option. It also requires six pages of directions in the *RK-P200C*'s instructions manual. But as a printer, it offers a graphic coordinate system and can draw even beyond its graph functions.

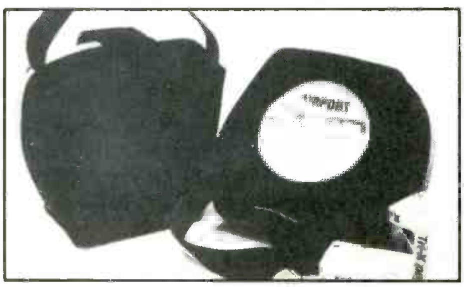
Perhaps it's merely a reflection of the *Penwriter*'s varied capabilities, but we'd suggest that the *RK-P200C*'s instructions in general could do with some revision and clarification. Although they've been written in a step-by-step style, it's not always altogether clear how the steps relate or which are general (i.e., are always used to set up particular functions) and which are specific to the function or task itself. Too often, the logic used in writing the instructions is computer-style instead of human.

Still, with the *RK-P200C*, *Panasonic* has a product which is near the top of its market category, lightweight (5.5 lbs., complete with a carrying handle built-in), versatile and surprisingly easy on the budget.—G.A.

Bits & Pieces


TT1400 DJ Turntable


HotTopper Melter/Dispenser


X-Ray Protect-A-Bag


Freeline Cordless Telephone

Out to "rock the joint" and prove that in no way are you a "sucker DJ?" Then you'd better know about the new professional **TT1400 DJ turntable** from *Numark Electronics Corp. (503 Newfield Ave., Raritan Center, P.O. Box 493, Edison, NJ 08818).* Yo, check this out, a "micro-miniature tone arm light" for "spot illumination of the stylus and its tracing path to ensure precise record cueing," sliding pitch control with "an advanced quartz defeat switch," and a brushless DC motor capable of bringing the platter "up to playing speed in just a 90 degree rotation." All this and electronic braking, too. Price: $399.95.

As the now-abated gourmet popcorn boom of a few seasons ago demonstrated, there are consumers who take their popcorn very seriously. Perhaps with this market in mind, *Presto (3925 N. Hastings Way, Eau Claire, WI 54703)* last year introduced the **HotTopper Melter/Dispenser (03000).** This "totally new concept in convenience appliances" automatically melts butter or margarine, heats syrups and other liquid toppings, then sprays, streams or brushes as little or as much topping as desired. The HotTopper's cord can be removed, so it can be used cordlessly, and it's completely immersible for easy cleaning. Price: $29.95.

Airport security X-rays can ruin film and destroy irreplaceable exposures. *Coast Manufacturing Co., Inc. (118 Pearl St., Mt. Vernon, NY 10550)* has designed the Red Accent **X-Ray Protect-A-Bag** to shield film. The bag holds up to 12 rolls of 35mm film or an autofocus camera plus 3 or 4 rolls of film. A lead-foil lining insures the film being carried is fully shielded from standard X-ray inspections at airports. The bag has a nylon exterior, a lint-free interior, two Velcro closures and a carrying handle. Price: $14.95.

With something like a thousand motion pictures with Dolby stereo sound currently available on videocassette, a lot of serious movie buffs will probably be buying the new **Shure Home Theater Sound System (HTS 5000).** Available from the *Herrington Catalog (10535 Chillcothe Rd., Kirtland, OH 44094)* and elsewhere, this device decodes Dolby Surround channels present on videocassettes, then sends the output to as many as four speakers. This allows the home audience to thrill to the spectacular audio effects of such hits as *Raiders of the Lost Ark* and *Close Encounters.* The HTS5000 provides up to six channels of output, with Shure's Acra-Vector decoder ensuring the directional accuracy of sound as it was originally recorded. Connected to your stereo system, this can also enhance stereo broadcasts and, according to Herrington, flawlessly reproduce the sound quality of CDs. Price: $599.

This sounds like a handy item for a fully remote electronic home entertainment system. It's called the **Beam Booster,** and it was invented by Apple Computer's Steve Wozniak. Described as "an ingenious little device" by the *Herrington Catalog (10535 Chillicothe Rd., Kirtland, OH 44094),* it allows you to operate a remote controlled TV, VCR, CD player or cable box without the bother of aiming it or bringing yourself into the unit's direct range. Using a single 9-volt battery (included), the Beam Booster attaches to remote controls with double-sided foam tape (also included) and re-transmits the infra-red signal at a much stronger level. Price: $29.95.

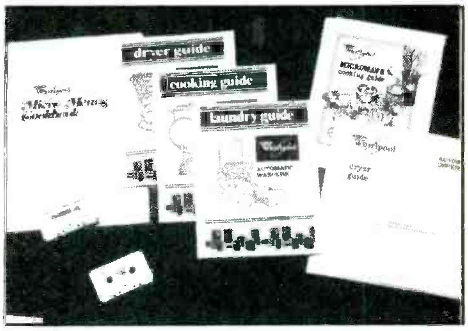
Introduced in 1983, the cordless telephone nearly became yet another aborted revolution in electronic communications. Consumer interest was such that scores of manufacturers and brands rushed the market, competition got out of hand and before you could say "the new Edsel," buyer confidence was nil and cordless phone sales took an abrupt nose dive. Four years later, the market shows some signs of coming back to life, like the new **SPP-100 Freeline Cordless Telephone** from *Sony (9 W. 57th St., New York, NY 10019).* Among improved features are interference elimination, security/line protection, greater power source reliability and true tone compatibility for use with various long-distance systems and services. Sony also offers a one-year warranty on the SPP-100. Price: $189.95 to $209.95.

Bits & Pieces

Hitachi (401 W. Artesia Blvd., Compton, CA 90220) has introduced its first **CD player** with a changer, a fully programmable unit with a 6 disc and 1 disc magazine. The **DAC-50** offers random access programming of up to 32 tracks of any 6 discs either from a wireless remote control or at the player. There's also a repeat function, random playback and a two-speed audible/music search system that tracks discs in either forward or reverse direction. The fluorescent display shows disc number, track number, elapsed time of a CD and total playing time with number of programs on a disc. Price: $499.95.

CD Player with Changer

As a service to its visually impaired customers, the *Whirlpool Corp. (Benton Harbor, MI 49022)* offers its general appliance guides and microwave oven cookbooks in Braille, large-type and audio cassette formats. For a complete list of guides and booklets available, with price and ordering information, write the firm's Appliance Information Service.



Information for the Visually Impaired

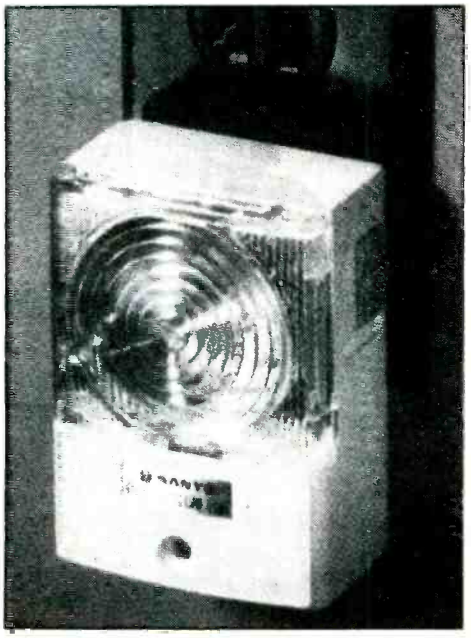
Video system add-ons, judging by catalogs and press releases GADGET receives, are a tremendous growth industry right now. *Vidicraft,* for example, has developed an **Integrated Video Enhancer (IVE-100)** for use with monaural VCRs. Used during playback, it enhances detail and image sharpness sometimes blurred in the recording process. Used while recording, it pre-enhances the image, producing razor-sharp tapes off-the-air or from a video camera and during tape dubbing. A stabilizer ensures "clear playback of copy guarded tapes" and allows the user to "copy them as well" (a development which should thrill the video industry in Hollywood). Available through the *Herrington Catalog (10535 Chillcothe Rd., Kirtland, OH 44094)* and elsewhere, the IVE-100 also includes a "commercial alert" which sounds an alarm when TV spots come on (which should thrill the TV networks and the advertising industry). The unit comes equipped with inputs for two VCRs, a built-in RF modulator for connection to a standard TV and an amp which can send output to three additional devices with video input. It is, however, for monaural VCRs only. Price: $249.

Lock De-Icer

Here's one of our favorite kinds of gadgets, economical and designed to do something worthwhile. The **Lock De-Icer**, with built-in flashlight and key ring, inserts into a frozen or iced car or door lock and within a few seconds warms the mechanism. No more burned fingers (from trying to thaw the lock with matches or a lighter) or frustration on wintery mornings or sub-zero nights. Imported by *The Davenport Co. (P.O. Box 24, Willow Springs, IL 60480-0024),* the Lock De-Icer uses two "AA" batteries. Price: $5.

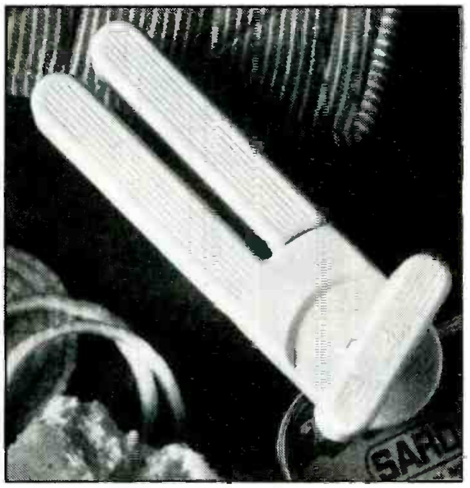
We've all been warned about colorless, odorless and tasteless carbon monoxide. Canada's *Co Sensor International, Inc. (160 Gibson Drive, Unit 4, Markham, Ontario L3R 3K1, Canada)* is marketing an in-home monitor, modeled on the larger systems used in industry. The **Co Sensor** plugs in anywhere and monitors the air in your house for carbon monoxide. When the deadly gas is detected, an alarm sounds and a light goes on. Co Sensor says its product is "the first home monitor and alarm that warns of this deadly gas's presence." The unit comes equipped with an AC adapter and features a yellow LED, which warns of possible equipment malfunction, a green LED, indicating safe air and a red LED which glows if carbon monoxide is present. Price: $134.

Here's a light that goes on when the power goes off. The **Automatic Power Failure Light** plugs into any 110-volt outlet and can be unplugged and used as a hand flashlight. It automatically shuts off and begins recharging when power is restored and lasts 50 minutes per charge. A permanent nickel cadmium battery recharges indefinitely. It's available from *Sporty's Tool Shop (Claremont Airport, Batavia, OH 45103-9747).* Price: $16.95.



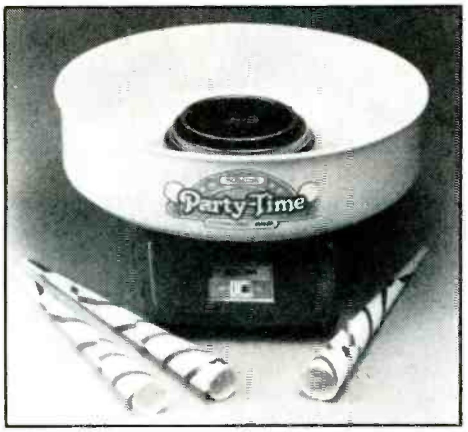
Automatic Power Failure Light

Bits & Pieces

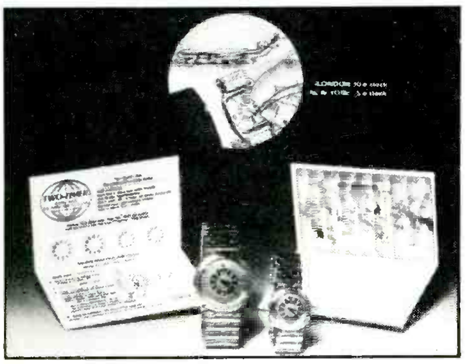


Ultimate Can Opener

G-300S Radar Detector



Cotton Candy Maker



The Two-Timer

Whoever it was who said, "build a better can opener, and the world will beat a path to your distributor," has apparently gone to work for *Imperial Knife (1776 Broadway, New York, NY 10019)*. The company has begun marketing what it calls the **Ultimate Can Opener**. For once this new and improved product does seem to go existing can-opening implements at least one better. The Ultimate Can Opener removes the entire lid and holds it, meaning you'll never have to touch it. It also leaves behind a smooth, unjagged edge and operates in either clockwise or counter-clockwise directions. Rugged and simple, the Ultimate Can Opener carries a five-year warranty from Imperial Knife. Price: $12.

If your motto is "just because I'm paranoid doesn't mean they're not after me," you might be interested in finding out more about the *CCS Communication Control (160 Midland Ave., Port Chester, NY 10573)* **Supercar.** It represents no less than the "pinnacle of safety and security in protection vehicles." Essentially a high-tech, security customization, CCS can rebuild Mercedes-Benz, BMW, Cadillac or Saab cars, fortifying them with special armor for bullet and bomb proofing, reinforcing bumpers and even making the tires bullet-proof. Among the many security options available are radio telephone systems, car bomb detection devices, tear gas/smoke dispensing systems, shock seats and radio tracking devices. CCS promises "there is no visible sign that the car has been altered" and can also do the job on jeeps, sports cars and even, we'd guess, sub-compacts. Price (exclusive of the vehicle): $90,000 and up.

More progress in radar detection as *GUL Industries Corp. (23970 Craftsman Rd., Calabassas, CA 91302)* introduces its new top-of-the-line **G-300S Radar Detector.** Small enough to be carried in a briefcase, purse or coat pocket, the G-300S "has been designed to provide optimum sensitivity to police radar without sacrificing the selectivity needed to avoid random falsing," while its "gallium arsenide diode mixer circuit" gives the driver the "maximum amount of time to check speed and, if needed, slow down." The unit also features a trademarked R.I.D. (radar interference defeat) computer circuit which analyzes incoming signals and eliminates false alerts caused by other radar detectors in nearby vehicles. Price: $99.95.

Given its association with carnival midways and state fairs, cotton candy isn't anything like most of our mothers used to make. But the *Robeson Industries Corp. (49 Windsor Ave., Mineola, NY 11501)* **Cotton Candy Maker (model 3701)** brings this old-time midway favorite home. Just like the big, commercial units, this home maker turns out sticky, flavorful cotton candy in minutes. Price: $79.95.

If you're among the 41 percent of American men wearing some form of facial hair, does *Norelco (Consumer Products Division, North American Philips Corp., High Ridge Park, P.O. Box 10166, Stamford, CT 06904)* have a product for you. **Man Care Beard and Moustache Trimmer (MC-22)** is a slim, compact instrument for precision trimming. It runs on two AA batteries (included) and features carbon steel blades, a stand, blade guard, styling comb and instructions. The MC-22 also has "distinctive black and silver Rotatract razor styling." Price: $27.95.

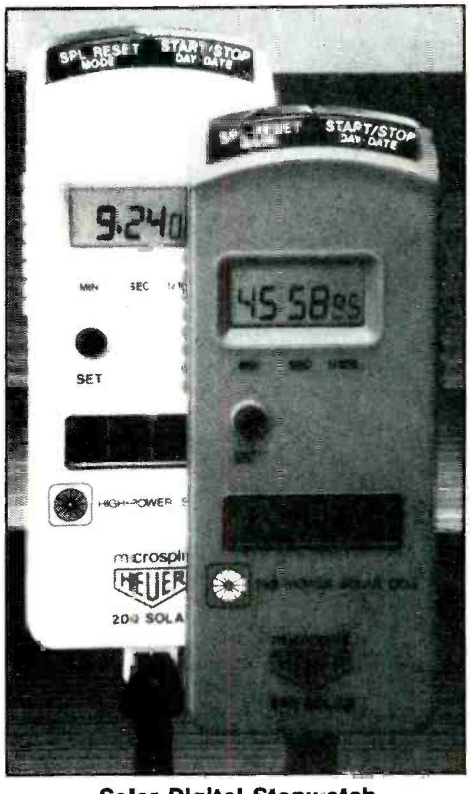
International travel can leave you "zoned-out" when it comes to keeping up with time zone changes. The **Two-Timer**, the invention of Arthur Leopold, a two-decade veteran of the airline industry, is described as a "world-wide see-thru time zone disc." Made of sturdy see-through mylar, the Two-Timer is a tiny disc which fits onto the face of a watch crystal. The user aligns the hour of the destination point with the hour of the departure point and instantly an analog dial watch is transformed into a dual time zone instrument. Sold by *Two-Timer, Inc. (P.O. Box 3115, Harmon Meadow, Secaucus, NJ 07094)*, the simple device is sold in sets of three with a world-wide time zone map. Claimed as a fringe benefit of Two-Timer is "the wear and tear it saves on travelers' watches." Price: $2.95.

Bits & Pieces

If you've every tried to change a tire by yourself late at night on the side of a highway, or dread having to do so, the **Tire Rescue Kit** probably belongs in the trunk of your vehicle. Available from *Herrington (10535 Chillicothe Rd., Kirtland, OH 44094)*, this unit plugs into the cigarette lighter and can "inflate a completely flat tire in less than four minutes." The kit includes a trouble light with flasher, a direct-reading pressure gauge, a 15-ft. coiled power cord and a 3-ft. high-pressure air hose. It also has extra needles for inflating rafts, balls and bicycle tires. Price: $65.

Tire Rescue Kit

A stopwatch worn around the neck in recent months has become a popular youth fashion accessory. Although by the time you read this, the style may have run its course, *Tag-Heur Time & Electronics Corp. (960 S. Springfield Ave., Springfield, NJ 07081)* has added a bright, new twist to the fad. The firm's **200 Solar microsplit digital stopwatch**, designed to be worn around the neck, comes in bright colors and an unusual oblong shape. It features stopwatch, 12-hour watch and calendar functions and is also solar-powered. As a stopwatch, it can measure precisely to 59 minutes 59.99 seconds, which is probably why it's called a microsplit, and it's both repairable and guaranteed by Tag-Heuer. A battery operates the watch when there's not enough light (the sun or another source) to power it. Price: $35.

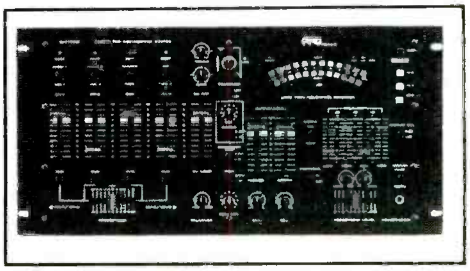


Solar Digital Stopwatch

Among the 127 companies which originated the international 8mm video standard was *Kyocera International, Inc. (110 Randolph Rd., Somerset, NJ 08873)*, and the firm has just introduced its second 8mm camera to be marketed in this country. Among advantages claimed for the 3 lb., 3 oz. **KD-2010U Finemovie 8 Camcorder** are improved camera resolution and low-light sensitivity. The unit includes a 6:1 power zoom lens, infrared autofocus and a rechargeable battery good for an hour of use between charges. A two-hour battery is also available as an option. Another option, the CRD 101 and 201 audio-video cables ($7.50 each), makes it possible for the KD-2010U to directly record TV programming when connected to the outputs of a TV receiver/monitor or TV tuner. Price: $1,795.

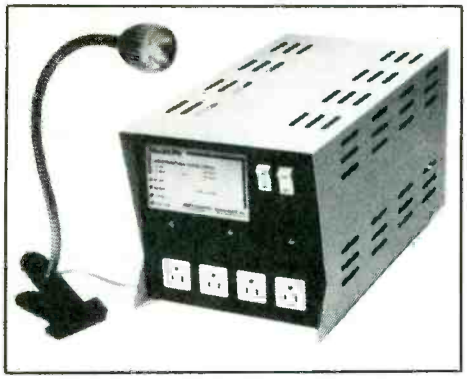
Have you ever wanted to "hear a whisper at 100 yards," or pick up the sound of "a car door at five blocks?" How about hearing "a dog bark at two miles?" *Safety Advisors Manufacturing, Inc. (5112 Weber, Skokie, IL 60077)* says its **Action Ear** will allow you to do all of the above and more. The Action Ear brings distant sounds in closer (and in stereo) and makes quiet sounds louder. Developed for law enforcement work, the device is powered by a single 9-volt battery, features volume controls for each ear and, because of its fully enclosed earcups, can even be used as "shooters earmuffs." Just remember to turn the volume all the way down. S.A.M. also warns these are "not to be used for illegal eavesdropping." Price: $148.50.

Any weekend (or full-time) club disc jockey might be interested in the new **DM1950 PreAmp/Mixer** with aural exciter being marketed by the professional products division of *Numark Electronics Corp. (503 Newfield Ave., Raritan Center, P.O. Box 493, Edison, NJ 08818)*. The unit includes an LED beat indicator, enabling "disc jockeys to count beats per minute of specific music selections," while push-button cue switches and cross fade control allow for smooth, seamless transitions. As for that Aphex Aural Exciter, used in the recording and "sound reinforcement" industries for over a decade, it provides "psychoacoustic enhancement" for any "audio program material." But wait, there's more, like house and booth master controls, continuously variable talk-over control, DJ mic loop and separate bass and treble controls for DJ mic input. Price: $999.95.



DM1950 PreAmp/Mixer

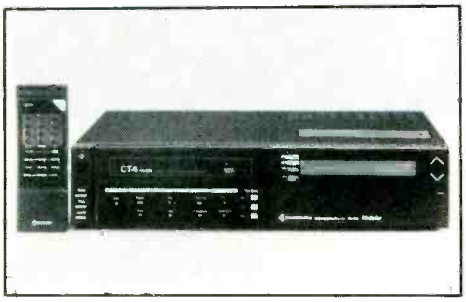
Bits & Pieces



Uninterruptible Power Supply

Anxious about the power supply going to your PC or other electronic equipment? *Electronic Specialists, Inc. (171 S. Main St., Natick MA 01760)* is proud to present its on-line, sine wave **Uninterruptible Power Supply**. Capable of supplying up to 20 minutes of power during extended outages, this unit operates without disruptive switching transients and incorporates automatic internal battery recharge. There's also Wide Band EMI/RFI filtering and high-speed, high-current spike suppression, not to mention an integral overload/short circuit proof configuration. Line phase lock, automatic blackout illumination, a battery-saver, automatic shut down option and external battery option are also featured. Price: 250 watt—$10.95; 500 watt—$14.95.

For the Walter Mitty in each of us, authentic **cockpit posters.** According to *Sporty's Tool Shop (Claremont Airport, Batavia, OH 45103-9747),* "these posters are so detailed that every instrument, placard and switch is clearly visible—even the smallest lettering is readable." Each of the posters (two of which won a Printing Industry of America quality award) is 36" by 24" and printed on coated stock, specially varnished with a glossy, protective finish. Cockpits offered are the Piper Archer II, the Boeing 747-300, Cessna 172, Beech Starship I, Super King Air 300 and Learjet 55. A great gift for aircraft-minded kids. Price: $29.70—for all six; $7.95 each.



VR4700L VHS VCR

Four heads vs. two heads is one of those decisions consumers buying a VCR are inevitably confronted with. *Samsung Electronics America (301 Mayhill St., Saddle Brook, NJ 07662)* has added a new element to the equation with its introduction of the moderate-price **VR4700L VHS VCR**, with "rotary four-head video recording/playback" and linear stereo sound. Part of the company's "Medalists" line of VCRs, the VR4700L offers 110-channel cable-compatible random access tuning, a 14 day/6 event programmable timer, picture search, three speeds for tape play, MTS auxiliary jack and one-touch recording. Price: $539.95.

CD4 CD Player

It may look like a standard CD player, but beneath the sleek exterior of the **CD4 Compact Disc Player** lurk such marvels as "false error correction activation reduction," a "servo-laser intensity system" and "brick-wall digital filter in conjunction with an advanced multiple pole low-pass filter." New from *Analog & Digital Systems, Inc. (1 Progress Way, Wilmington, MA 01887),* this is the product of a "world class combination of designers and engineers" from the U.S., West Germany and Japan. The CD4 also features proprietary "16-bit digital to analog converters" and a simplified circuit layout, designed to yield "less noise pick-up" and "reduced hum." Price: $900.

Coming in next month's GADGET newsletter

• Toshiba's XR-P9RC CD Player—The unique "wedge" raises the stakes in the portable player sweepstakes.

• The VP-700 Voice Messenger—A new telephone answering machine that replaces audio tapes with a digital voice chip, from Colonial Data Technologies.

• Mini-Portable Cellular Phone—General Electric enters the cellular field with a super-compact instrument, for car or coat pocket.

Also in the next GADGET—Sony's Discman D-10, a catalog of the best and safest for tots, Toshiba's new cordless rechargeable vacuum cleaner, the return of the Lava Lamp and much, much more.

By Homer L. Davidson

BOOM-BOX PLAYERS

When you start to remember how good your boom-box used to sound, it's still not too late to do the little things that put new life into portable tape players and radios.

☐EVERYTHING WITH MOVING PARTS RUNS DOWN WITH AGE. When it comes to electronic equipment, the sound gets fuzzy, records sound as if they were pressed in a hot waffle-iron, and cassettes develop gurgles that rival the best sound-effects from the Disney cartoon movies. And of all the gear that suffer the worst ravages of time and use, the portable *boom-box* suffers the most because it's always in harm's way. If it's not getting bounced, dropped, or fried in the trunk of a car, it's getting beach sand in the tape drive and rain in the speakers.

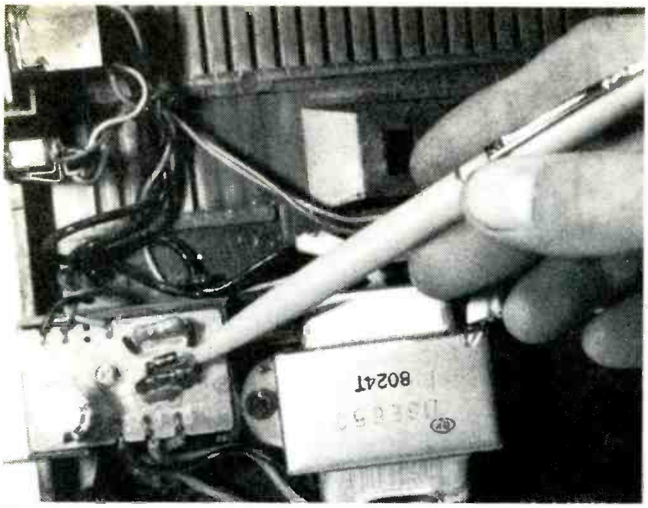
But a few simple adjustments and repairs are all it takes to make sluggish *boom-boxes* come to life and rock the neighborhood. And keep in mind that a few simple repairs early enough prevent an expensive, catastrophic breakdown later. A simple do-it-yourself maintenance routine may be all that's needed to prevent a costly, professional repair job.

Here are a few easy-to-make *boom-box* repairs that can be done by just about anyone who can tell one end of a soldering iron from the other.

Dead—Nothing

To determine if an AM/FM Stereo Cassette *boom-box* is dead when connected to the powerline, switch over to battery operation. Suspect a defective linecord or plug if the unit operates on batteries but not from the powerline. Inspect the AC linecord and the off-on switch for breaks or poor contacts. Try another power cord, if handy. Sometimes, the power cord of your electric razor will fit the *boom-box*'s AC connector.

Check the continuity of the AC cord by testing it with the the *ohmmeter* function of a VOM or DMM. If the cord tests OK, check the silicon diodes used in the power supply. Look for burned or break marks. You may find two or four single diodes wired as a full-wave or bridge-rectifier circuit. Remove one end of each diode and make a leakage test. On a



Check the power supply's silicon diodes when there's no sound, or no tape movement. When tested with an ohmmeter, a leaky or shorted diode will indicate a low resistance measurement with any kind of test lead arrangement.

normal diode a low resistance should be found in only one direction. If the diode shows a reading with the test leads reversed the diode(s) is (are) leaky, and should be replaced.

Dead When Battery-powered

Make sure that the radio plays when AC-powered before checking for poor batteries. One dead or several weak batteries can prevent proper operation; the sound may be distorted or the tape may run at a lower-than-normal speed. Inspect the battery terminals for dirty or corroded contact areas. Sometimes, when the batteries are left in the player for a long time they will leak and corrode, destroying the battery terminals. If the batteries have leaked, scrape each battery contact with the blade of a pocket knife until they are sparkling clean.

Before installing new batteries, run their terminals against a rough towel or cloth to clean their contacts. Also, make sure that the polarity of each battery is correct. If the player doesn't operate with a new set of batteries, check the total voltage at the battery-terminal wires with the 20-volt range of a VOM or DMM when the batteries are under load—meaning that the radio or tape player is turned on.

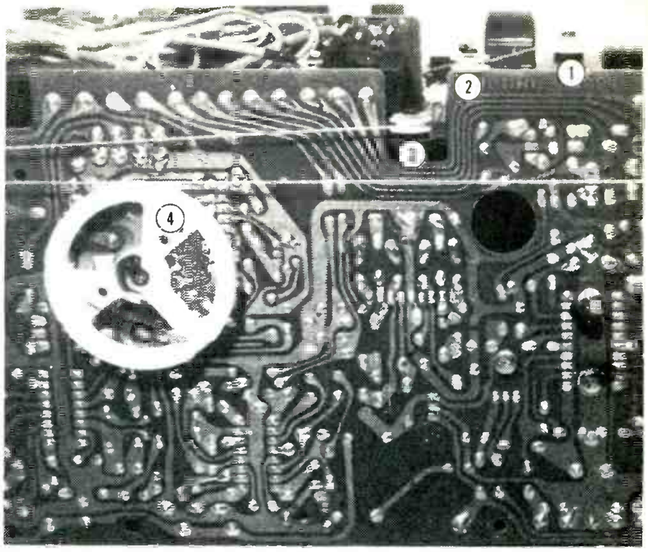
Keep The Dial Cord On Track

Check for a broken dial cord, or for a dial cord that's slipped off a pulley, when stations can't be tuned in or the dial pointer won't move. Remove the back or front cover to get at the dial-cord assembly. Most of the larger portable *boom-boxes* can be internally inspected by removing the Phillips screws located in the back cover.

Inspect the dial cord for a break or slippage. Sometimes, the plastic dial-cord pulleys break loose from their plastic bearings and allow the dial cord to lie loose. Repair the pulley's plastic bearing by substituting a metal screw (use a small screw that fits inside the pulley area).

To do that, first make a sketch of the dial-cord stringing, then remove the dial cord. While holding the damaged pulley in the correct position, apply heat from a soldering iron. When the plastic softens, press the screw into the plastic and let the assembly cool. Then restring the dial cord.

To restring a broken dial cord, draw a rough sketch showing where the cord passes around each pulley and the drum that's attached to the tuning capacitor. Select a piece of dial cord one foot longer than necessary and tie one end to the drum. Then route the cord around the pulleys and back to the drum (using masking tape to hold the dial cord on the pulleys until finished). Attach the free end of the cord to the small spring sticking out of the drum. Then pull on the cord to slightly stretch the spring and then secure the cord with a knot.

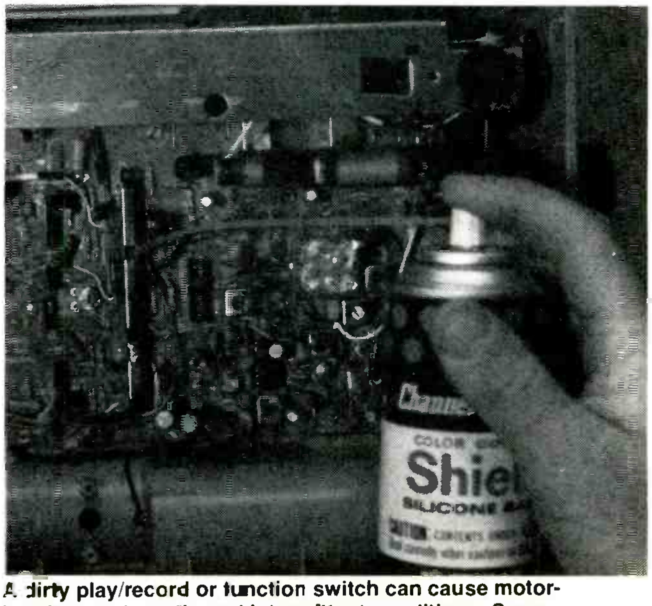


Inspect the dial (4) drum and the plastic pulleys (1, 2, 3) for broken areas. If necessary, rewind the dial-cord assembly with thin dial cord. Make sure the dial pointer is moving in the correct direction as you rotate the tuning knob.

Place a dab of glue on each end of the dial cord to prevent unraveling after you're certain that the cord is rotating in the right direction.

Erratic Operation

A loud popping noise, motorboating, intermittent, or erratic operation may be caused by a dirty function switch. A loud squealing noise may be heard when in the record or play mode of a cassette recorder if the function switch is dirty. To clean the switch, spray contact-cleaning fluid on the switch's contacts, then move the switch back and forth a few times to

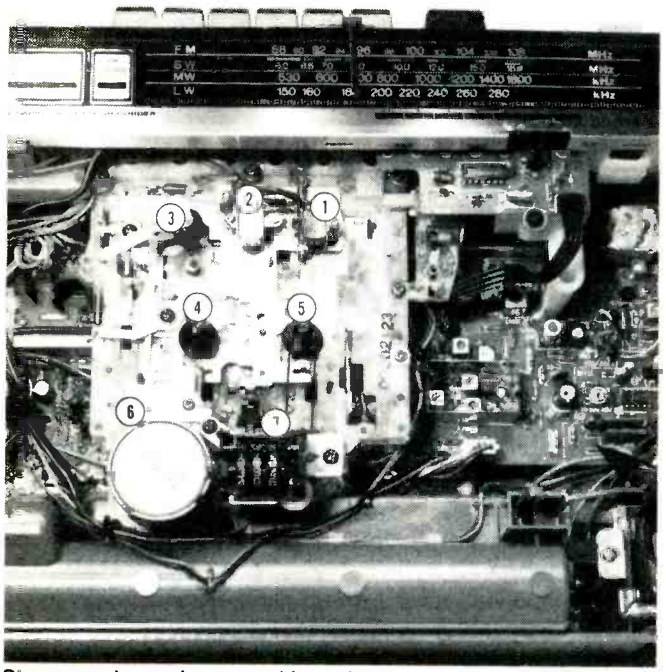


A dirty play/record or function switch can cause motorboating, and erratic and intermittent conditions. Spray contact-cleaning fluid down inside the switch area.

clean the contacts. Do the same with other dirty switch contacts, or a dirty (noisy) volume control.

Slow Speeds

Improper tape speed, or no tape movement at all, can be caused by tape that's wrapped itself around the capstan drive shaft, or an old, dry capstan pressure roller, or a defective motor. Inspect for tape wrappage around the pressure roller or its bearing. Also inspect the capstan by rotating it with your fingers. Notice if the capstan/flywheel seems to drag, indicating dry or gummed bearings. Suspect a defective motor if the capstan appears to be free.



Slow speeds can be caused by a dry or worn rubber pressure roller (3), gummed spindles and drive motor (4, 5, 6), very dirty heads (1, 2), or a dry and gummed indicator (7).

Rotate the motor pulley with the cassette player turned on. Sometimes, a "dead" motor starts, indicating that it's an intermittent motor. Measure the voltage at the motor's power supply terminals if the motor appears to be dead. No voltage indicates poor wire connections or a dirty off-on switch. If the motor proves defective, replace it with a unit having the exact same part number.

A Good Cleaning

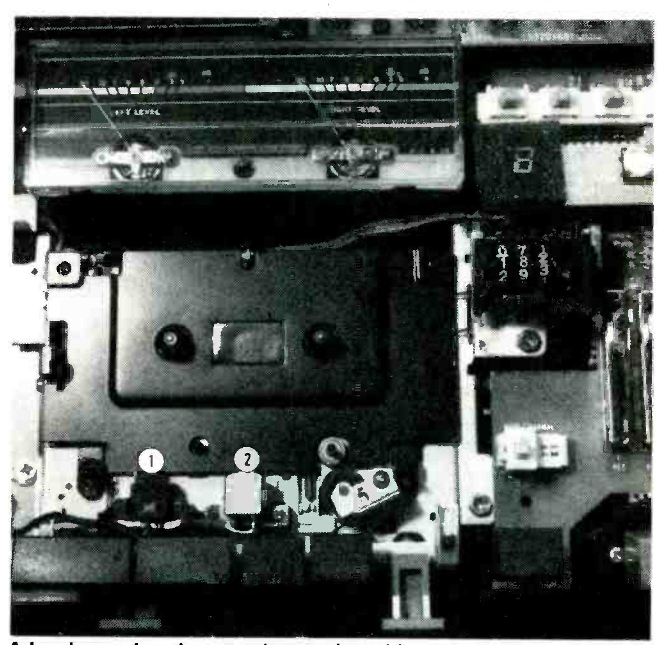
A dirty tape head may produce weak volume, or a dead or noisy channel. Use a cleaning stick or a Q-tip saturated in alcohol to clean off the record/play head, erase head, capstan, and the pressure roller. Deposited tape oxide appears brown or shiny-black in color, so remove anything that resembles those colors from the pressure roller and the tape-head surfaces. (Those parts usually can be cleaned through the front loading area.) Clean off the oxide each week if the *boom box* is operated continuously. A cassette cleaning-cartridge can also be used to help keep the tape path clean. When the plastic cover is removed to make other repairs, clean up all oxide from the chassis and mechanical areas with a cleaning stick soaked in alcohol. (A Q-tip can be substituted for the cleaning stick, because they are basically the same thing.)

A dirty tape head can cause weak sound, distortion, or a noisy stereo channel. Check the erase head for excess oxide that may prevent full erasure of a previous recording.

A Loud Rushing Noise

Suspect a broken tape-head lead, its connection, or an open tape head, when only a loud rushing noise is heard on either channel of the cassette player. Turn up the volume control and notice if sound is coming out of one channel. Clean off the tape head with alcohol; then insert a cassette and check once again.

Often, the tape-head wires will break off right at the connections. After you make the repair, make sure the tape-head cable is flexible and moves freely with the tape head.

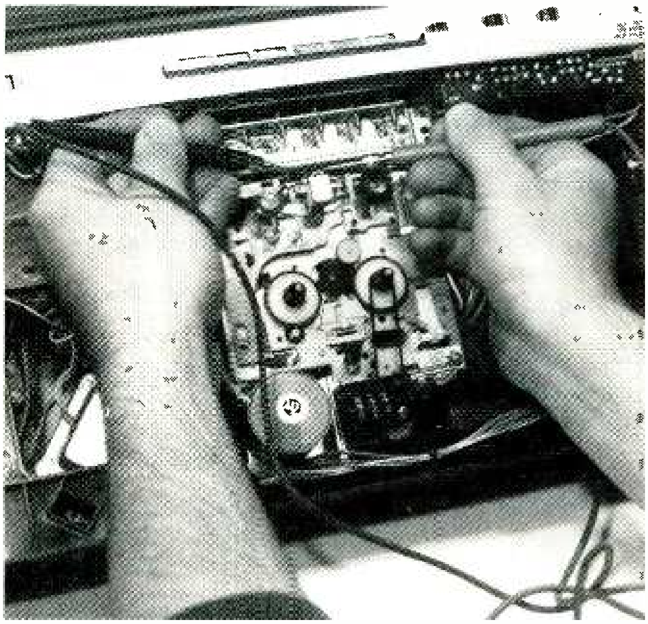


A loud, rough noise may be produced by an open tape head (1, 2) winding or wires broken loose from the tape head terminals. Turn the volume up to determine if the noise is in one or both speakers. Often, the dead or defective channel(s) is indicated by the VU meters (if so equipped).

Jumbled-sounding recordings can be caused by a defective or dirty erase head. First, remove (clean) the oxide from the erase head and then try making another recording. Suspect an open erase head or circuit if the previous recording isn't erased. Make sure that you check the wiring connections at the rear of the erase head.

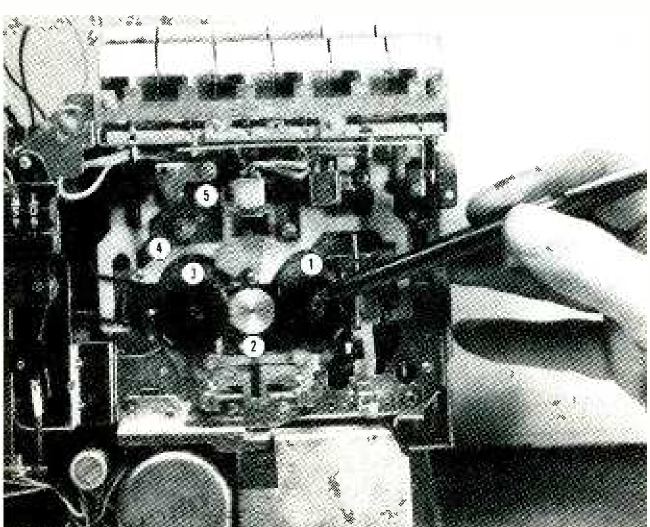
Checking The Record/Play Head

The record/play tape head can be checked with an ohmmeter's 2-kohm range. First, inspect the tape head's connections, then make a low-ohm continuity test of the tape head. Usually, a stereo tape head will have four connections for two separate windings. Compare both stereo windings. They should be quite close in resistance. An infinite resistance reading indicates an open winding. A very low or zero resistance measurement may indicate leaky or shorted turns.



Check the tape-head windings with an ohmmeter's 2-kohm range. Compare the measurements with the resistance readings of a tape head known to be in good condition.

Check the resistance between the head's *high* terminal and the chassis ground because it's possible to find leakage between the metal shell and a tape-head winding. Push or pull the tape-head terminals with the ohmmeter leads attached. Sometimes, an intermittent connection will appear to be open due to a poor internal connection. The continuity of the erase head may be tested in the same manner.



Tape pulling or spillout may be caused by a stopped or slow take-up reel or turntable. Suspect a broken belt, or a drive pulley that isn't engaging the take-up reel.

Tape Spillout

Tape drag or spillout can be caused by a dirty or worn pressure roller, an erratic or slow take-up reel, or a defective cassette. Most tape-spillout problems are caused by erratic or non-rotation of the take-up reel. While drag causes *wow* and *flutter*—or gurgles (much as if the tape were playing under water)—spillage allows the tape to come out of the cassette and spill into any of the rotating mechanisms. Whatever it gets into, at the very least, the tape outside the cassette gets damaged—permanently.

Often, erratic operation is caused by ordinary dirt that has become quite sticky over a period of time. Clean up both reel spindles or turntables with alcohol and a cleaning stick. Also, check the hub for gummed or dry bearings. To inspect the bearing area, remove the "C" washer at the top and pull the turntable off. (A *single* drop of light oil on the bearing might help.) Also notice whether the take-up reel rotates smoothly.

Other Checks

In some models, a spider ring inside the plastic turntable is rotated to a higher level to apply more pressure to the take-up reel. Rotate the spider ring for greater pressure and check the take-up adjustment. Don't forget to check the rubber pressure roller for wear, or a sticky substance that can cause tape spillout. A binding tape-counter assembly can cause tape drag (slower speed). Most important, don't assume that the cassette's shell is good because it *looks* good. A slight warp, unnoticed by a quick glance, can cause tape drag, spillout, or total lock-up.

Intermittent AM or FM

Go directly to the AM-FM selector switch when either band is erratic or intermittent. Often, a dirty AM-FM selector-switch prevents FM stations from being tuned. Locate the switch and spray contact-cleaner fluid inside the contact area. Spray into the end area of a slide-type band switch. Move the switch back and forth to work the cleaner into the contacts and to get the cleaning action going. Also, inspect the switch's terminal wires for a broken or poorly-soldered connection.

Intermittent Sound

Intermittent reception can be caused by a defective speaker, earphone jack, or amplifier section. First, check for the intermittent sound on both radio and tape operation. If the sound is intermittent on both, suspect a defective speaker or amplifier. Connect an external speaker to determine if the radio's own speaker is intermittent.

Suspect a defective earphone jack or cable when the sound is intermittent only for earphone operation. Flex the earphone cable to test for loose or broken wires. Inspect the male plug for possible poor contact or broken internal connections. Check the female jack for bent or poor wire connections. A bent, dirty, or shorting earphone jack can prevent speaker operation.

Distorted Sound

Weak and distorted sound may result from a leaky audio power-amplifier integrated circuit or the speaker. Determine if distortion is only from one speaker channel. Inspect the body of the integrated circuit for indications of overheating.

(Continued on page 105)

ECONOMY NiCd BATTERY CHARGER

Here's a convenient and safe way to charge both trickle and fast-charge NiCd batteries

By Ladislav and Peter Hala

☐ALTHOUGH THE TAPE AND RADIO WALKMAN, THE POCKET-TV, and battery-powered toys are becoming ever more popular, there is no getting around the fact that they are incredible energy consumers, and the cost of their upkeep skyrockets when you have to keep feeding them energy using common carbon-zinc or alkaline batteries. Also, the operating cost is especially high when you forget to switch them off before you fall asleep. But all these worries can be eliminated by substituting NiCd (nickel-cadmium) batteries for ordinary zinc and alkaline types.

Although the cost of NiCd's is some two to three times greater than that of the alkalines, they can be recharged up to 1000 times, thus saving you pocket-money. However, there is an additional cost one has to take into account: that of a battery charger.

Although there are a considerable number of commercially-available chargers in the marketplace, most are simply "trickle-chargers;" they charge the batteries at a very low rate of current for a very long period of time. Few, if any, have a battery-test or condition indicator, none have an adjustable rate of charge, and none of the generally-available, low-cost chargers will fast-charge one of the new breed of fast-charge NiCd cells. (While you can always trickle-charge a NiCd designed for a much higher charging rate, the reverse isn't true. Normally, you cannot safely recharge a NiCd designed for trickle-charging.)

But for less than $10 if you're a good shopper—less than $20 if you're a poor shopper—you can build the Economy NiCd Charger, which has several *pro* features not found on the usual charger you're likely to find at your local electronic or auto-aid stores.

Special Features

The most-interesting feature of the Economy NiCd Charger is visual indication of: A) normal operation (green LED); B) standby or open battery circuit (orange LED): C)

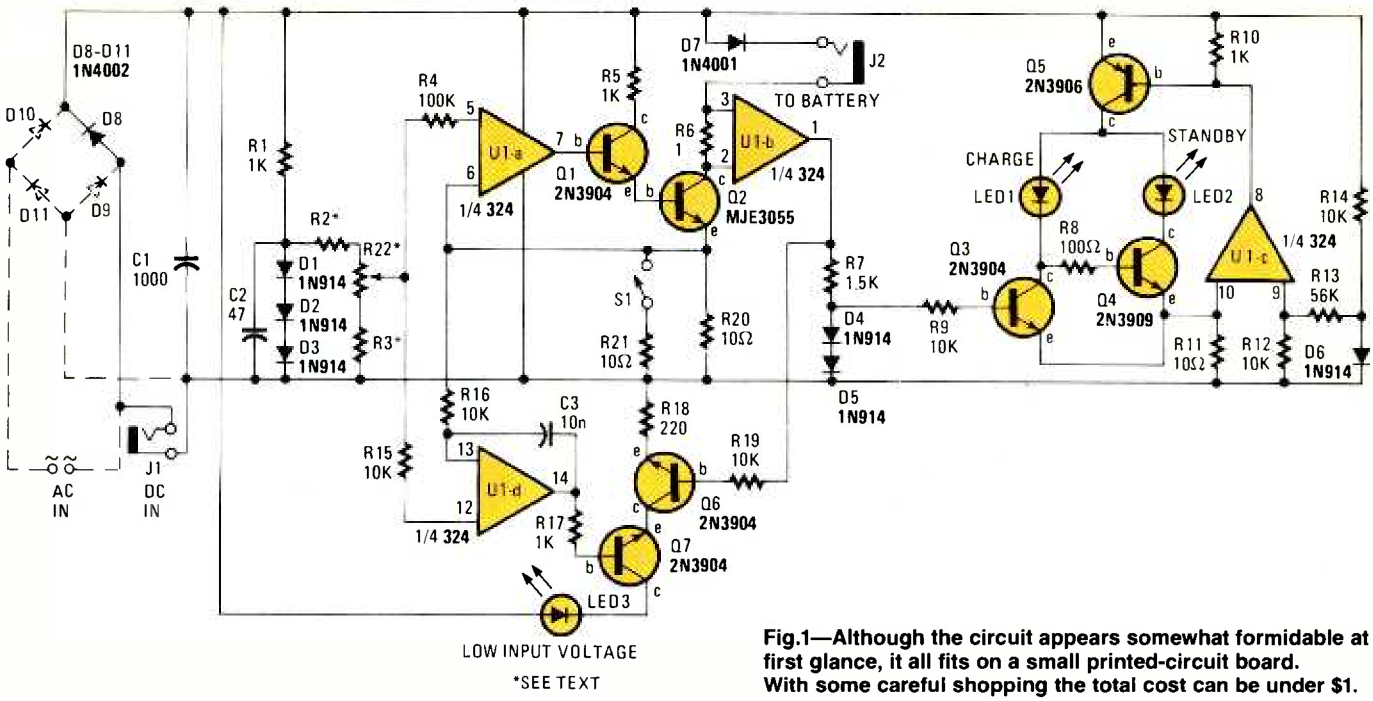


Fig.1—Although the circuit appears somewhat formidable at first glance, it all fits on a small printed-circuit board. With some careful shopping the total cost can be under $1.

low input voltage (red LED).

Unlike many home-brew NiCd charger circuits that don't feature the ability to select various charge currents, the Economy NiCd Charger can adjust its charging current continuously in two ranges: either from about 2-mA to 150-mA, or from 4-mA to 300-mA. Another feature that most chargers lack is some kind of indication of whether or not there is an open circuit between the batteries and the charger—perhaps due to a poor connection. The Economy NiCd Charger indicates that the battery is connected or disconnected.

Another big plus for the economy charger is the power efficiency of power transistor Q2) and the power supply's transformer. Good efficiency has been achieved by using a commercial AC to DC adapter switchable from 3V to 12V, and by using a low-voltage detection circuit.

A special note about the power supply is in order. The normal power source is what is called a plug-in or *wall adapter*, which consists of a small plastic case that plugs into an electric outlet. The case contains a power transformer, a rectifier, and usually some amount of capacitive filtering. Its output is a low value of DC—usually between 3 and 12 volts, or switch-selectable within that range—and the DC output connects to J1, the charger's power socket.

Since transformer-adapters are available at rock-bottom prices on the surplus market, we have also made provision for their use. The transformer-adapters consist only of a low-voltage transformer in a plastic case that plugs into an electric outlet. Since the transformer-adapter's output is AC, the rectifier and filtering must be provided within the charger. That is done through the optional components D9, D10, D11, and C1. The transformer's secondary connects to the terminals indicated in Fig. 1 by the two small sinewaves and marked "AC IN."

About the Circuit

The heart of the charger is U1, an LM324 quad op-amp. It is a relatively inexpensive integrated circuit whose inputs can be swung down to, and below, the ground, thus allowing us to compare voltages at ground potential.

Diodes D1 through D3 comprise a simple Zener diode of about 2.2V. Although the voltage varies only slightly with the input voltage, the variations are insignificant for the desired voltage stability. Since you can buy a package of fifty 1N914 diodes for under $3, the choice of using 3 diodes is cheaper than using a 2.2V Zener diode. Besides, you will need more 1N914 diodes, so buying in bulk will save you some money.

Variable resistor R22 can be any value between 10,000 and 50,000 ohms. Consequently, you will have to calculate the values for R2 and R3 to give you a regulation range from about 0.02V to 1.5V. For example:

$$R2 = (E_D - E_{MAX}) \div (E_{MAX} \div R22)$$

where E_D is the voltage drop across D1–D3, and E_{MAX} is the maximum voltage setting of R22. R2 and R3 are determined by:

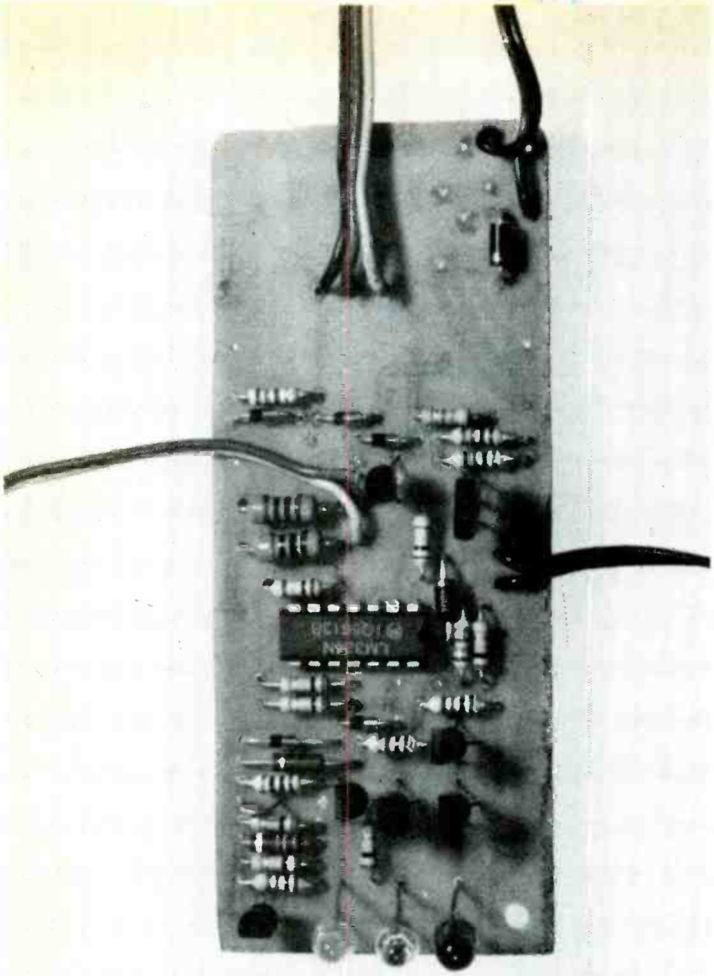
$$R2 \text{ (in ohms)} = \tfrac{7}{15}(R22),$$

$$R3 \text{ (in ohms)} = V_{R3}\text{(at the 0.02V level)} \div (R_{MAX} \div R22),$$

$$R3 \text{ (in ohms)} = \tfrac{1}{75}R22$$

(for a 10,000-ohm variable resistor this works out to be about 4700 ohms for R2 and 150 ohms for R3). The reason we use R3 is that at low charge currents the voltage drop across R6 is so small that it cannot be detected by U1b. Although the battery is charged with that low a current, the charging/no-charging detection circuit indicates open circuit. We improve the detectability simply by raising the value of R6, but by doing so the efficiency of the circuit decreases; therefore a compromise must be reached.

U1a, Q1, Q2, and associated resistors comprise a simple current source. The voltage drop detected across R20 (and R21 when S1 is closed) is compared to the preset voltage of R22. If the voltage on R20 is lower, U1a *pushes* the output towards the positive side; thus, Q1 and Q2 open more until sufficient current causes a preset voltage drop. Resistor R5 is needed to limit the base current through Q2 in case the batteries aren't connected. The quiescent base current is sufficiently small so as not to cause



The printed-circuit board layout is clean and open. Small sections of *ribbon cable* have been used to connect the external hardware such as the input and output jacks, etc.

any harm to the transistor, but it's large enough to assure good regulation. Diode D7 protects the battery(s) against discharging if the circuit is switched off while the batteries are connected.

Detection

The charging/no-charging detection circuit is comprised of U1b, Q3, Q4, LED1, LED2, D4, D5, and their associated resistors. When no battery(s) are connected there is no voltage drop across R6 and the output voltage from U1b is zero; Q3 is thus turned off and Q4 is turned on through LED1 and Q6, thereby causing the *standby* LED (yellow) to illuminate. When the batteries become connected, a small voltage drop develops across R6. The output voltage of U1b then swings to almost V+—which is then trimmed down to about 0.4 volt by D4 and D5—and is fed through R8 to Q3, causing Q3 to open and Q4 to close. Now the green *charge* LED illuminates, while the *standby* LED is switched off.

The current entering Q3 is relatively constant due to a constant voltage across D4 and D5. The constant current is especially important when we want to use a variable input voltage. If we did not have any control of Q3's base current the brightness of LED1, and therefore LED2, would change with the changing input voltage, giving us confusing results. To assure constant brightness over a large supply input-voltage range, we implemented a constant current source for the LED's comprised of U1d, Q5, D6, and their associated resistors. The circuit is very similar to the constant-current source used for charging, but here we control a PNP transistor. Since a LM324 op-amp doesn't swing its output to V+ completely, R10 is required to pull up the output of U1d so that Q5 can be closed.

Error Detection

The error circuit consists of U1c, Q6, Q7, and LED3. Whenever the preset value of R22 is larger than the maximum delivered current a voltage drop develops across U1c (and U1a as well). Then, a positive voltage of less than V+ appears at the output of U1c, which in turn opens Q7. But LED3 will illuminate only if both Q6 and Q7 are open, and Q6 will be open only when the battery(s) is in the circuit. To explain why we have to use such a complicated circuit we have to return back to the constant-current charging circuit. We mentioned that U1a opens Q1 and Q2 as much as possible whenever the the drop voltage across R20 is insufficient. That can occur in two cases: when batteries are disconnected or connected.

The first case can occur when R22 is set at a higher level than can flow through R5. Since we want to indicate low, insufficient input voltage only for the second case, Q6 must be used in the circuit.

Finally, D8 protects the whole circuit against any accidental reverse supply voltage. The diode can be left out if you use an adapter without a reverse-polarity switch. Since the diode voltage drop is between 0.7V and 1V, we are actually using 10.5 volts - 10 volts from the 12 volt input (in case diodes D7 and D8 are connected in the circuit). Therefore, if you do not worry about any damage, it would be much better to omit D8.

Now let's build the charger.

Construction

Assembly is simple and it should not take more than a long evening. All components except potentiometer R22, switch S1, and J1 and J2 are installed on a printed-circuit board, for which we provide the full-scale template shown in Fig. 2. Install the components in this order: First the resistors, then the capacitors.

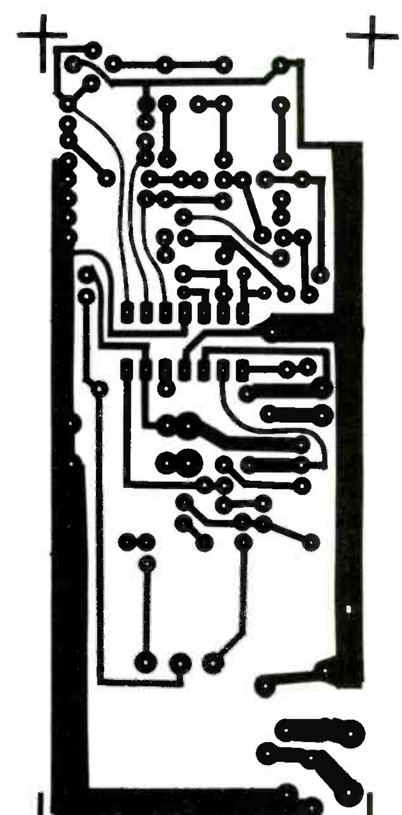


Fig. 2—This is a full-scale template for the printed-circuit board. There are a few extra holes, which are actually pre-made connections for the optional AC power source.

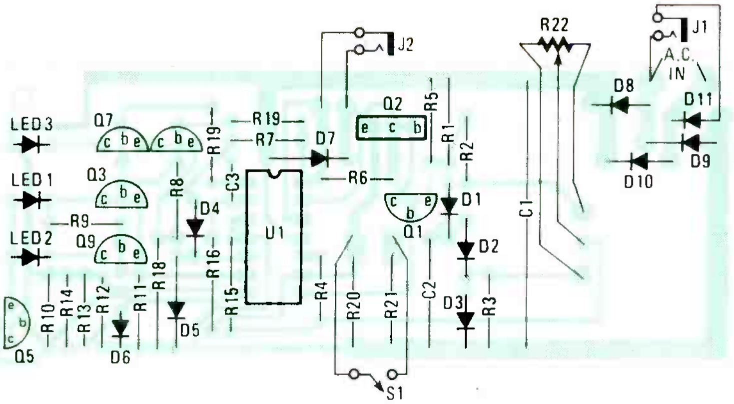


Fig. 3—When stuffing the parts on the printed circuit board, double-check that integrated-circuit U1 is positioned correctly, and that each diode is installed with the correct polarity.

PARTS LIST FOR THE ECONOMY NiCd BATTERY CHARGER

Semiconductors

D1, D2, D3, D4, D5, D6—1N914 small-signal diode
D7—1N4001 or 1N4002 silicon rectifier diode
D8, D9, D10, D11—1N4002 silicon rectifier diode
LED1—Light-emitting diode, orange or yellow
LED2—Light-emitting diode, green
LED3—Light-emitting diode, red
Q1, Q3, Q4, Q6, Q7—2N3904 transistor
Q2—MJE3055 transistor
Q5—2N3906 transistor
U1—LM324 op-amp integrated circuit

RESISTORS

(All resistors ¼-watt, 10% unless otherwise stated.)
R1, R5, R10, R17—1000-ohm
R2, R3—10,000- to 50,000-ohm, see text
R4—100,000-ohm
R6—1-ohm
R7—1500-ohm
R8—100-ohm
R9, R12, R14, R15, R16, R19—10,000-ohm
R11—10-ohm
R13—56,000-ohm
R18—22-ohm
R20, R21—10-ohm, ½-watt, 1%
R22—10,000- to 50,000-ohm linear potentiometer

CAPACITORS

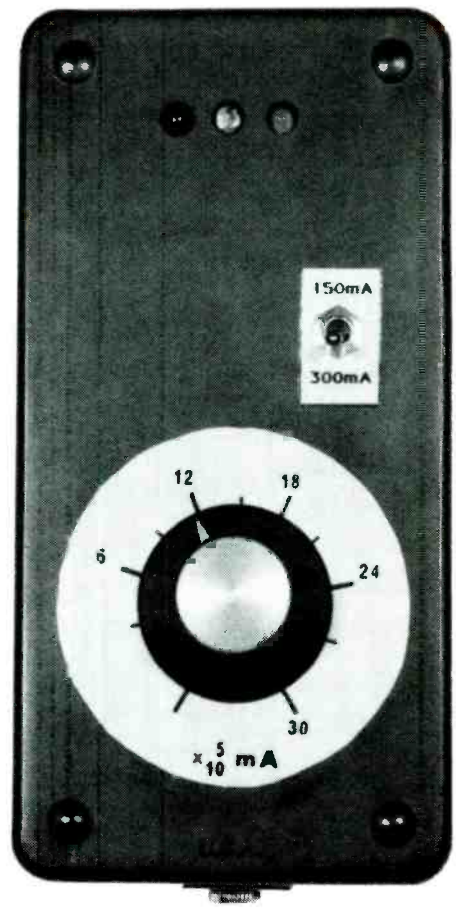
C1—1000-µF, 16-WVDC, electrolytic
C2—47-µF, 10-WVDC electrolytic
C3—10-nF (.01-µF), ceramic

ADDITIONAL PARTS AND MATERIALS

J1, J2—Miniature phone jack
S1—SPST miniature toggle switch
AC to DC adapter, switchable 3 to 12-volts, plastic cabinet, printed-circuit materials, wire, solder, etc.

(If you are using a DC adapter as the power source, you can omit C1 and C2. We have included them in the circuit diagram and have made space for them on the PC board.) If you use an AC transformer-adapter, you will have to install diodes D9, D10, and D11 along with filter capacitors C1 and C3. Capacitor C3 was intended to protect U1d against oscillations, but the capacitor proved to be unnecessary.

Next, install the diodes and the LED's. Leave the LED's leads about 1-in. long so that you can place a potentiometer above the circuitry. Finally, install the transistors and the integrated circuit.



To prevent damage caused by overcharging, both the charge rate switch (S1) and the charge rate control (R22) should be clearly labeled and calibrated. You can use the supplied template for R22 if you don't need or want more precise values. However, check the overall calibration with a dummy load and a meter.

Pay particular attention to the orientation of the semiconductors and capacitors. Although the printed-circuit board was designed for transistors in a TO-92 case, we have provided additional traces and pads for those transistors whose lead configuration is similar to that of the TO-18; this way you won't have to cross their base lead under the case.

Finally, connect J1, J2, R22, and S1.

Check the connections carefully after all components are installed. Before applying power, make sure that switch S1 is in the 150-mA position, that potentiometer R22 is set for its minimum value, and that no battery is connected to the output. Then apply about 4.5-VDC to J1. The orange LED should be lit, indicating the *standby* (power on) state. Connect a 100 ohm, 10-watt resistor in series with an ammeter to output jack J2. That should cause the green LED to illuminate, indicating *charging*, while the orange LED should be turned off. If this doesn't happen, try increasing R22's value. If the LED's switch states then the value of R3 or R6 is too small and should be increased. If turning the potentiometer doesn't help, look for an open circuit or a bad component. If a red LED turns on after you connect the resistor and ammeter, then you have to check the value of R4. By turning the potentiometer towards the maximum value you should observe an increase in the current through the resistor until no further increase is possible. At this point the red LED should be on, indicating a low input voltage for the desired charging current.

TABLE 1—LED INDICATORS

Green LED1	Orange LED2	Red LED3	Operation	Troubleshooting
●	○	○	Normal operation--Charging	
○	●	○	Standby (power on) in case batteries are not connected	Connect batteries.
			No Charging in case batteries are connected —open circuit;	Look for an open circuit between the charger and batteries.
			-input voltage is lower than the battery voltage.	Increase the input voltage.
●	○	●	Charging, but the input voltage is inadequate for the desired current.	Increase the input voltage or decrease the charge current.
●	●	●	Voltage across the output leads is the same as the battery voltage.	Increase the input voltage.

○ Indicates LED off ● Indicates LED on

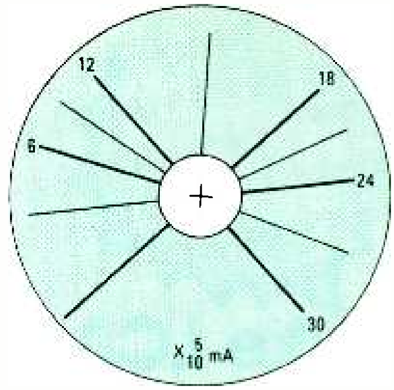


Fig. 4—Although you should determine your own calibration for various charging currents, this scale will put you well inside the ballpark if you use a linear potentiometer for resistor R22.

By increasing the input voltage the red LED should be turned off. All possible LED combinations are listed in Table 1. One curious situation occurs when all LED's are lit. In this instance the battery has the same voltage as the maximum voltage that can be found across the output leads, so the circuit cycles between charging and non-charging states, causing the LED's to switch back and forth.

Calibrating the current scale is easy and it can be done in two ways: 1) According to the ammeter connected in series with the battery(s); 2) According to the voltage readings across R20.

To help you get the calibrations inside the ballpark, a full-size calibration template for R22 is provided in Fig. 4. Either trace the template or make a photocopy.

Applications

As mentioned earlier, you can charge your batteries at a constant current of about 2 mA to 300 mA. The range can be extended beyond 300 mA by decreasing the value of R20 (and R21), and by assuring that the power supply or power transformer and transistor Q2 can handle the maximum current. Higher charge current might also make it necessary to fit Q2 with a heatsink. Also, if you do not need to go down to 2 mA and do not need sensitive adjustment of the current up to 150 mA, you can eliminate switch S1 and connect resistors R20 and R21 with a jumper.

Consult the battery manufacturers' data or *spec* sheet when recharging any NiCd battery. If data isn't provided or available, you'll most likely find the recommended charging rate is printed directly on the battery.

Table 2 provides acceptable charging guidelines for commonly-available NiCd cells; the kind you'll find at Radio Shack and at mail-order electronic parts distributors. As a rule of thumb, the charge current should be about one tenth of the total current capacity applied for about 12 to 14 hours. That value is often described as *the 14 hour charging rate*; it is usually printed directly on the battery. For example, the battery's label might be imprinted "Charge rate is 40 mA for 14 hours."

For rapid or fast-charging, you can use up to one quarter of the total charge current for about 5 to 6 hrs. However, it is not recommended that batteries intended for a 12 to 14 hour *trickle-charge* be fast-charged because it's possible for the internal pressure to exceed allowable limits and blow the safety vent. A NiCd with an open safety vent becomes a "dead," or an unrechargeable battery. If you need fast-charge batteries, get the fast-charge type: They are specially designed to vent excessive internal pressure.

TABLE 2
TYPICAL NiCd SLOW AND FAST CHARGING CURRENT

Size	Volts	Current Capacity (Amp Hour)	Normal charge	Fast charge
AAA	1.25	0.150	15	40
AA	1.25	0.45	45	115
C	1.25	1.10	110	275
D	1.25	1.10	110	275
9-volt	7.2	0.065	6.5	17

Wide Range Power Source

Although the charger is intended for use with a DC power supply rated up to 12 volts, it can also be used with the higher-voltage adapter-type supplies commonly available in the surplus market.

If the supplied voltage is insufficient for a particular battery (made up of several series-connected NiCd cells), you can install another power jack in series with J1, so two supplies can be series-connected. In this way you can regulate the input voltage from 3 to 24 volts and charge up to 12 NiCd batteries. Of course, you would have to increase the voltage rating of C1 and possibly increase the value of R1 to 2200 ohms.

Bear in mind that a "high-voltage" power source made up of two series-connected supplies doesn't charge the batteries any faster, nor—as explained earlier—should the high-voltage source be used in an attempt to fast-charge what are normally trickle-charge batteries. The only purpose for series-connected supplies is to provide more voltage than the fully-charged rating of the NiCd power pack—whether the "pack" is factory-wired or *homebrewed*.

Finally, since the charger is, in fact, a constant-current source, it can be used as such in your experiments and applications. ■

HANDS-ON REPORT

Fluke LCA-10 Line Current Test Adapter

If you already own a DMM, there's a cheap and easy way to measure how much line current is used by your appliances.

THE FIRST TIME YOU SEE THE FLUKE LCA-10 *Line Current Test Adapter*—which is list-priced at only $12—you're bound to marvel at its simplicity. The device makes the somewhat difficult and often expensive task of measuring AC line current into a notably easy operation.

The problem with making line-current measurements of appliances, machines, or anything else that works off the AC powerline, is that you've got to literally break into the wiring by opening one leg—usually the *hot* leg—so that you can insert an AC current-meter in between the powerline and the load device (appliance). And then, after you have actually opened the wiring, what size meter do you use? If you guess wrong, or if the device pulls a tremendous starting surge—even though its operating current is low—it's more than likely that you'll end up with the meter's pointer wrapped around the right-hand stop pin.

Both the break-in and overload problems are usually resolved with a special type of AC measuring device, usually called a *clamp-on* or *snap-around* meter, which literally clamps around one of the wires feeding an appliance. Such instruments determine current flow in the wire via inductive pickup; the magnetic field that surrounds the power cord causes a current to be developed in the clamp device.

However, for those times when you can't get to one wire, you can use a special adapter that connects between the AC source and the appliance's power plug. The adapter—which resembles a plastic loop—provides a way to hook the clamp meter around one feed wire. While the system works very well, it's relatively expensive, usually costing from $50 and up.

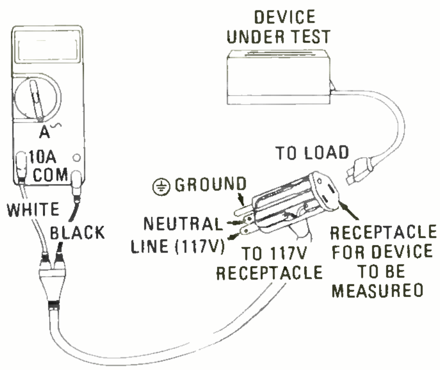


Fig. 1—The LCA-10 Line Current Test Adapter is really nothing more than a convenient way to break into the powerline's hot leg and measure current.

Converting the DMM

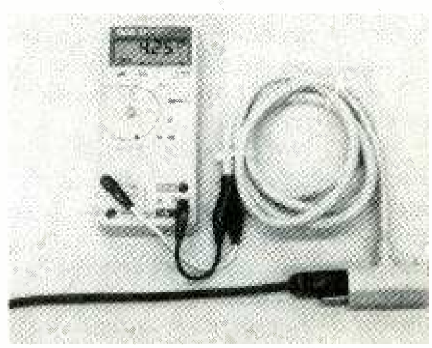
If you have one of the modern DMM's with a 10-ampere range and recessed *banana* jacks, you can make powerline current measurements with considerably less fuss and expense than by using a clamp meter. The key to it all is the Fluke LCA-10 *Line Current Test Adapter*, (see photos) which consists of a combination U-ground power plug with a piggy-backed U-ground receptacle and two hooded banana plugs (for recessed jacks).

To measure the current flow of any device, you simply connect the leads from the LCA-10 to your DMM (set it to read the 10-A range), connect the U-ground plug to a receptacle, and then connect the appliance to the piggyback socket. When the appliance is turned on, current will be indicated directly by the meter. An auto-ranging meter, like that shown in the photos, will directly display a rather broad range of values: from less than 0.4A through 20A.

As you can see from Fig. 1, the adapter actually opens the *hot* wire of the receptacle. If you carefully trace the plug connections, you'll see that the ground wire is carried through to the socket on the back of the adapter, as is the neutral wire. The hot terminal (LINE) of the plug is actually opened and an internally connected wire runs from that point to the black (COM) test jack, while the white test jack connects to the hot terminal on the piggyback

(Continued on page 101)

The adapter is simply a 5-ft. harness having a plug and receptacle on one end and hooded banana jacks on the other.



The adapter doesn't necessarily have to plug in to a wall receptacle. It can just as easily plug into an extension cord, even the 2-wire (no ground wire) type.

THE WATERBUGG ALARM

This inexpensive circuit helps prevent costly flood damage by detecting the condition before it becomes a problem.

By Dave Sweeney

□BASEMENT WATER-DAMAGE COMES AS A SURPRISE BEcause a flood makes no noise as it oozes into an area and makes the padding underneath recreation-room carpeting soggy. Usually, the water leaks from the utility room—from the hot water heater as it ages and springs tiny leaks, or the clothes washer when a sock or handkerchief blocks the drain sink. Cold weather sometimes cracks a pipe—again creating quite a mess if no one discovers that water is dripping to the floor. After a while, the water flows under walls and into adjacent rooms, where the damage can become quite expensive; and if lights or appliances are present, an electrical hazard could evolve.

Moisture Sensing

To sense the presence of wetness on the floor, you can build a compact water sensor and alarm that uses almost no battery power while it monitors the surface, and sounds a loud pulsating alert at the first sign of wetness. The 5 inch by 5 inch plastic module sounds an alarm for hours to draw attention to the wet floor. Small, and using no external wires or sensors, the alarm hides under a hot-water heater, a kitchen sink, in the bathroom, or any other place where a wetness problem might occur.

Designed for *set it and forget it* operation, the *Waterbugg* incorporates waterproof packaging (nothing more than a readily available plastic enclosure) that keeps the electronic circuit high and dry for years. In addition, the circuit draws almost no current because the only power consumption is due to the leakage through a single, reverse-biased SCR (*S*ilicon-*C*ontrolled *R*ectifier). Measured in microamps, current drain amounts to almost nothing as long as the floor remains dry. The biggest problem that you'll have to contend with is remembering to change the batteries after about two years, provided that you haven't suffered a wetness problem.

The parts for the Waterbugg will cost less than eight dollars, and you can put the circuit together in less than 90 minutes. Once built, the Waterbugg is easily tested outside the house by simply placing it on the sidewalk and tossing a glass of water toward the alarm. When the water wets the concrete under the plastic box, the alarm will sound. A reset button will stop the alarm and make it ready for the next time.

About the Circuit

Refer to Fig. 1. To sense wetness, the alarm depends on the switching action of SCR1—which conducts only in one direction and only after experiencing a positive voltage on its gate with respect to its cathode.

Once turned on, SCR1 stays on and disregards any change in the gate voltage. (Even if the leak stops, or if the flow changes direction, the alarm continues to indicate that a problem has occurred.) Switching SCR1 on, connects a piezo

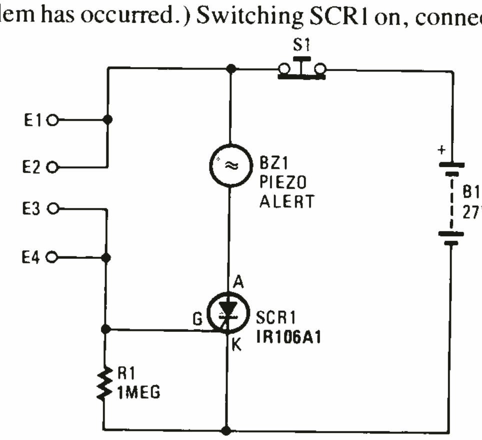


Fig. 1—The circuit, though consisting of very few components is capable of a variety of applications. For example, as it is, the circuit might be used as a continuity tester.

alert (BZ1) to three series-connected 9-volt batteries, applying 27-volts DC to BZ1. S1 (a normally closed, pushbutton switch) resets the circuit, by interrupting current through SCR1.

Once reset, the alarm stays off until another gate voltage is applied. To apply the gate voltage, the floor resistance is sensed through the electrodes E1–E4. Wetness changes the electrical resistance between a pair of metal feet from infinity (floor dry) to only a few hundred ohms (floor wet). The voltage across R1 then rises and turns on the SCR and horn.

The Waterbugg can be placed anywhere that flooding is likely to occur; under a water-heating unit or in the laundry room, etc.

Construction

Since, the alarm will sit in an out-of-the-way place for extended periods of time, for continued effectiveness, the circuit requires rust-proof electrodes and a watertight case. The first requirement is fulfilled by metal strips cut from a thin sheet of aluminum (sold at hardware stores) and used for the Waterbugg electrodes (E1–E4). Each 3-inch by ½-inch strip is folded after mounting to the plastic case (see photos). The case, impossible to tip over accidentally, rests on the four aluminum feet, which, in turn, solidly contact the floor despite irregularities.

The plastic case, readily available in supermarkets, is the type used to keep sandwiches fresh. And because it is air and moisture tight, it's just the thing for the floor environment; it

PARTS LIST FOR THE WATERBUG

B1—27-volt DC (3 9-volt transistor-radio batteries)
BZ1—Piezo alert alarm (Radio Shack 273-066)
R1—1-Megohm, ¼-watt, 5% resistor
S1—Single-pole, single-throw, normally-closed push-button switch
SCR1—IR106A1 (or similar) silicon-controlled rectifier

ADDITIONAL PARTS AND MATERIALS

Printed-circuit (or perfboard) material or barrier strip, aluminum sheeting, enclosure, epoxy, wire, solder, etc.

An ordinary plastic sandwich box—which can be found at drug and variety stores, or supermarkets—is used to house the series-connected batteries and components that make up the circuit.

also provides an easy-to-drill cabinet for the piezo alert and the reset switch.

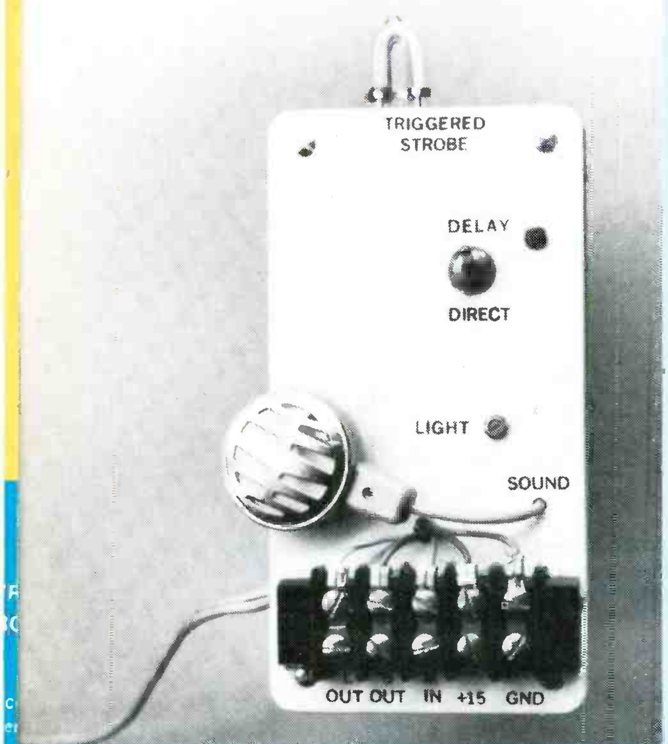
The circuit itself can be put together by using any construction method desired—on a barrier strip or perfboard, using point-to-point wiring, or on a printed-circuit board. The choice is yours. After the R1 and SCR1 connections are soldered, epoxy them to the alert, and your project is ready for testing. Simply place the unit on the ground and toss a glass of water at it. As the water saturates the ground beneath the unit, placing a short across the E1/E2 and E3/E4 terminals, the alarm should go off. If it doesn't, check the wiring of the components—probably the only way to screw up the circuit is to wire the SCR the wrong way; that is, assuming that you haven't gotten hold of a defective component.

Other Uses

The circuit has other practical uses, the most obvious being, as a continuity tester (without modification). Or try removing the Piezo alert and connecting the Waterbugg to an AC control circuit, that's attached to a water pump. In that way, when you're away from home and flooding occurs, the pump will be triggered into operation—preventing water damage. You can also connect the Waterbugg to a magnetic switch, allowing the circuit to function as a door- or window-open indicator. Or add a mercury switch and you've got yourself a tilt indicator (very similar to the *Ultimate Burglar Alarm*, which appeared in the Sept/Oct issue of **Hands-on Electronics**). As you can see, the circuits applications are limited only by your imagination. And best of all, it's cheap!

AC Power

Although the batteries will last their shelf life because no current is drawn until the alarm goes off, you might want to ensure the alarm's reliability by substituting a "117 VAC-to-24 VDC battery-eliminator" adapter for battery B1. The unloaded output from the adapter is about 27 volts, so the project will work just fine. ■



SUPER STROBE

Up in the sky; is it sound triggered!? Is it light triggered?! Is it pulse triggered?! Yes! It's Super Strobe!!

By D.E. Patrick

☐THE SUPER STROBE IS A VERY VERSATILE PROJECT. Unlike many projects based on strobes, such as in a light-operated slave mode or sound-operated mode, you're limited only by your imagination with such a multifaceted project.

For example, using a photodiode or transistor as a light sensor, the unit may be used as a slave strobe or flash. Thus, it can be triggered by a camera's flash unit and used as an auxiliary unit. Using a moving object such as a fan's blades as a shutter, it can be employed to make the blades seem to stand still. The presence, absence, or reflection of light may be used to trigger the unit.

Also, sound can be used as a trigger source. For example, the action of smashing a light bulb or popping a balloon can all be frozen in time on film.

External pulses might be used to accomplish the same end from another circuit, or even music for psychedelic effects.

Even a pulse stretching circuit is supplied to help expose different types of film!

Trigger and Supply Boards

The unit is composed of two simple circuit boards: the flashtube power and trigger board, and the flashtube control board. Both units can be operated directly from line voltage. However, an isolation transformer is strongly recommended to prevent any shock hazards.

A 117-to-150-volt transformer is shown as T1 and a 10-to-20-volt transformer is shown for T2 on the control board to be discussed later, but they can be the windings of a single transformer.

In any case, the flashtube trigger board (see Fig. 1) contains a voltage-doubler circuit composed of C1, D1, C2, and D2. The voltage doubler provides from 250 to 400 VDC to operate the flashtube. But the voltage doubler may be eliminated with a transformer having a 300-volt secondary winding. Also, we need around a 3- to 5-kV trigger pulse to fire the flashtube. That voltage is generated by R1, C3, T3, and SCR1.

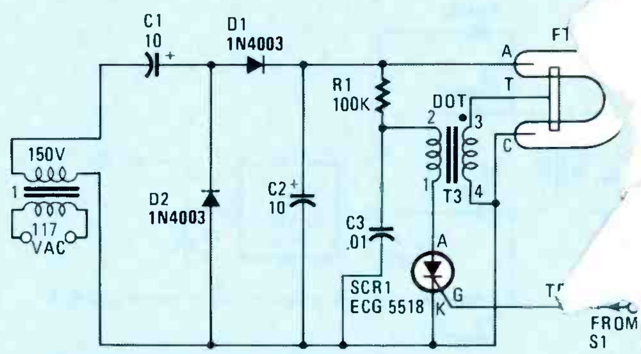
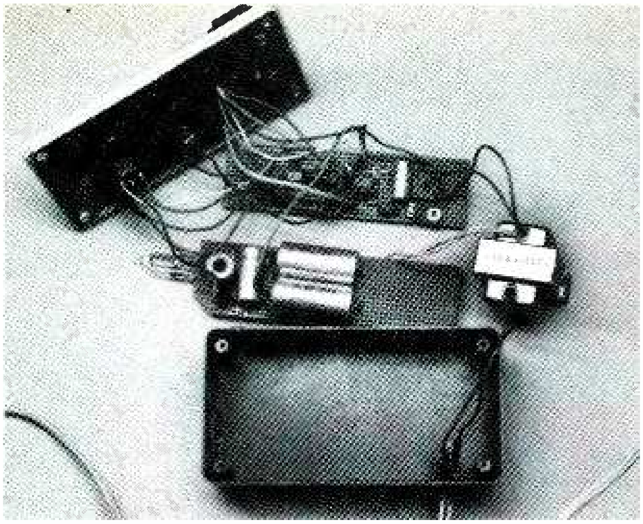


Fig. 1—The flashtube supply board is very similar to one featured in the February issue. In fact, you can use that project along with the trigger board in this article to make your Super Strobe after disconnecting the neon trigger.

When power is first applied, SCR1 is off, allowing C3 to charge up to the voltage supplied by the voltage doubler thru R2. The voltage across R2 is coupled thru T3 to SCR1's anode. When a positive pulse is applied to SCR1's gate, it will turn on, allowing C3 to discharge thru the primary of T3. Thus, the high voltage pulse or spike needed is generated across T3's secondary and applied to the trigger electrode of the flashtube.

Since the voltage doubler applies approximately 300 volts across the flashtube, when the trigger voltage reaches 3 to 5 kV, the gas inside the tube ionizes, producing its characteristic flash of white light. C3 discharges thru T3, SCR1 turns off again, and the cycle of events will repeat itself when a positive trigger pulse is applied to SCR1's gate. The max-



Notice that none of the parts are grounded to the case, and the case is plastic. Instead they share a common. That is to prevent accidental shock from the high-voltage circuit.

imum flash rate is determined mainly by the time constant of the R1-C3 combination.

Conditioning and Control Board

Power for the flashtube control board (see Fig. 2) is supplied by T2 (or a second winding of T1, if you prefer). In the prototype, a two-winding transformer yanked out of an old surplus calculator was used, with the low-voltage winding

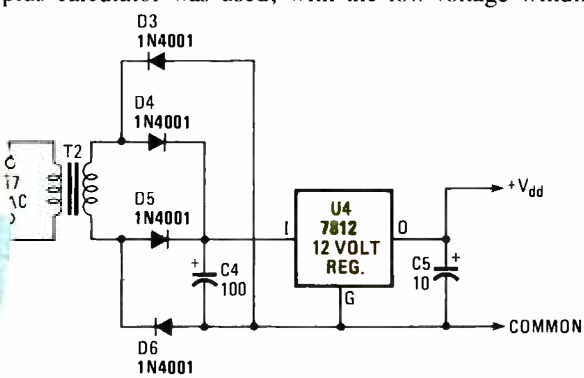


Fig. 2—The power supply for the project taken from an old fluorescent-display calculator. This provided windings for both the trigger and flashtube supply boards.

supplying 20 volts. That was rectified by a four-diode bridge rectifier (D3 thru D6), filtered by C4, and regulated by U4 (a 5-volt 7805). A 7815 or 7812 providing +15V or +12V, respectively, might also be substituted, by making changes in the conditioning circuits.

In any case, in Fig. 3 you can see that U1 (an LM311 comparator), R12, R13, R14, and R15 condition the input from D7; a photodiode for light-triggering capability. U1 compares the voltages between pins 2 and 3. When light strikes D7, its reverse-bias resistance drops and the voltage on pin 2 drops as well, which triggers the comparator. Variable resistor R12 allows you to adjust for different light conditions and diode types.

However, a phototransistor may also be used as an optional optical-pulse input if desired (see the optional configurations in Fig 4). That will make the trigger thresholds higher, and dark to light (Fig. 4A) or light to dark (Fig. 4B) triggering possible.

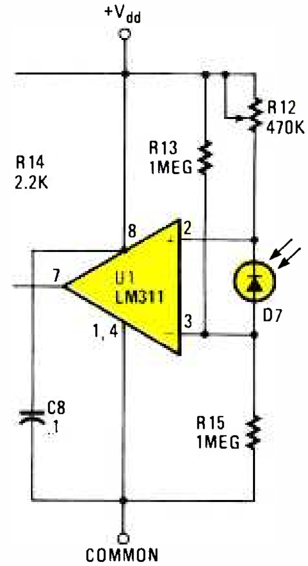


Fig. 3—The circuits adjustablity allows it to respond to whatever light conditions you chose. The LM311 is used because of its speed and low-power consumption.

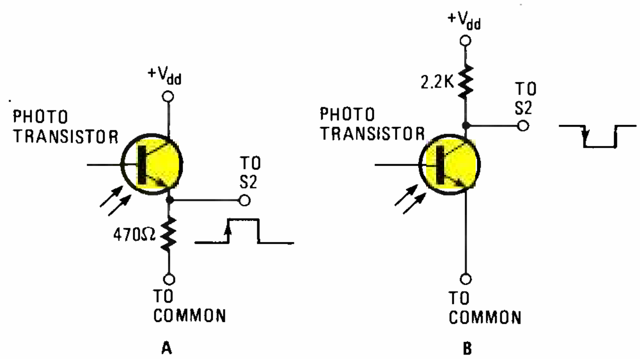


Fig. 4—Use of phototransistors in place of the photodiode comparator, permits the detection of either dark to light (4A) or light to dark (4B) transitions.

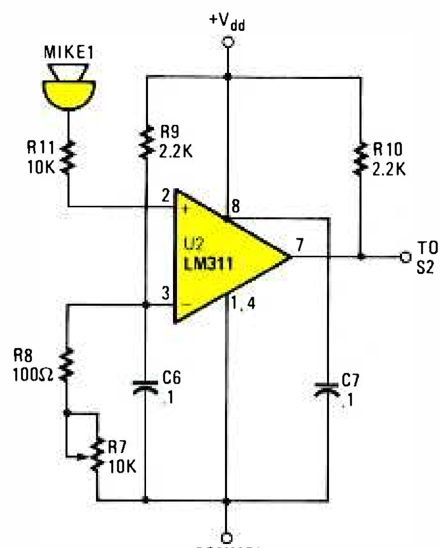


Fig. 5—The sound-activated portion of this circuit makes it excellent for capturing wild animals on film at night. If you've got an electric shutter, you can use the strobe as both the trigger circuit, and the flash unit.

In Fig. 5, U2 (another LM311 comparator), R7, R8, R9, R10, R11, and C6 condition the input from MIKE1—a crystal

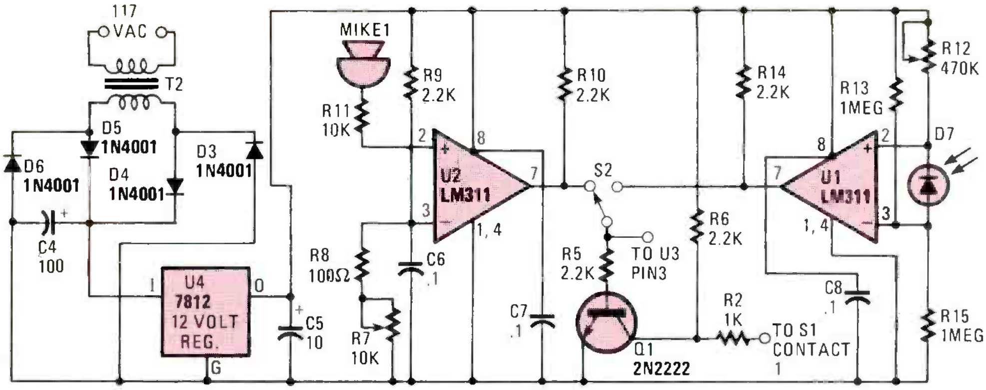


Fig. 6—If you wish to trigger the strobe on light-to-dark transitions with the diode configuration, then bypass transistor Q1 by connecting U1's output directly to the SCR gate.

PARTS LIST FOR THE SUPER STROBE

SEMICONDUCTORS

D1, D2—1N4003 rectifying diode or equivalent
D3–D6—1N4001 rectifying diodes or a 1-amp bridge.
D7—Photodiode (see text)
LED1—Light-emitting diode
Q1—2N2222 NPN switching transistor (2N2222A, 2N3904, or equivalent)
SCR1—ECG5518 Silicon-controled rectifier (Radio Shack 276-1000 or equivalent)
U1, U2—LM311 comparator or equivalent
U3—7555 CMOS timer
U4—7805 5-volt, 1-A regulator (see text)

CAPACITORS

C1, C2—10-μF, 300-WVDC, electrolytic
C3—.01-μF, 400-WVDC, disc
C4—100-μF, 100-WVDC, electrolytic
C5—10 to 47-μF, 25-WVDC, tantalum
C6, C7, C8, C9, C10—.1-μF, disc

RESISTORS

(All fixed resistors are ¼-watt, 10% units unless otherwise noted.)
R1—100,000-ohm, 1-watt
R2—1000-ohm
R3, R4—1000-ohm for 12- to 15-volt supplies, and 470-ohm for a 5-volt supply
R5, R6, R9, R10, R14—2200-ohm
R7, R11—10,000-ohm (R7 can be linear-taper potentiometer)
R8—100-ohm
R12—470,000-ohm (can be a linear-taper potentiometer)
R13, R15, R16—1-Megohm (R16 can be a linear-taper potentiometer)

ADDITIONAL PARTS AND MATERIALS

T1, T2—Power transformer, 117-VAC, 1-A primary; 150-volt and 20-volt secondary windings, which can be the windings of a single transformer (see text for more).
MIKE1—Crystal microphone
Case, line cord with molded plug, hardware, hookup wire, terminal block, perfboard, solder, etc.

microphone used for sound triggering capability. As micro voltage is produce by MIKE1 due to sound waves, it triggers U2 into action. U2 outputs a low which acts as an input pulse.

The outputs of both U1 and U2 (logic lows) must be inverted to be of any use to the SCR, which requires high-

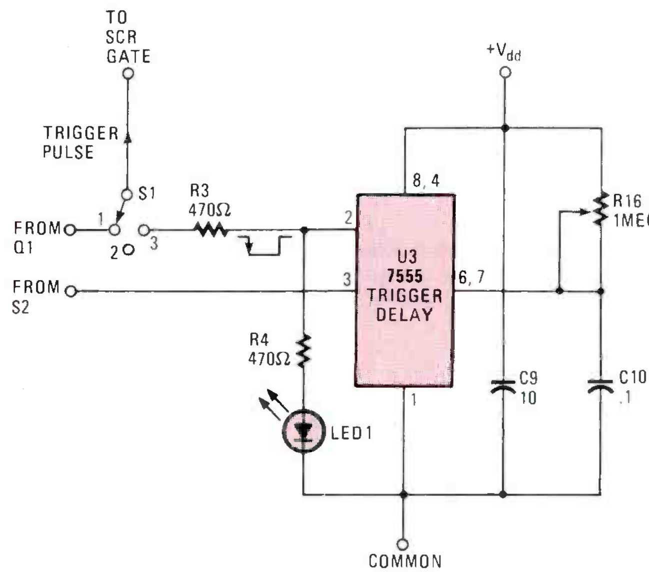


Fig. 7—The 7555 timer is operated in monostable mode, and enabled by a logic low. This allows the flash to remain on for a longer period of time in order to expose a slower film, or for special effects. Note that leaving the strobe on for too long will burn out the project.

logic trigger pulses. Thus, Q1 is used (see Fig. 6) to invert their pulses and output to the SCR.

S1 (see Fig. 7) feeds SCR1's gate with direct output from the collector of Q1, in position 1. In position 2 SCR1's gate can be triggered by anything you care to connect to contact 2 on S1. In position 3, the output of U3 (pin 3) is fed to SCR1's gate.

U3 accepts input from one of the trigger circuits (a logic low) and remains on for a time set by C10 and R16. This allows the circuit to stay on longer to expose less sensitive film, or for streaking effects.

The output of U3 simultaneously drives both LED1 and the gate of SCR1. Thus, LED1 can be used to indicate that the control section is working properly. Also, R16 is variable to permit adjustment of the time stretching, and C10's value may be increased for longer times, or lowered for shorter times.

An optional switch S2 allows the user to select between sound or light pulse triggering (see Fig. 8). But, a screw type terminal block may also be substituted, where frequent set up changes are not required. The prototype shown in the photos uses the latter configuration with a 5-position terminal block on the outside of the enclosure. There, the common, $+V_{dd}$,

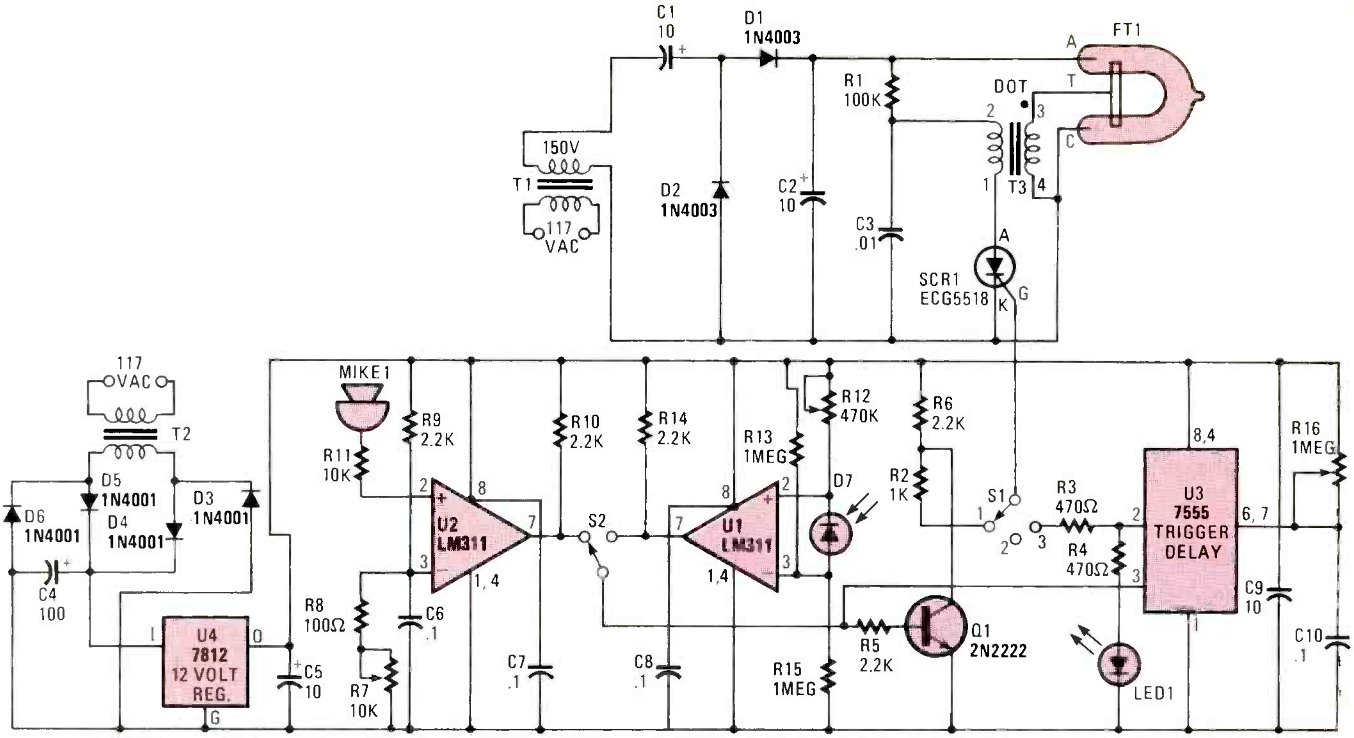


Fig. 8—Although this diagram shows the use of a switch (S1) for mode selection, in our model, we used a terminal strip. Also a double secondary transformer was used in place of the two transformers shown.

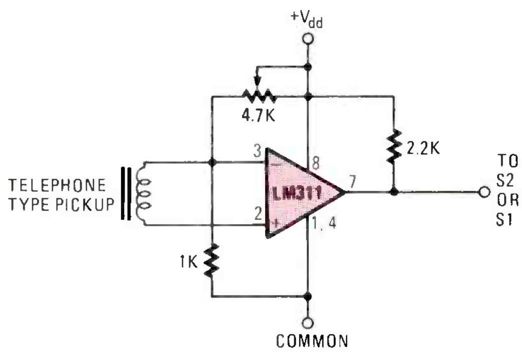


Fig. 9—The telephone pick-up sensor is useful for monitoring the action of relays. By placing the pickup next to the solenoid, when the solenoid is activated the strobe will flash. Thus, the strobe can be tripped by a solenoid or motor without messy wire connections and disconnections.

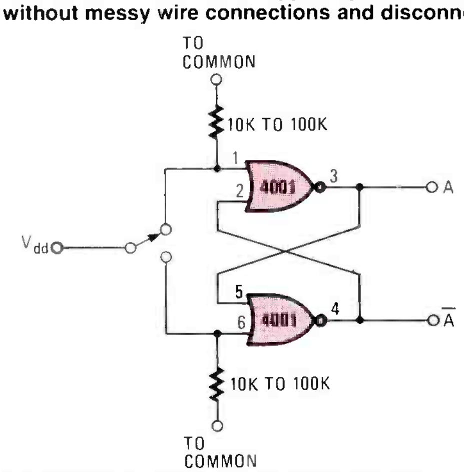
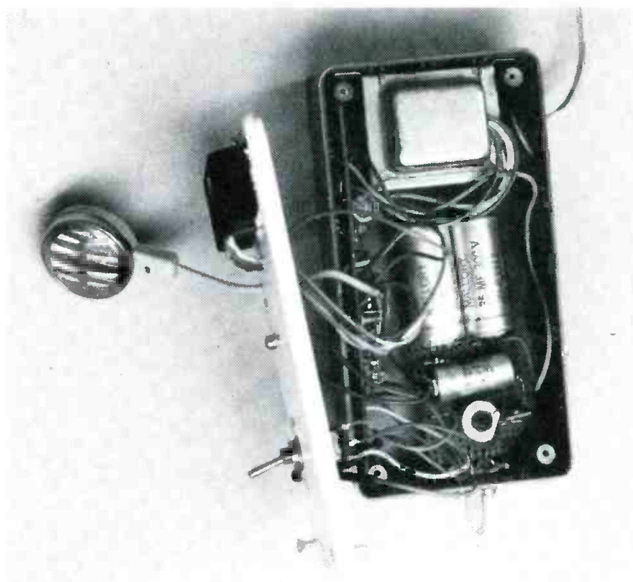


Fig. 10—A mechanical switch can be used with this debouncer to activate the strobe in either the on or off mode. This is accomplished by selecting the desired output pin (3 or 4). This is useful for burglar-alarm systems so long as the camera is well protected from theft.



All parts should fit neatly in the plastic case without any lines being shorted. All high-voltage leads should be insulted from metal parts, as a lack of insulation may lead to arcing. A good insulating material is silicon rubber.

comparator outputs, and pulse stretch input, are easy to get at and play with.

Optional Control Circuits

There are some optional control and signal-conditioning configurations, all of which can readily be built from parts in most junk boxes. Note that trigger circuits connected directly to contact 2 of S1 must be positive going, while those connected to S2 must be negative going.

Please also note that when using the pulse stretcher or external trigger, that you should *never* allow the trigger pulse

(Continued on page 104)

Electronic Fundamentals

By Louis E. Frenzel, Jr.

When capacitors and inductors team up, 2 + 2 can equal zero

WHEN AN LC CIRCUIT IS *RESONANT* STRANGE THINGS happen to the total circuit impedance. When we say a circuit is resonant we mean that the applied frequency causes both the inductive and capacitive reactance to be the same—equal. Depending on whether the circuit is what is called parallel, or series resonant, the total circuit reactance is the sum of the inductive and capacitive reactances (parallel resonance), or it is zero (series resonance). Yes, zero. In effect, what we're saying is that in a series-resonant circuit 2 + 2 can equal zero. This month we're going to take a close look at both capacitors and inductors to see how and why they function in frequency-sensitive circuits.

We're also going to look at at both LC and RF filters and see how they are used to control overall frequency response, why they can null (notch) one or a group of selected frequencies, and how and why they can pass (boost) one or more selected signals that may be a lot of theory but it flows easily.

Our lesson uses the *programmed instruction format*, whereby the information is presented to you in "chunks" called *frames*. You will read the information in each frame and then immediately answer a question based on the material by filling in a question blank(s) with appropriate words or figures. The answer to each question is given in parentheses at the beginning of the next frame in sequence.

As you progress through the lesson, use a sheet of paper to keep the frame immediately below the one you are reading covered so that you won't accidentally see the correct answer. The easiest way to do that is to slide the paper down until it just touches the line separating the frames.

We hope you enjoy learning about electronics through programmed instruction. Please write and let us know how you like it. Start now with frame 1.

Resonance and Filters

1. Capacitors and inductors are reactive components that offer opposition to the flow of alternating current. The opposition is called reactance: capacitive reactance (X_C) and inductive reactance (X_L). These two types of reactance are generated in vastly different ways. Inductors develop a magnetic field and oppose changes in current. Capacitors develop an electric field and oppose changes in voltage. X_L increases with an increase in frequency, X_C decreases with an increase in frequency. Inductors cause the current to lag the applied voltage by 90°, capacitors cause the current to lead the voltage by 90°. The unique effects of capacitors and inductors in reality actually oppose or cancel one another.

Inductive and capacitive reactances ____________ *alternating current, but in different ways.*

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2. (oppose) Inductors or capacitors can each be used with resistance to form a combined opposition called *impedance* (Z). As shown in Fig. 1, inductors and capacitors can be used together to form a combined impedance. An inductor (L), capacitor (C), and resistor (R) are all connected in series to an AC voltage source. This is called an LCR circuit. The total

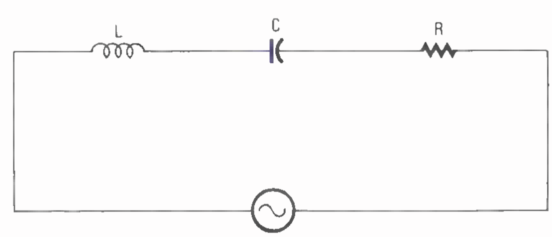

Fig. 1—A series LCR circuit must contain at the very least an inductor (L), a capacitor (C), and a resistor (R).

impedance is computed with the formula:

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

This is the same basic formula used to compute Z when either L or C alone are used with R. Note that we take the difference between the inductive and capacitive reactances to compute a total combined or *effective reactance*.

To find the total reactance in an LCR circuit, X_C *is* ____________ *from* X_L.

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3. (subtracted) For example, assume R = 10 ohms, X_L = 100 ohms, and X_C = 80 ohms. The total combined reactance is:

$$X_L - X_C = 100 - 80 = 20 \text{ ohms}$$

The total reactance is 20 ohms. The 80 ohms of X_C cancels 80 ohms of X_L. But since X_L is greater than X_C, in this case, the 20 ohms is inductive. The circuit appears to be one containing a 10 ohm resistor and an inductor whose X_L is 20 ohms. The equivalent circuit is shown in Fig. 2. The total impedance is:

$$Z = \sqrt{10^2 + 20^2} = \sqrt{100 + 400} = \sqrt{500} = 22.36 \text{ ohms}$$

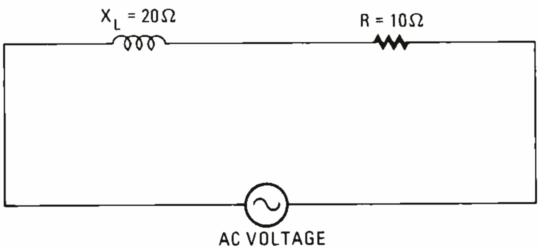

Fig. 2—If a series LCR circuit contains 10 ohms resistance, 100 ohms inductance, and 80 ohms capacitance, it will appear as a simple X_L-R circuit having an inductance value of 20 ohms, with no capacitance.

An LCR circuit has components with values of R = 15 ohms, X_C = 210 ohms, X_L = 170 ohms. The circuit appears to be ______________, and Z = ______________ ohms.

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4. (capacitive, 42.72) In this example, 170 ohms X_L cancels 170 ohms of X_C. But since X_C is greater, the total reactance is 40 ohms capacitive. Therefore, the circuit appears to consist of a 15 ohm resistor and a 40 ohm capacitive reactance. The total impedance is:

$$Z = \sqrt{15^2 + 40^2} = \sqrt{225 + 1600} = \sqrt{1825} = 42.72$$

The equivalent circuit appears in Fig. 3.

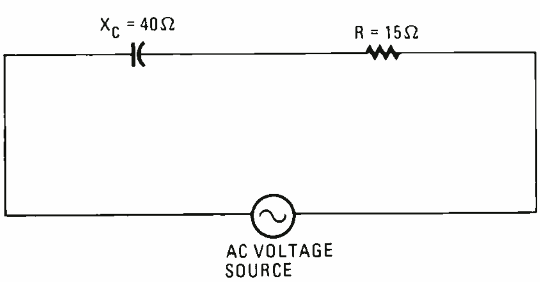

Fig. 3—If a series LCR circuit contains 15 ohms resistance, 210 ohms capacitance, and 170 ohms inductance, the circuit will appear to have 40 ohms capacitive reactance and no inductance. (Same principle as Fig. 2)

In an LCR circuit, the two types of reactances ______________ one another but the larger predominates.

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5. (cancel) To find the current in an LCR circuit, all you do is compute the total impedance, then use Ohm's law.

$$I = E/Z$$

To compute the voltage drop across each component, you again use Ohm's law:

$$E_L = I \times X_L$$

$$E_C = I \times X_C$$

$$E_R = I \times R$$

Go to frame 6.

Resonance

6. Something really special occurs when X_L exactly equals X_C. They cancel one another completely, leaving only the circuit resistance to control the current. This condition is called *resonance*.

In a LCR circuit, X_L = 30 ohms, X_C = 30 ohms, R = 7 ohms. This circuit is said to be at ______________. The total circuit impedance is ______________ ohms.

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7. (resonance, 7) As you know, both X_L and X_C vary with frequency. The graphs in Fig. 4 show this variation. X_L increases as frequency increase. X_C decreases with frequency. But for various combinations of L and C, there is one frequency where $X_L = X_C$. This is said to be the resonant frequency (f_r) of this LC circuit. If we change either L or C, the X_L or X_C changes and the resonant frequency f changes.

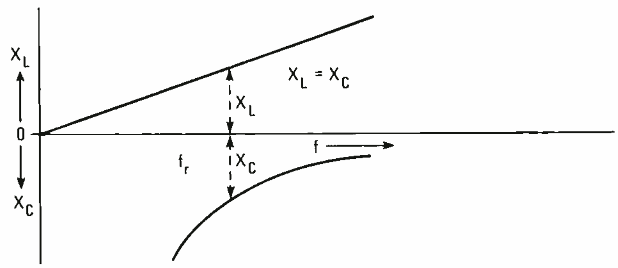

Fig. 4—X_L always equals X_C at the resonant frequency.

By varying L or C, we are tuning the LC circuit to a specific resonant frequency.

Changing L or C is called ______________ the LC circuit, which changes its ______________ frequency.

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8. (tuning, resonant) It is important to be able to compute the resonant frequency where $X_L = X_C$. We can do that by setting their two formulas equal and rearranging them by simple algebra to solve for f. The result is:

$$X_C = 1/6.28fC$$

$$X_L = 6.28fL$$

$$X_L = X_C$$

$$6.28fL = 1/6.28fC$$

Without going through the algebra,

$$f = (/6.28) / LC$$

Knowing the values of L (in henries) and C (in farads) the resonant frequency can be computed.

For example, the resonant frequency of a 2 henry inductor and a .1-μF capacitor is:

$$C = .1\text{-}\mu F \text{ or } .0000001F$$

$$f = (1/6.28) / (2 \times .0000001)$$

$$f = (1/6.28) / .0000002$$

$$f = 1/6.28(.000447)$$

$f = 1/.0028$

$f = 356\ Hz$

Now try this computation yourself. The resonant frequency of a 2.5-mH coil and a .003-µF capacitor is ____________ kHz.

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9. (58.14) Here's how the computation is made. First, convert L and C to henries and farads respectively.

$L = 2.5\text{-mH} = .0025H$

$C = .003\text{-}\mu F = .000000003$

$f = (1/62.8) / (.0025 \times .000000003)$

$f = 1/6.28 / .0000000000075$

$f = 1/6.28(.00000274)$

$f = 1/.0000172$

$f = 58139.5$ Hz, or about 58.14 kHz

You can see by the basic resonant frequency formula, the frequency is inversely proportional to the values of L and C. If L or C increase, f decreases.

If L or C decreases, the resonant frequency

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10. (increases)At resonance $X_L = X_C$ so they cancel one another, leaving only the circuit resistance to oppose the AC. At resonance, the total circuit impedance is simply the resistance, or $Z = R$. If the frequency is below resonance, then X_L decreases and X_C increases. That makes X_C greater than X_L, so the circuit acts as if it has a capacitor in it.

If the frequency is above the resonant value, X_L increases and X_C decreases. Then X_L is greater than X_C so the circuit acts as if it had an inductor in it. Off resonance, the circuit has a certain amount of reactance so the total impedance is higher. Thus, the circuit current will be lower.

The impedance of a series LCR circuit is lowest at ____________.

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11. (resonance) We can draw a graph showing the variation of circuit impedance and circuit current as frequency varies. See Fig. 5. At resonance, the impedance is lowest ($Z = R$) so the current is the highest.

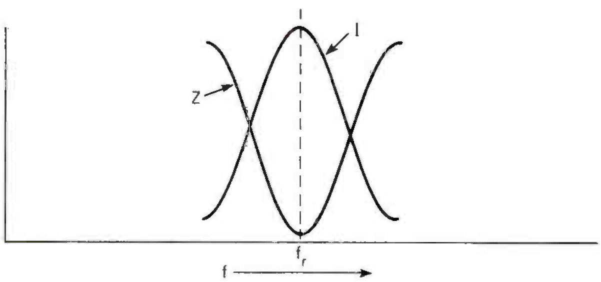

Fig. 5—In a series LCR circuit, at the resonant frequency the impedance is minimum while the current is maximum.

Let's take an example. Assume $X_L = 150$, $X_C = 150$ ohms, $R = 5$ ohms. If the applied voltage (E) is 10 volts, then the circuit current (L) is:

$I = E/Z$

$Z = R = 5$ ohms

$I = 10/5 = 2$ amperes

Knowing X_L, X_C, R and I, we can calculate the voltage drops across each component. The voltage across R is E_R:

$E_R = I \times R = 2 \times 5 = 10$ volts

The voltage across X_C is E_{XC}:

$E_{XC} = I \times X_C = 2 \times 150 = 300$ volts

The voltage across X_L is E_{XL}:

$E_{XL} = I \times X_L = 2 \times 150 = 300$ volts

The resistor voltage (E_R) is:

A. higher than
B. lower than
C. the same as

the applied voltage.

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12. (C. the same as) The applied voltage, 10 volts, all appears across the resistor. But look at the voltage drops across L and C. Both are 300 volts, 30 times the applied voltage! The voltage across L is 180° out of phase with the voltage across C so these two voltages cancel one another if you look across L and C at the same time. However, looking across L or C you actually do see the 300 volts. This is called *the resonant step-up voltage* or *the resonant rise*. The effect of resonance is to produce a voltage step-up or gain across the inductor or capacitor. The high voltage is very useful in tuned circuits.

The high voltage across L or C at resonance is called the resonant ____________ or ____________.

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13. (rise, step-up) One of the most common applications of a resonant circuit is tuning in a receiver. Tuning is the process of selecting one of many radio or TV stations. Each station transmits on a fixed frequency. By adjusting either the capacitor or inductor in the receiver's tuned circuit, a desired signal may be selected.

One type of circuit used for doing this is shown in Fig. 6. An antenna is connected to the primary of a transformer. The secondary of the transformer is also the inductor of a tuned circuit. A variable capacitor C is used to tune the circuit to a

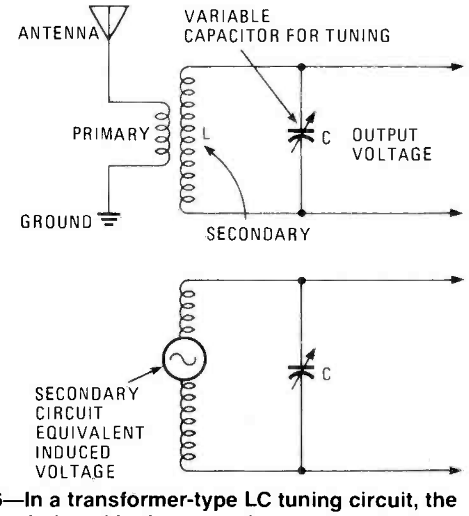

Fig. 6—In a transformer-type LC tuning circuit, the voltage induced in the secondary appears to be in series with the secondary winding and the tuning capacitor.

desired frequency. The antenna picks up signals from a wide range of frequencies, which cause current flow in the primary. The current induces a voltage into the secondary winding. The induced voltage appears in series with the inductor (secondary winding) and the capacitor. The circuit output is taken from across the capacitor.

A resonant circuit is used in a receiver to ______________ a station on a specific ______________.

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14. (select, frequency) Note that in Fig. 6 it appears as though the secondary winding—which is the inductor in the tuned circuit—and the capacitor are connected in parallel. However, since the induced voltage occurs within the coil, the circuit is, in effect, a series resonant circuit.

The induced voltage appears in ______________ with the inductor and capacitor.

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15. (series) The ability of a resonant or tuned circuit to select a signal depends upon the response of the circuit to frequency changes. You saw this earlier in the plots of impedance and current vs. frequency. Figure 7 shows how the circuit current varies with frequency changes of the applied voltage. At the resonant frequency (f_r), the current is the highest and the resonant step-up voltage appears across the capacitor. The idea is to adjust the capacitance value so the resonant frequency of the circuit corresponds to the transmitting frequency of the station to be received. At this time, peak current occurs.

The resonant rise across the capacitor occurs when the resonant frequency ______________ the station frequency.

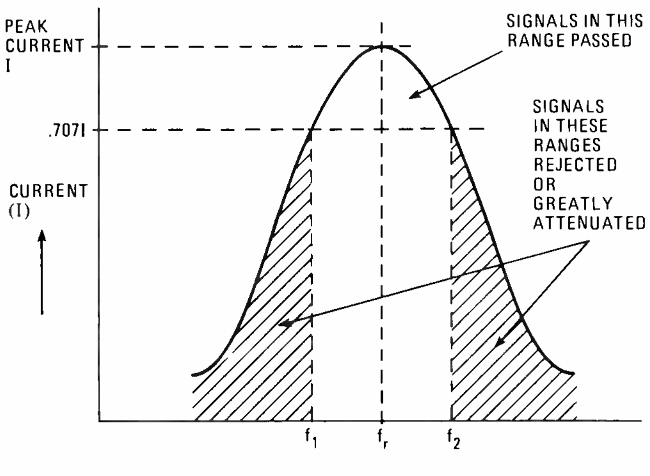

Fig. 7—The peak signal current in a series-resonant tuning circuit occurs at f_r, the resonant frequency.

16. (equals) The important thing to note in Fig. 7 is that the plot of current vs. frequency is not a single sharp spike occurring at the resonant frequency. Instead, the current is high over a range of frequencies. It drops off gradually on either side of the peak. For that reason, the tuned circuit will pass or accept frequencies close to and on either side of the resonant frequency nearly as well as a signal exactly at the resonant frequency. This range of frequencies over which a tuned circuit will accept signals is called *the passband* or *the bandwidth* of the circuit.

A tuned circuit will pass or accept signals over a ______________ of frequencies.

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17. (range or band) Tuned circuits can be designed to have a narrow or a wide passband. The width of the passband determines the selectivity of the circuit. The selectivity is the ability of a tuned circuit to pick out a desired signal and reject others closely adjacent to it. A circuit with a very narrow passband has good or high selectivity. A wide passband circuit has broad (poor) selectivity.

A circuit with a small passband has ______________ ______________.

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18. (good selectivity) The size of a passband is called *the bandwidth* and is measured in frequency. It is measured between two points on the curve that are 70.7% of the peak value. At these points, the amplitude is 3 dB down from the peak value. Specifically, the peak value of the circuit current is multiplied by .707 to obtain the upper and lower points on the curve that defines the circuit bandwidth. See Fig. 7. The .707 amplitude points define two frequencies, f1 and f2. It is assumed that any signal whose frequency is between these two points will be passed essentially unattenuated. Any frequency outside the bandwidth will be greatly attenuated or rejected by the tuned circuit.

The bandwidth is defined by those points on the selectivity curve that are ______________ of the peak value.

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19. (.707) Refer to Fig. 7. If the peak is 3, the bandwidth is defined by those points on the curve that are .707 x 3 = 2.121. The point below the center or resonant frequency (f_r is called the lower cut-off frequency (f1). The other point above the center frequency is called the upper cut-off frequency (f2). The difference between the upper and lower cut-offs is the bandwidth (BW).

$$BW = (f2 - f1)$$

Assume f_r is 1 MHz. If f1 is .950 and f2 is 1.05, the bandwidth is:

$$BW = 1.05 - .95 = .1 \text{ MHz or } 100 \text{ kHz}$$

The bandwidth of a tuned circuit with f1 = 85 kHz and f2 = 93 kHz is ______________ kHz.

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20. (8 kHz) The selectivity of a tuned circuit is determined by the Q of the circuit. The Q of the circuit is essentially the Q of the coil. Recall that the Q of an inductor is the ratio of the inductive reactance to the resistance.

$$Q = X_L/R$$

The higher the reactance and the lower the resistance, the higher the Q. The higher the Q, the better the selectivity.

The narrow bandpass is obtained with ______________ Q.

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21. (high) The lower the Q, the wider the bandwidth and the poorer the selectivity. By selecting an inductor with high inductance at the resonant frequency, and by keeping the resistance low, a high Q and a narrow passband can be obtained.

Figure 8 shows the selectivity curves for two different tuned circuits. The first (A) has an extremely narrow pass-

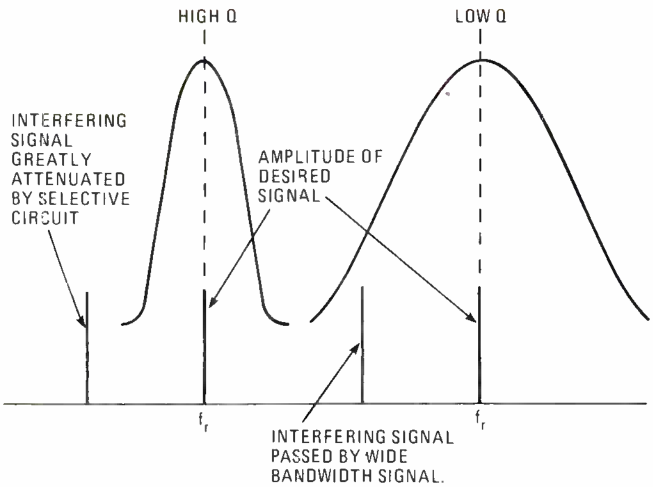

Fig. 8—Selectivity curves of tuned circuits. Curve A is high Q, narrow bandwidth; curve B is low Q, wide bandwidth.

band. Note that such a circuit can choose one signal but reject another. The second curve (B) has a broad passband. Its circuit passes two signals which will interfere with one another.

Interference can be minimized by ____________ the ____________ of a tuned circuit.

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22. (increasing, Q or selectivity) The bandwidth (BW) of a resonant circuit can be computed if the resonant frequency and Q are known.

$$BW = f_r/Q$$

If the resonant frequency is 7 MHz and the Q is 20, the bandwidth is:

$$BW = 7/20 = .35 \text{ MHz or } 350 \text{ kHz}$$

The bandwidth of a circuit with a Q of 15 and a resonant frequency of 30 kHz is ____________ Hz.

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23. (2000) So far we have only discussed series resonant circuits. A parallel resonant circuit is shown in Fig. 9. A capacitor and an inductor are connected across an AC voltage

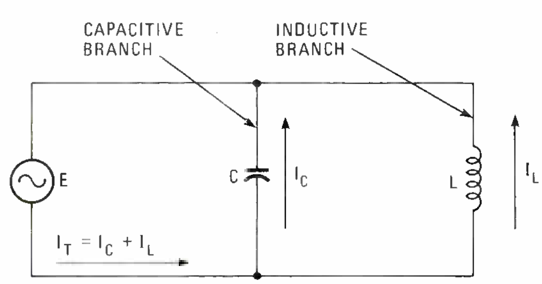

Fig. 9—In a parallel LC circuit the total current (I_T) is the sum of the capacitive and inductive currents.

source. Each draws current from the source. If the circuit is resonant, then $X_L = X_C$ at the frequency of the applied voltage.

If the reactances are equal, then the current in the capacitor (I_C) ____________ the current in the inductor I_L.

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24. (equals) While the branch currents are equal in amplitude, keep the phase relationships in mind. The current in the capacitor leads the applied voltage by 90°. The current in the inductor lags the applied voltage by 90°. Figure 10 shows the AC sinewaves of current and voltage. Note that the capacitor and inductor currents are 180° out of phase with one another.

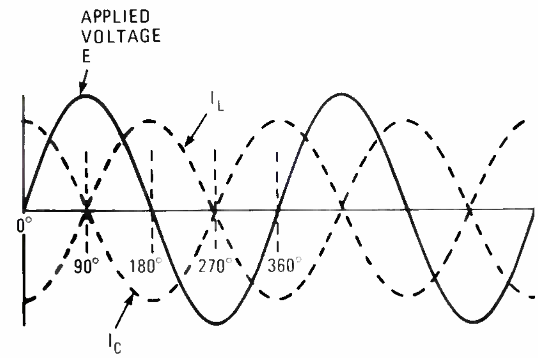

Fig. 10—In a parallel resonant circuit the capacitive current is 180° out of phase with the inductive current.

They are equal in amplitude but opposite in phase. According to Kirchhoff's law, the sum of the branch currents in a parallel circuit equals the total line current drawn from the source, or

$$I_T = I_C + I_L$$

At resonance, it appears that a parallel LC circuit draws ____________ current from the source.

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25. (no or zero) From Fig. 10, you can see that adding the equal and opposite currents results in zero. Therefore, no current is drawn from the source. The circuit at resonance appears to be an infinitely high resistance. However, this is a theoretical condition only. It would occur only if there were no resistance in the circuit. In reality, the capacitor leads have resistance and the coil which is wound with wire also has resistance. Therefore, the phase shifts are not exactly 90° each. But the resistance values are very small and for the most part the capacitive current does equal and cancel the inductive current. The result is that at resonance, the LC circuit appears to be a very high value of resistance. The small current drawn from the source is in phase with the applied voltage.

At resonance, the LC circuit looks like a ____________ value of ____________ to the applied voltage.

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26. (high, resistance) The value of the impedance of the parallel LC circuit at resonance depends upon the Q of the circuit. This, in turn, depends upon the Q of the coil. The impedance (resistance) at resonance is:

$$Z = QX_L$$

where $Q = X_L/R$ of the coil, and X_L is 6.28fL where f is the resonant frequency. Assuming a Q of 30 and X_L of 750 ohms, the impedance is:

$$Z = 30(750) = 22{,}500 \text{ ohms}$$

To the applied voltage, the circuit looks like a 22,500-ohm resistor.

To increase the impedance at resonance, the Q should be ____________.

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27. (increased) Off resonance, X_L does not equal X_C. Below the resonant frequency, X_L decreases and X_C increases. Therefore, the inductor will draw more current from the AC source than the capacitor, and the inductor dominates the circuit's operation. In fact, the circuit appears inductive because the total line current lags the applied voltage.
Above resonance, X_L increases and X_C decreases. The capacitor draws ____________ current than the inductor. Therefore, the current drawn from the source ____________ the applied voltage.

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28. (more, leads) In summary then, a parallel LC circuit appears to be a very high value of resistance at resonance. Above resonance, the circuit is capacitive. Below resonance, it is inductive.

Go to frame 29.

Filters

29. A filter is a frequency-sensitive circuit that is designed to pass some frequencies but reject others. There are various ways of interconnecting resistors and capacitors or capacitors and inductors to form circuits that will accept some frequencies but greatly attenuate others. There are literally thousands of applications for such circuits, but the main use is to retain a desired signal but eliminate interference and noise.
A filter ____________ or ____________ selected bands of frequencies.

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30. (passes, rejects) There are four basic types of filters: low pass (LP), high pass (HP), bandpass (BP), and band reject (BR). The names, of course, tell their function. Let's take a look at each.

A low-pass filter (LPF) is a circuit that passes all frequencies between DC and some upper cut-off frequency. All frequencies above the cut-off frequency are rejected. Figure 11A shows an ideal response curve of an LPF. This is a plot of the filter output's amplitude vs. frequency. In practice, a curve with such steep attenuation cannot be realized with electronic components. Figure 11B shows a practical low-pass filter response curve. Note the gradual slope as signals above the cut-off frequency are reduced in amplitude.
In an LPF, frequency below the ____________ are ____________.

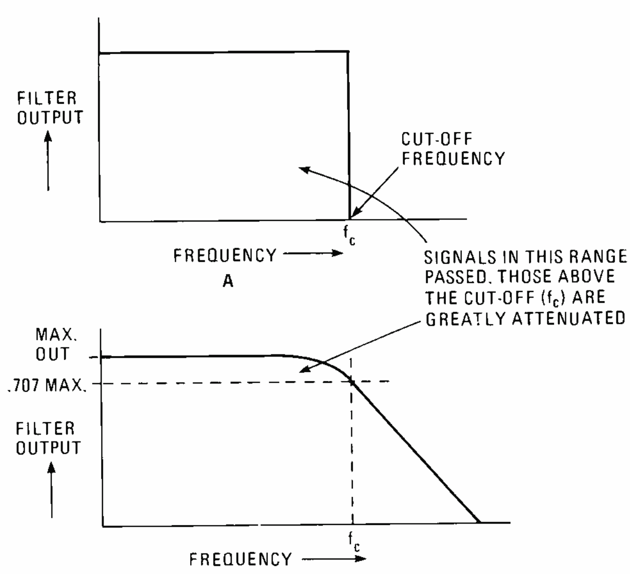

Fig. 11—Fig. 11A shows the ideal curve for a low-pass filter. Fig. B is the actual response that's possible.

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31. (cut-off, passed) Refer again to Fig. 11B. The cut-off frequency is that frequency where the filter's output signal amplitude is .707 of its maximum output at lower frequencies. This is also called the 3-dB down point. The amplitude at .707 is 3 dB less than the maximum amplitude at the lower frequencies.
The output of an LPF is 5 volts at 100 Hz. The cut-off is 200 Hz. The output at the cut-off frequency is ____________ volts.

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32. (3.535) The simplest low-pass filter can be made with a resistor and capacitor, as shown in Fig. 12A. The multi-frequency input signal is applied across the RC combination, and the output is taken from across the capacitor. If you redraw the circuit so it appears as in Fig. 12B, you will see that it is basically a frequency-sensitive voltage divider. As the input frequency changes, the reactance of the capacitor varies; therefore, the output voltage will change if the frequency changes.
A simple RC LPF is basically a ____________ ____________.

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33. (voltage divider) Refer to Fig. 12. If the frequency increases, X_C decreases. As a result, the output voltage goes down. Remember that the voltage drop across a component is directly proportional to its reactance or resistance: the higher the frequency, the lower the output voltage. At lower frequencies X_C rises, so the output voltage increases. As you can see, lower frequencies produce a greater output than higher frequencies. Of course, that is the function of a low-pass filter.

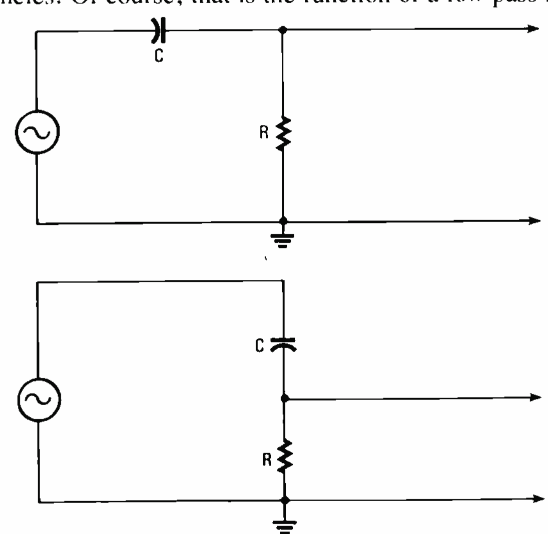

Fig. 12—If you redraw the circuit of the simple RC low-pass filter shown in A, you find it's nothing more than the simple series voltage divider that's shown in B.

Figure 13 shows a plot of the output voltage vs. frequency for a simple RC LPF. Note how the output gradually declines or "rolls off" at the higher frequencies.
The output voltage varies with frequency because the ____________ ____________ changes.

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34. (capacitive reactance) The curve in Fig. 13 shows the cut-off frequency—which is .707—or 3 dB down from the maximum output voltage at the lower frequencies. The cut-off is determined by values of R and C. The cut-off occurs at

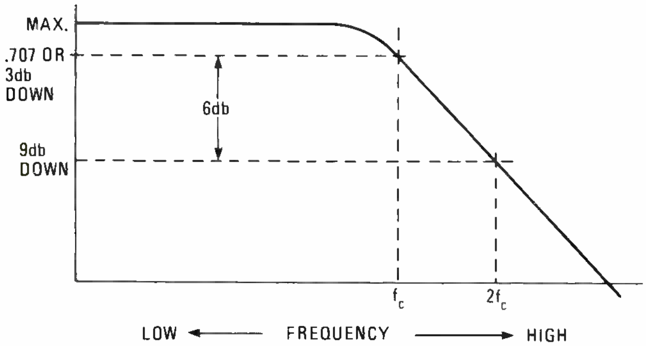

Fig. 13—The cut-off frequency for a low-pass filter is that frequency (f_r) whose voltage is "3 dB down," meaning it is .707 of the circuit's maximum output voltage.

the frequency where X_C = R. You can compute the cut-off frequency (f_C) with the simple formula:

$$f_C = 1/6.28RC$$

For example, if R = 10,000 ohms and C = .05µF, the f_{co} is:

$$f_c = 1/6.28(10{,}000)(.00000005)$$

$$f_c = 318.47 \text{ Hz}$$

The cut-off for a LPF with R = 1000 ohms and C = 100 pF is ______ MHz.

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35. (1.59) While the simple RC LPF is useful in many applications, it has two main disadvantages. First, since it is a voltage divider it greatly attenuates the input signals. As a result, amplifier stages must be used to offset the signal loss. Second, the attenuation occurs very gradually beyond the cut-off. In an RC filter, the attenuation is at the rate of 6dB per octave. An octave is a frequency ratio of 2 to 1 between two signals. For example, 800 Hz is one octave above 400 Hz while 1600 Hz is one octave above 800 Hz. If the cut-off is 800 Hz on a LPF, the output at 1600 Hz is 6dB lower than it is at the cut-off. See Fig. 13 where the output at $2f_C$ is 6dB lower than the output at f_c. For some applications, a sharper, more rapid attenuation above the cut-off is required.
The two main disadvantages of an RC filter are:

a. ______
b. ______

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36. (high attenuation, roll off too gradual) One way to increase the rate of roll above the cut-off is to cascade several RC circuits, as shown in Fig. 14. For each additional added section the rate of attenuation increases by 6dB per octave. The circuit in Fig. 14 rolls off at 18dB per octave. However,

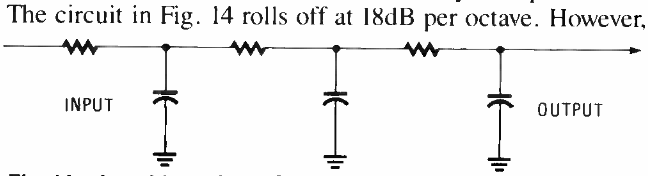


Fig. 14—A multi-section RC low-pass filter consists of several basic RC low-pass filters connected in cascade.

since each section is a voltage divider, the attenuation is extremely high, making amplification necessary. Only a maximum of three or four sections can be used in practice.
A two section RC LPF has a roll off of ______ dB per ______.

---

37. (12, octave) As shown in Fig 15, you can also make a high-pass filter (HPF) with a simple RC network. The output is taken from across the resistor, but the voltage-divider effect

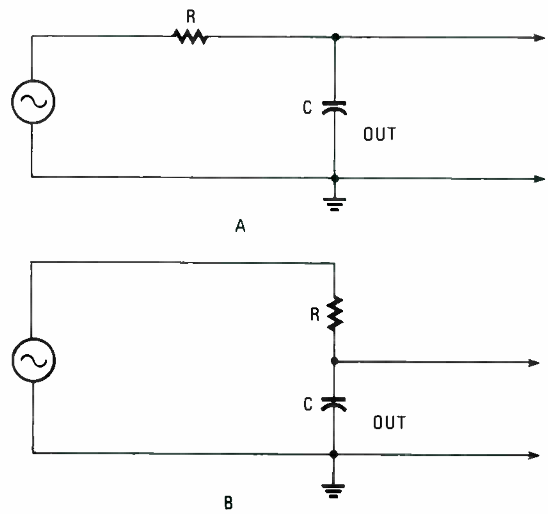


Fig. 15—The simple RC high-pass filter shown in A is simply the series voltage divider shown in B.

and the change of X_C with frequency are still responsible for the filtering effect. A high-pass filter passes frequencies above the cut-off and greatly attenuates those below the cut-off.
A HPF attenuates frequencies ______ the cut-off.

---

38. (below) Figure 16A shows the ideal response curve of a HPF. Figure 16B shows the real response of the single RC HPF in Fig. 15. At high frequencies, X_C is very low so less voltage is dropped across the capacitor; thus, more voltage appears across the output. As the input frequency decreases, X_C goes up: More voltage is dropped across the capacitor and less appears across the output resistor. The circuit passes high frequencies and attenuates the lower frequencies.
The HPF and LPF depend upon the variations of the ______ ______ with frequency for their operation.

---

39. (capacitive reactance) The formula given earlier for computing the cut-off frequency if R and C are known can also be used on HPF's. Further, the output roll-off rate is the same at 6dB per octave. High-pass RC sections may also be cascaded to achieve a sharper response curve, but as with multiple low-pass sections attenuation is very high. Figure 17 shows a three section HPF.
A faster attenuation rate with frequency can be obtained by ______ RC sections.

---

40. (cascading) It might have occurred to you that since it is the change in reactance with frequency plus the voltage

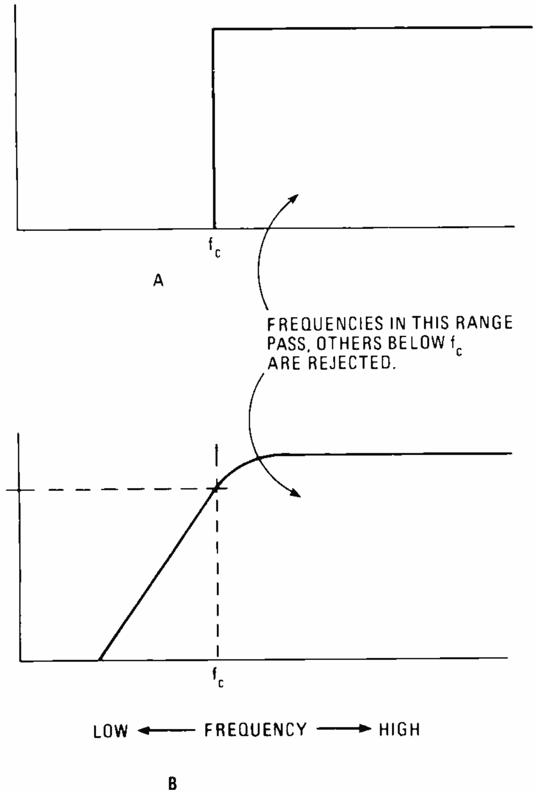


Fig. 16—The ideal response of a high-pass filter is shown in A. The practical response that's possible is shown in B.

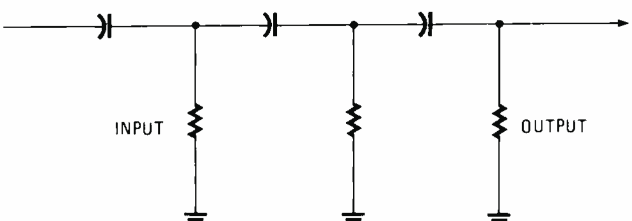


Fig. 17—A three-section RC high-pass filter is nothing more than three cascaded basic RC high-pass filters.

divider effect that makes a filter work, that an inductor could be substituted for the capacitor in these simple circuits. That, in fact, is true. Simple RL networks can do the same job as the RC networks described.

If the frequency increases, the inductive reactance will ______________.

---

41. (increases) And if the frequency goes down, X_L goes down.

Figure 18 shows simple RL filter circuits. Which is the low-pass? ______________ *Which is the high pass?* ______________

---

42. (A, B) Circuit B in Fig. 18 is a high-pass filter. At the higher frequencies, X_L is high so more voltage appears across it and less across R. As the frequency drops, X_L decreases. Therefore, less output voltage occurs across the inductor and more across the resistor.

The circuit at Fig. 18A is a low-pass filter. At the lower frequencies, X_L is low so less voltage is lost across L and more appears at the output. If the input frequency increases, X_L goes up. More voltage is lost across L so less appears across R.

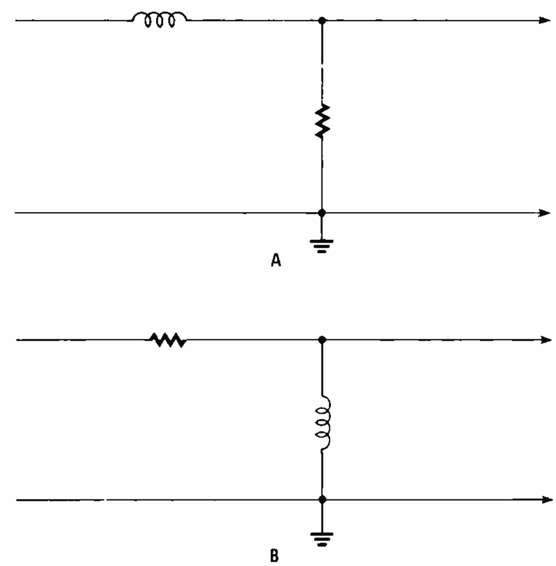


Fig. 18—Two kinds of RL circuits. In A the output is taken from across the resistor. In B the output is across the inductor. Each has a different frequency response.

Otherwise, the performance of RL and RC circuits is similar. Their response curves are identical to the RC curves given earlier.

In an RC LPF, the output is taken from across a ______________. *In an RL LPF, the output is taken from across a* ______________.

---

43. (capacitor, resistor) RL filters are not as practical and as widely used as RC filters because inductors are larger, heavier, and more expensive than capacitors. Further, because they are wire-wound, the coil has resistance—which adds extra losses.

For comparable performance it is best to use an ______________ *filter.*

---

44. (RC) One way to greatly improve the performance of low- and high-pass filters is to combine both inductors and capacitors. By eliminating the resistors, signal attenuation is less, and the combined reactance changes make for faster attenuation with frequency changes. Thus, the response curves are sharper and more selective. Figure 19 shows several different forms of LC low- and high-pass filters. Of course, these sections may be cascaded to further improve selectivity

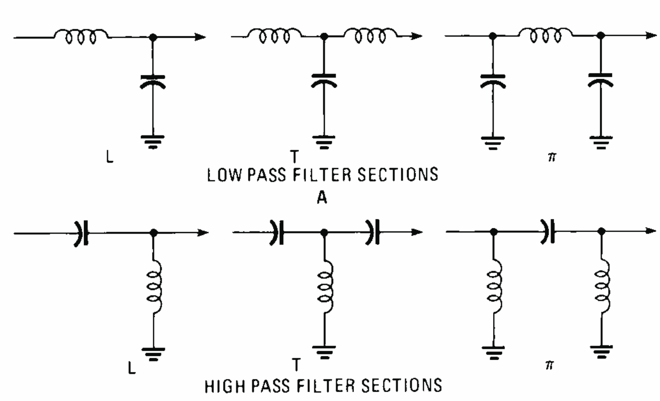


Fig. 19—The designations L, T and π (*pi*) are used to describe the physical arrangement of LC filters because the layout resembles the particular letter or symbol.

with additional attenuation.
LC filters have ____________ ____________ and ____________ ____________ than RC filters.

45. (less attenuation, better selectivity) The filter circuits in Fig. 19 are known as constant-k filters. They are widely used in electronic equipment.

Another variation of LC low- and high-pass filters is the so-called m-derived type shown in Fig. 20. Only L sections are shown to illustrate the point. In the low-pass type shown at A, a series LC section replaces the C normally found in the constant-k L section. This LC section resonates at some frequency slightly above the cut-off frequency and produces a very deep "notch" of attenuation. The response curve is shown in Fig. 21. The m-derived circuits use the effect of resonance to greatly improve selectivity. At the resonant frequency, L2-C acts as a very low resistance, therefore, most of the input voltage appears across the input inductor and little appears at the output.

m-derived filter circuits use ____________ to improve selectivity.

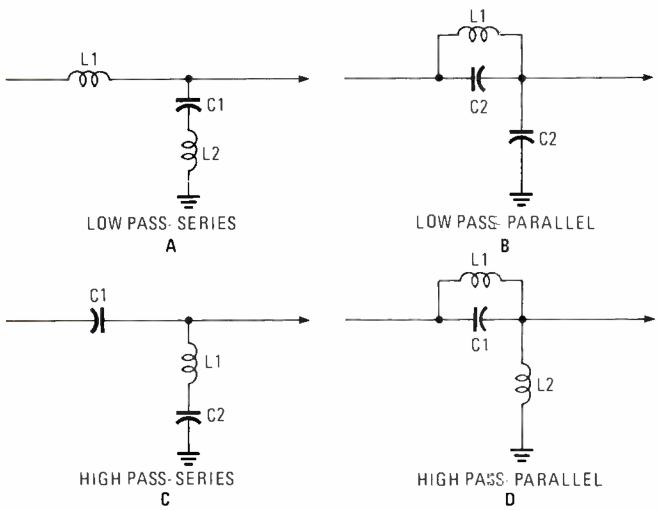


Fig. 20—m-derived low-pass and high-pass filters are available in two configurations, which can be cascaded.

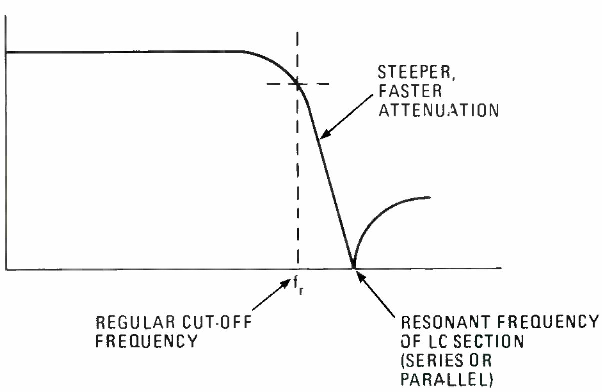


Fig. 21—m-derived LC low-pass filters have a steep (faster) attenuation compared to that of a simple filter.

46. (resonance) The same effect can be achieved with the circuit shown in Fig. 20B. Here, the input inductor of the LPF is shunted by a capacitor to produce a parallel-resonant circuit. The output is taken from across the capacitor as in a constant-k filter. L and C1 resonate at a frequency somewhat above the cut-off. At that frequency, L and C1 act as a very high resistance across which most of the input voltage is dropped. Little appears at the output. The response curve is the same as that shown in Fig. 21. The circuit in Fig. 20A is called a *series m-derived LPF* while the circuit in Fig. 20B is called *parallel or shunt m-derived LPF*.

A deep notch of attenuation occurs in an m-derived LPF slightly ____________ the cut-off frequency.

47. (above) The resonant effects of m-derived circuits can also be applied to high-pass filters, as shown in Figs. 20C and 20D. Both series and shunt versions are shown. A typical response curve is illustrated in Fig. 22. Note the deep notch of attenuation that occurs just below the cut-off frequency; it is

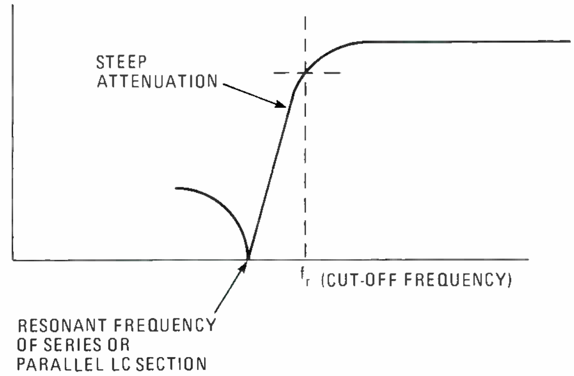


Fig. 22—An m-derived high-pass filter also has a steep (faster) attenuation than that of a simple filter.

the resonant point of the series or shunt LC section.

Filters using resonant LC sections to improve selectivity are called ____________ filters.

48. (m-derived) Now let's talk about bandpass filters (BPF): circuits that pass a certain range of frequencies but reject all those above and below that range. Figure 23 shows the ideal and practical response curves of a BPF. Note that there are two cut-off frequencies, one above and one below the peak, center, or resonant frequency. The difference between the upper and lower cut-offs is called the filter's bandwidth (BW).

$$BW = f2 - f1$$

A BPF ____________ frequencies above and below the cut-off frequencies.

49. (rejects) The curve in Fig. 23B is familiar to you because you saw it in the previous discussion of resonance. Any resonant circuit, series or parallel, is a type of BPF. Figure 24 shows two ways resonant circuits can be connected to produce the bandpass function. At A, a series resonant LC section is used. At resonance (the filters center frequency) LC acts as a very low resistance, therefore, most of the input voltage appears across the output resistor. On either side of resonance, the LC section has a higher impedance. Therefore, more input voltage is dropped across it and less appears at the output.

Now, analyze the operation of the BPF in Figure 24B and fill in the blanks below.

At resonance, the parallel LC section acts as a ____________ ____________, therefore, at the filter

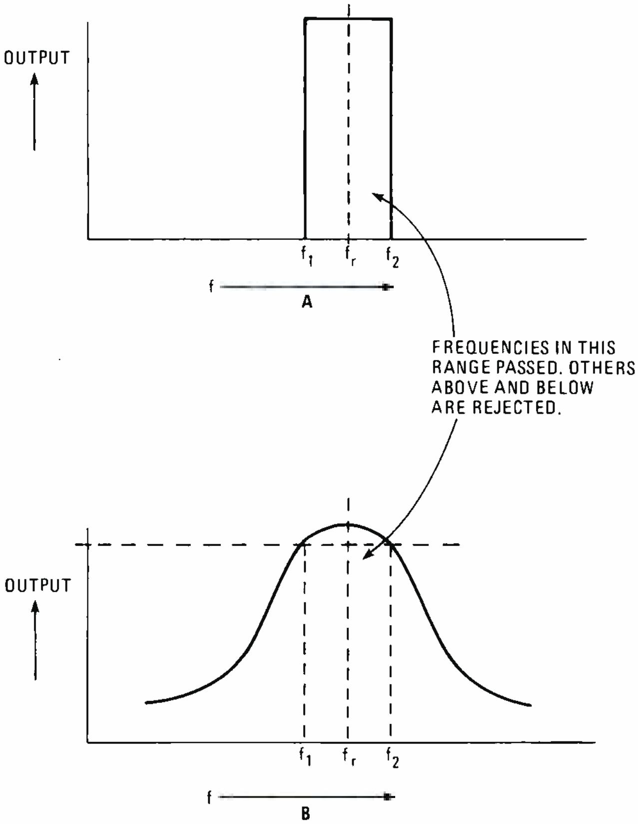


Fig. 23—The ideal response curve of a bandpass filter is shown in A. The practical response is shown in B.

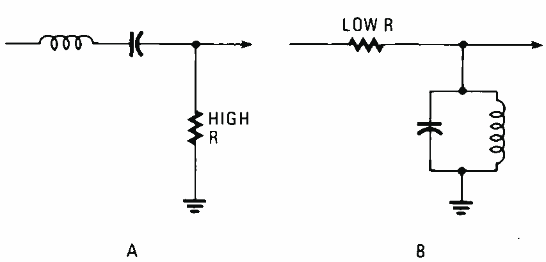


Fig. 24—These are the two simple kinds of bandpass filters.

center frequency, the output voltage is ___________.

---

50. (high resistance, greatest or maximum) Resistors are not ordinarily used in BPF circuits because of the great signal attenuation they cause. Instead, both parallel and series LC resonant sections are combined to create highly-selective bandpass filters. Figure 25 shows several popular variations. A and B are constant-k BPF's where the resonant sections, both parallel and series, resonate at the center frequency. At C and D are m-derived BPF's, whose LC sections resonate at two different frequencies, namely the upper and lower cut-off frequencies. This provides steeper attenuation rates and improved selectivity. There are many other variations of these basic circuits.

In constant-k BPF's, the LC sections are tuned to the ___________ ___________*. In m-derived BPF, the LC sections are tuned to the* ___________ ___________.

---

51. (center frequency, cut-off frequencies) The opposite of a bandpass filter is called a band-reject or band-stop filter. Its purpose is to eliminate a single frequency or narrow range of

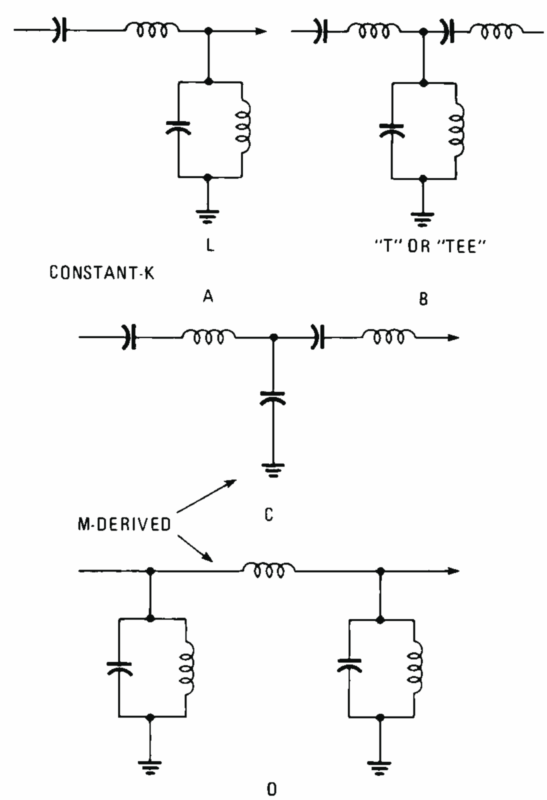


Fig. 25—The more complex bandpass filters are the constant-k and m-derived types. They provide steeper attenuation, and therefore, greater selectivity.

frequencies. It is sometimes called a notch filter because it notches out an undesired signal while passing all other frequencies above and below it. Ideal and practical band-reject filter response curves are shown in Fig. 26.

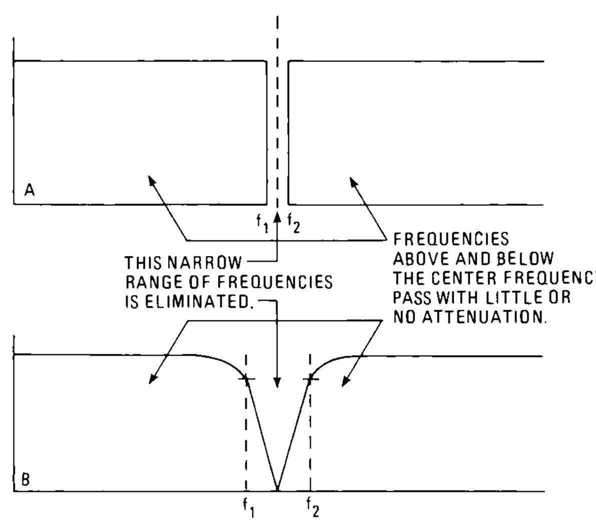


Fig. 26—The ideal band-reject (notch) filter curve is shown in A. The practical band-reject curve is shown in B.

Ideally, a notch filter would eliminate only one frequency, but in practice it's not possible to construct such a filter. However, a band-reject filter whose center frequency is the undesired one can be constructed. But those frequencies slightly above and below the center frequency will also be attenuated. The upper and lower cut-off frequencies, f2 and f1, define the band reject range. ■

By Herb Friedman

FRIEDMAN ON COMPUTERS

Even clones have their flaws

IF YOU'RE IN THE MARKET FOR AN IBM-PC/XT computer, you've most likely been astounded—if not astonished—at the broad range of prices for PC-compatibles and clones. In some instances, what appears to be *a completely IBM-compatible* computer will be advertised for less than half the price of a true IBM system. In fact, you will be faced with a seemingly endless selection of hardware, at prices a mere fraction of what IBM charges, and all the devices will claim to be either IBM-compatible, or an IBM-clone. The term *clone* implies that the computer or device is a 100% *functional copy* (not an *electrical copy*) of similar IBM equipment. (But keep in mind that one store's clone is another's *fast buck*.)

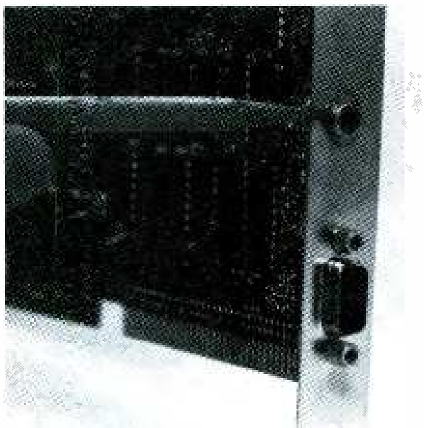
No IBM Computer

To understand why it's possible to sell a complete IBM-PC/XT clone or compatible at astounding discounts, you must bear in mind that there is no such thing as an *IBM computer*. Instead, there is a set of components that a store puts together in a package that they call a PC or PC/XT; and of the components in the package, the only item that's unique is the *system unit*: the cabinet housing, the power supply, and the motherboard into which everything else plugs in. It is the *system unit* to which the terms IBM-compatible and IBM-clone refer.

Unfortunately, there is no such thing as a true clone of the system unit because some of the firmware is proprietary, and IBM does not license anyone else to use it. In actual fact, many compatibles come very close to cloning the IBM PC, but *close* isn't good enough if the software that you need simply won't run on the clone.

Every manufacturer of compatibles and clones makes certain that their computer will run dBase II, Lotus, WordStar, and the other *biggies* of the software industry. The problem, however, is that some of the not-so-big software will only run on a true IBM-system unit, regardless of what anyone says; and the system unit must be 100% IBM—the software might not tolerate aftermarket accessories intended to *improve* what IBM hath wrought.

For example, the NEC V20 has been hailed almost universally as a speed-up substitute for the 8088 CPU used by IBM. We even covered it last month in terms of also being able to run CP/M programs on the PC. Every magazine that we've read has claimed that the V20 had full IBM compatibility. Well, it's just ain't so. At least two very fine engineering programs simply won't run on the V20.



The pencil points to the phono jack used for the composite-color output on a standard IBM graphics adapter. The D-type RGB color-monitor connector is located directly below the phono jack.

Surprisingly, the problem is not the CPU but the high-level language used for the programs. Both were written in PASCAL—in particular, one of the most popular versions of PASCAL—and that version of PASCAL can't handle the V20 under certain kinds of programming. Just imagine the time and effort that you'll waste if the programs fail to run on a computer that has successfully run the *biggie* software. Never are you going to believe the problem is in your computer. (And keep in mind that many new programs are being written in that particular version of PASCAL.)

IBM-type Programs Always Work.

The lesson in all that is that if you intend to use your IBM-type computer for popular programs, almost anything will work. But if you want to ensure that you'll be able to run some not-so-popular software, or programs that have yet to be written, then there's no choice other than a true IBM-system unit.

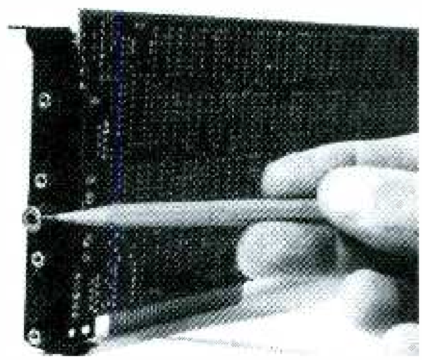
All Peripherals Work

Unlike the system unit, the cloned internal peripherals all work; some even work better than IBM's own hardware, and for a lot less cost. We have never seen a compatible disk controller, disk drive, serial and parallel ports, clocks, game ports, or mono and graphic adapters that didn't work properly.

On the other hand, we have seen a lot of "throw-in" software by peripheral manufacturers that wouldn't work with other peripheral devices; but true IBM-compatible software works with all the accessories.

The Monitor Problem

But there *is* a compatibility problem with low-cost monitors—if it can be called a problem. Many IBM-compatible and cloned computer systems are low-balled (underpriced) because they are supplied with a composite monochrome or color monitor instead of the IBM-type TTL-mono or RGB color monitor.



A composite-color output is provided even on this Paradise combination monochrome-color adapter for IBM-compatibles, which features both TTL-mono and RGB monitor outputs.

To explain: A notably good composite monochrome monitor, such as the Zenith ZVM-123, can be purchased for as little as $75; a good low-cost IBM-type TTL monitor, such as the Zenith ZVM-124, sells for $125–$150. A composite color monitor can be purchased for as little as $125. An RGB monitor is about $200–$400 depending on quality. So a store can really low-ball the price if they

(*Continued on page 102*)

By Don Jensen

JENSEN ON DX'ING

The news from across the great pond

CAN A SWEDE ACTUALLY PAY MORE IN taxes than he earns? For the answer to that and other equally provocative questions, you could listen to *Radio Sweden International*. Or you might learn about Sweden's neighbor on "Finnish Notebook," a regular program of sound sketches over *Radio Finland*.

Radio Norway International broadcasts in English less frequently—only once a week—but has some of the finest broadcasting facilities around.

Sadly, *Radio Denmark*, once one of the most popular shortwave stations on the air, has cut its English-language offerings to practically nothing. And recently, the Danes even scrapped their backup transmitter, a 38-year-old wireless relic.

But easy or not-so-easy to hear, those four shortwave broadcasters offer SWL's a true Scandinavian shortwave smorgasbord.

It's probably a toss-up as to whether the Swedish or Finnish SW operations offer the more varied and interesting programming. In some respects, they are following similar broadcasting paths.

Both, for instance, have foregone the typical world-news formats that are so common with other major shortwave outfits. Both focus on news events in their own northern corner of the globe. *Radio Sweden International* calls its offering "Nordic News," while *Radio Finland*'s is called "Northern Report."

The Stockholm station, since the 1940's, has gone out of its way to attract SWL's to its programs with a special weekly feature called "Sweden Calling DX'ers." If you want to know about new stations, new shortwave schedules, and new frequencies used by broadcasters worldwide, that is the place to tune into. The Tuesday English version of the program, whose host is transplanted American, George Wood.

There are also German-, French-, Portuguese-, Spanish-, and Russian-language versions of the SWL show, too.

This multi-language program schedule is available to SWL's by writing to Radio Sweden International, S-105 10, Stockholm, Sweden.

And if you send in your SWL information for use on the program, you can get, free, the script material from the program.

Radio Sweden International broadcasts from superpower 500-kilowatt transmitters at Horby and Karlsberg. Its daily half-hour English program can be heard at 0230 UTC on 9,695 kHz; 1400 UTC on 15,345 kHz; or 2300 UTC on 9,695 or 11,705 kHz. (The Swedish shortwave service will send its multi-language program schedule to SWL's who write to *Radio Sweden International*, S-105 10, Stockholm, Sweden.)

Radio Finland, with headquarters at Helsinki, doesn't quite match the shortwave "horsepower" of the Swedes, but it's easily heard with its 250- and 100-kilowatt transmitters. A new unit is to be inaugurated at the Pori broadcast center later this year.

Because of scheduling, mornings often are the best time to tune into *Radio Finland*.

Try 1200 UTC on 11,9435 or 15,400 kHz; or a repeat at 1300 UTC on the same frequencies. You can get another crack at the same 25-minute program on 15,400 kHz alone at 1400 UTC.

Radio Norway International's 500-, 250-, 120-, and 100-kilowatt shortwave transmitters don't have to take a backseat to anyone in broadcasting. But the Oslo shortwave has opted for just one English shortwave program each week, aired during its Sunday schedule.

The program, "Norway Today," is repeated a number of times on Sunday, and so you should be able to find a convenient time to tune it in. You can try at 1300, 1400, or 1700 UTC on 15,305 kHz; or at 1900 UTC on 11,850 kHz.

Radio Denmark is the odd-man-out in nordic broadcasting. Whereas its neighbors are expanding, it is just holding its own after having slipped backwards. Several decades ago, *Radio Denmark* was a favorite bit of listening for many English-speaking SWL's. Its weekly "Saturday Night Club" was must listening. But in more recent years, financial constraints and aging transmitting equipment, plus a governmental policy—stating that the station's mission did not go beyond reaching Danish-speaking listeners overseas—changed all that.

Now the only English you'll hear from *Radio Denmark* is in its station identifications, sign-ons and sign-offs.

And it only has a single 100-kilowatt SW transmitter, putting the station at a disadvantage in the "shout-it-louder" competition on today's shortwave bands. Its old 50-kilowatt transmitter, which was considered something of a powerhouse back when Denmark had a major SW presence, finally gave up the ghost last year, and no longer is available even for emergency use.

Still, you can hear *Radio Denmark* on 15,165 kHz at 2000 UTC. Or try one of the other frequencies: 11,845 kHz at 1200

(Continued on page 107)

*CREDITS: Ron Hopkins, Ontario; Gilbert Collins, Ontario; Robert Hill, MA; Richard D'Angelo, PA; Ontario DX Association, P. O. 161, Station A, Willowdale, Ontario M2N 5P0, Canada; North American SW Association, 45 Wildflower Road, Levittown, PA 19057.

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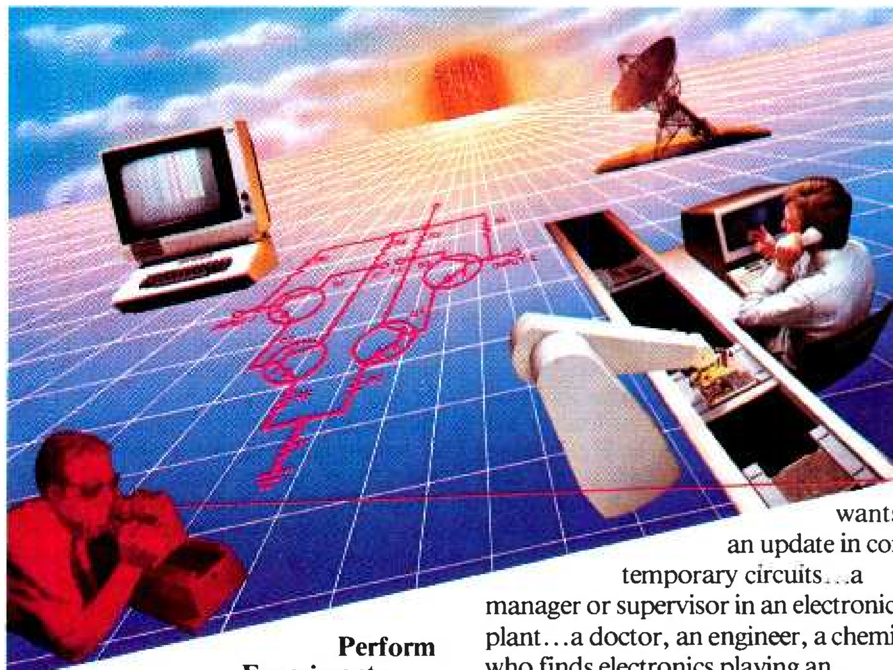

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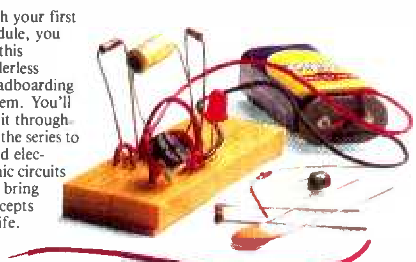

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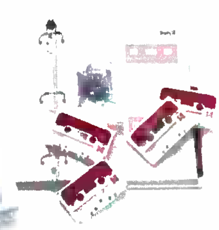

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By Joseph J. Carr, K4IPV

CARR'S HAM SHACK

Intermod signals don't really exist; at least not where you think they should be.

☐THERE ARE TWO INTERRELATED PROBlems that often mess up reception on the ham bands: intermodulation and crossmodulation. Although there are fine differences between the two, their cures are about the same, so I will take the liberty of calling both *intermod problems* (as do most hams on 2-meters). Intermod problems result in interference on a given frequency due to heterodyning (mixing) between two other (unrelated) signals.

For example, there is a hill in my home town that local hams call *Intermod Hill*. It happens to be one of the higher locations in the county, so several broadcasters and A.T.& T. have seen fit to build radio towers there. In addition, both of the two main radio towers bristle with landmobile antennas whose owners rent space on the tower in order to get better coverage.

We have, then, two 50,000-watt FM broadcast stations, a 1000-watt AM broadcast station, a many-frequency microwave relay station, and several dozen 30 MHz to 950 MHz VHF/UHF landmobile stations, as well as radio paging stations.

Nearby is a hospital that operates its own security-system radio station and a hospital pager. They also have a coronary-care unit that uses radio-telemetry to keep track of ambulatory patients. All of those signals can heterodyne together to produce apparently valid signals on other channels.

The frequencies produced are many, and roughly follow the rule: F(unwanted) = MF1 ± NF2; where M and N are integers (1,2,3 ...) and F1, F2 are the frequencies present. If the receiver system is linear there is little chance of a problem. But nonlinearities do creep in; and when the receiver is non-linear in a situation where extraneous signals are present, then intermods show up.

Many Combinations

Imagine the number of possible combinations when there are literally dozens of frequencies floating around the neighborhood!

My wife, Bonnie, is a nurse, and she works in the hospital mentioned earlier. I used to wait for her in our car, reading the mail on my 2-meter rig to pass the time. I could hear the hospital security department and the local mobile-telephone frequency clear as a bell on the 19/79 repeater frequency!

The ability (or lack of same) to reject those unwanted signals is a good measure of a receiver's performance. My first 2-meter rig was built from a kit and it was miserable. That was the radio used when I waited for Bonnie. But later, I bought a Kenwood TR-7600, and it doesn't respond to the out-of-band signals by producing intermods. Similarly, the FM radio in my Dodge Aspen is a $10 converter bought in a drug store, while the FM radio in my Chevy wagon is a genuine Delco. The Delco doesn't respond to either the out-of-band or other in-band FM broadcast signals that are present on *Intermod Hill*. The *cheapie* converter, however, is unusable within quarter mile of the place.

I suspect that the linearity or dynamic range of the input RF amplifier is the cause of the intermod in both of the above cases. There are other causes, however, and one must consider anything that can cause non-linearity. For example, a well-known car radio had problems with the AGC rectifier diode. It was leaky, and would produce a situation whereby the radio was easily overdriven by received signals.

In some sets, the manufacturer or homebrewer uses a pair of back-to-back silicon small-signal diodes across the antenna terminals in order to shunt high-voltage potentials to ground. The method was especially popular in homebrew mobile projects a few years ago. A large signal could drive the diodes into conduction ...and produce non-linearity. A ham friend of mine lived on Intermod Hill, and removed those diodes from a project adapted from a 20-year old ARRL publication.

A controversial possible cause is rusted connections. Many hams don't believe in the *rusted tower causes receiver intermod theory*, and for the most part I suspect that they are correct. But I have seen two situations that involved generation of harmonics in rusted/corroded connections. (The first was my dipole in 1959—I got a visit from the local TVI Committee. The other was a television antenna on which the owner—or a technician— had replaced the corrosion-proof antenna cable terminals with steel types.

The signals generated by a rusted screw can be received just as any other radio signal, but since the signals actually don't originate in the receiver they are not truly intermod.

Another incident caused a little consternation. A friend of mine was heard on the 31/91 repeater, so I called him. No response. I called him again, but still no response. One of the repeater-control operators—who owned multiple receivers to properly discharge his duties—came on the air and told me that Bill was on the 19/79 machine. Apparently, an intermod problem in the vicinity of that hospital shifted his signal on my receiver to the 31/91 machine.

One of the funniest intermod situations I know of (actually a related phenomena, not true intermodulation) happened to me when I worked in another hospital as a Bioelectronics Engineer. We used a telemetry unit to monitor patient ECG's in the PCCU, which is the unit that Coronary Care Unit patients go to after they are no longer acute, but still bear watching. The transmitters generated 1 to 4 milliwatts of VHF RF that was frequency modulated with the patient's electrocardiogram (ECG) signal. The signal level was so low that we needed five 17-inch whip antennas sticking down from the ceiling to cover an area that consisted of two corridors approximately 150 feet in length. Each antenna was connected directly to a 60 dB master TV-antenna amplifier. (The transmitter channels were located in the *guard bands* between the TV video and audio carriers.)

One of the whip/amplifier assemblies was right over the receiver console. One morning about 2 AM, a nurse called me at home complaining that Mr. Jones' ECG was riding in on Mr. Smith's channel. Not quite believing her, I nonetheless went to the hospital and checked the situation out. Swapping receivers, telemetry transmitters, and amplifiers did no good. Finally, after two hours of trying (and almost to the point of looking silly to nurses who don't easily tolerate the failures of others when it comes to their equipment), I noticed that the FM broadcast receiver was sitting on top of the telemetry receiver cabinet less than 18-inches from the antenna/amplifier, and it was playing. On a sheer hunch, I turned off the receiver and Mr. Jones went back to his channel. Previously, his signal was showing up on both his own channel and Mr. Smith's channel, but it was now only where it belonged. Turning the FM receiver back on caused the situation to return. Also, tuning the radio to another channel made the problem go away.

What happened in that situation? The local oscillator in the FM broadcast receiver was heterodyning with Mr. Jones' signal to produce an intermod signal on Mr. Smith's channel. That night we banned FM radio receivers, patient-owned TV receivers, CB rigs, and ham rigs in the CCU/PCCU area for exactly the same reason they are banned on commercial airliners: interference with the electronic equipment.

Of course, the nurses complained, but not too loudly. They were, after all, interested in the well-being of their patients.

Some Solutions

There are a number of ways to overcome all or part of your intermod problems. Modification of the receiver is possible, especially since poor design is a basic cause of intermod. But that approach is rarely feasible except for the most technically intrepid. There are, however, a few pointers for the rest of us.

First, make sure that the receiver is well-shielded. Poor shielding rarely shows up on costly, modern rigs, but is a strong possibility on lower-cost receivers and on homebrew equipment. Most transceivers have adequate shielding because of the requirements of the transmitter in the same cabinet with the receiver. But if there are any holes in the shielding, then cover them up with sheet metal or copper foil (available in hobby shops). For others, the best approach is to use one of the methods shown in Figs. 1 through 3. In all cases, you must identify one of the interfering frequencies, or (in some cases) at least the band.

It might also be the case that the interfering signal is entering the rig on the powerline, a situation especially likely if you live very close to a high-power broadcasting station. If there is space in the rig, then it might pay to install an AC line filter. Radio Shack and others sell EMI line filters suitable for ham rigs up to 200-watts or so (look at the ampere rating of the filter). Also, it is possible to install ferrite blocks on the line cord to serve as RF chokes. It is sometimes possible to reduce the EMI pickup by either reducing the cord length, or rolling it up into a tight coil. That solution works well where the cord is a quarter-wavelength on the interfering signal's frequency.

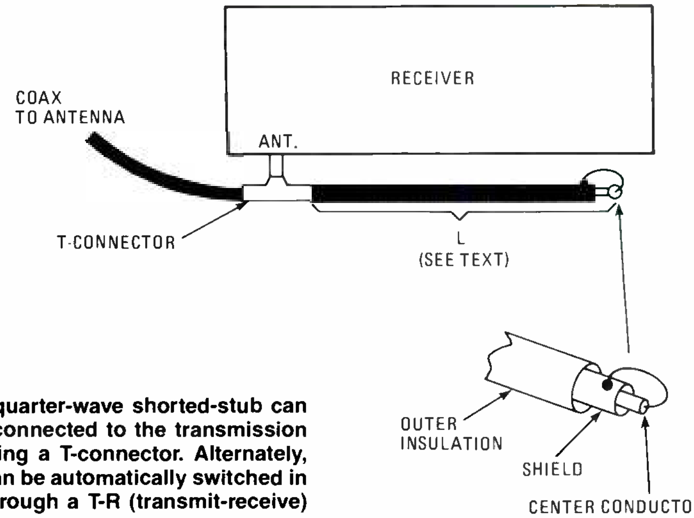

Fig. 1—A quarter-wave shorted-stub can be easily connected to the transmission line by using a T-connector. Alternately, the stub can be automatically switched in and out through a T-R (transmit-receive) relay

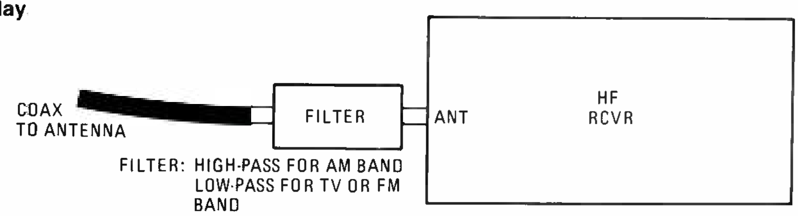

Fig. 2—Undesired signals from AM and FM stations which get into the receiver can be attenuated, if not eliminated by using a high- or low-pass filter.

Half-Wave Shorting Stub

A non-matching load impedance attached to the business end of a transmission line repeats itself every half-wavelength back down the line towards the input end. For example, if a 250 ohm antenna is attached to the load end of a half-wavelength piece of 50-ohm coax, an impedance meter at the input end will measure 250-ohms. Lengths other than integer multiples of a half-wavelength will "see" different impedances at the input end. The phenomena is the basis for transmission-line transformers used for antenna matching. Therefore, if we short the end of a piece of coax (see Fig. 1), the input end will "see" a short-circuit at the frequency for which the coax is a half-wavelength. The interfering frequency will be shorted to ground, while the desired frequency sees a high impedance—provided that the two frequencies are widely separated. The length L is found from:

$$L = 492V/F$$

where L is in feet, F is in MHz and V is the velocity factor of the coax (usually 0.66 for regular coax and 0.80 for polyfoam).

The method shown in Fig. 1 is best suited to cases where the interfering signal is in the VHF region. Because the length of the coax stub is very short relative to the HF wavelength of the desired band, some very untransmission-line-like behavior might take place when transmitting. Therefore, for transceivers I recommend adding a second antenna jack, especially for the stub, but connected to the receiver circuitry.

Another method (Fig. 2) is to use a frequency-selective filter. The type of filter to use and the cut-off frequency is determined by the problem. In a maze of frequencies like *Intermod Hill*, it might be wise to use a bandpass filter on the band of choice. Otherwise, use a low-pass filter if the interfering signal (at least one of them) is higher than the desired band, and a high-pass filter if the interfering signal is lower. For most hams, a low-pass TVI filter is desirable on HF, so the solution is automatically taken care of because the 35-45 MHz cut-off point of most such filters will attenuate most VHF signals trying to get back in.

Different Strokes

Figure 3 shows some of the different types of filter configurations that might be used. The first wavetrap (Fig. 3A) is a parallel-resonant circuit in series with the signal line. A parallel-resonant trap has a high impedance at the resonant frequency, but a low impedance on other frequencies, so it blocks the undesired frequency. Figure 3B shows a series-resonant trap across the signal line. The series-resonant circuit is just the opposite of the parallel case: It offers a low impedance at its resonant frequency, and a high impedance

continued on page 105

By Charles D. Rakes

Circuit Circus

Yesterday's concepts have value in today's electronics

Something old, something new what can circuit number 1 do for you? That's a question you can only answer after reading the following details about this unusual motor-speed control circuit. About 100 years ago, the single-cylinder gas engine began it's march through history as a revolutionary source of power that helped to boost our nation into the *high-tech* world of today.

Basically, all gas engines of that time period, and for many years to follow, ran on one of the two following principles of operation. The smoothest method of operation is when the fuel mixture is fed into the combustion chamber in a linear manner. That type is referred to as a *throttle-governor engine*. The throttle-governor engine received a power boost for every complete cycle of operation. Such an engine can be compared to an electronic circuit, operating in a linear fashion.

In the second, and most unusual method—referred to as a *hit-N-miss engine*—the engine's speed is controlled by simply turning on and off the fuel supply as the rpm's vary between high and low set limits. The engine receives a power boost only when the speed drops below a set limit. Under no-load or light-load conditions, it will coast, using no fuel until another boost is needed. The operation of the hit-N-miss gas engine can be compared to an electronic circuit operating in a digital manner.

A correlation between the operation of a gas engine of yesteryear and today's modern AC induction-type motors can be demonstrated by using the hit-N-miss, speed-control circuit in Fig. 1. The 555 timer (U1) operating as a very-low frequency oscillator (having a rate of less than 1 Hz) supplies drive current to the LED in the optocoupler, U2. The on-time drive current feeding U2 is controlled by R6 and can be set between a low of 10% up to a maximum of 50% on-time. A small 6- to 9-volt DC, wall plug-in supply that's connected to J1 takes care of the circuit's power needs. Triac TR1 (an SC141D 6-amp, 400-volt unit) can operate most small induction motors of 1/4-HP or less. And if needed, a triac with a greater power-handling capacity can be used for TR1.

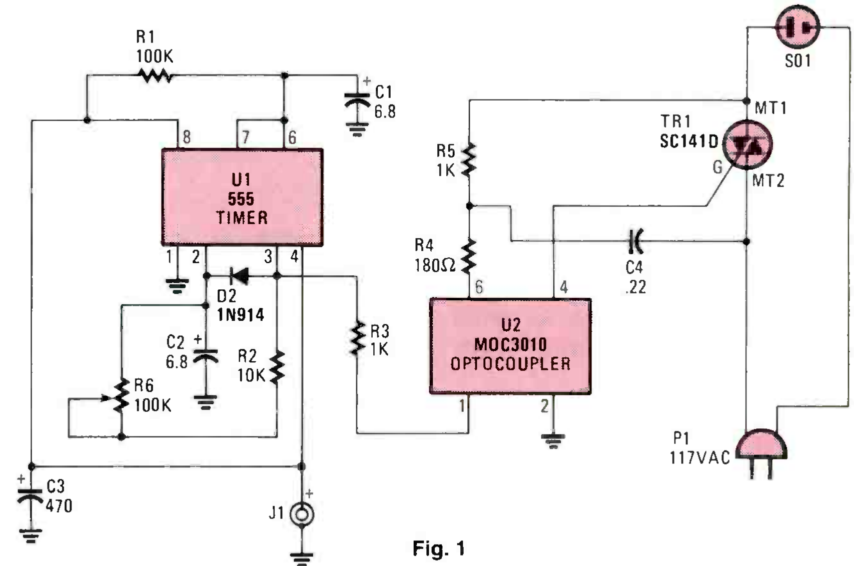

Fig. 1

The speed-control circuit can be assembled on a section of perfboard with push-in pins. (Any suitable layout will do just fine, as the circuit is non-critical.)

A good example of the circuit's operation can be demonstrated by connecting a small circulating fan to J2 and setting R6 for the maximum motor speed. After a short time, the fan's speed will increase until it reaches about 70% of its full rpm rating. At that setting of R6, the fan's motor is being turned on and off at a 50% rate of about .5 Hz. Slowly turn R6 in the opposite direction and note the speed change as the fan's motor is pulsed on and off.

The speed-control circuit works best with small motors that run with a light load, such as our fan. So choose your application carefully and enjoy something new that's based on a 100-year old idea.

Keep in mind that the voltage at SO1 is DC, or to be more precise, rectified AC. If you use a signalling or relay device, it must be rated for DC. For example, a 48-VDC relay would work.

A Flash in the Pan

It's always fun to experiment with electronic LED-flasher circuits; especially if we can make them do something unusual or useful without too much circuitry or

PARTS LIST FOR THE HIT-N-MISS SPEED CONTROL (FIG. 1)

SEMICONDUCTORS

D1—1N914, small-signal, silicon diode
TR1—SC141D 6-A, 400-PIV triac
U1—555 oscillator/timer, integrated circuit
U2—MOC3010 optoisolator/coupler

RESISTORS

R1—100,000-ohm, ¼-watt, 5%
R2—10,000-ohm, ¼-watt, 5%
R3, R5—1000-ohm, ½-watt, 10%
R4—180-ohm, ½-watt, 10%
R6—100,000-ohm, any-taper potentiometer

CAPACITORS

C1, C2—6.8-µF, 25-WVDC, tantalum
C3—470-µF, 16-WVDC, electrolytic
C4—0.22-µF, 600-WVDC, mylar

ADDITIONAL PARTS AND MATERIALS

J1—Phono jack for plug-in power supply
PL1—117-VAC plug with power cord
SO1—117-VAC receptacle
Perfboard or printed circuit material, 6- to 9-volt DC plug-in power supply, push-in pins, wire, solder etc.

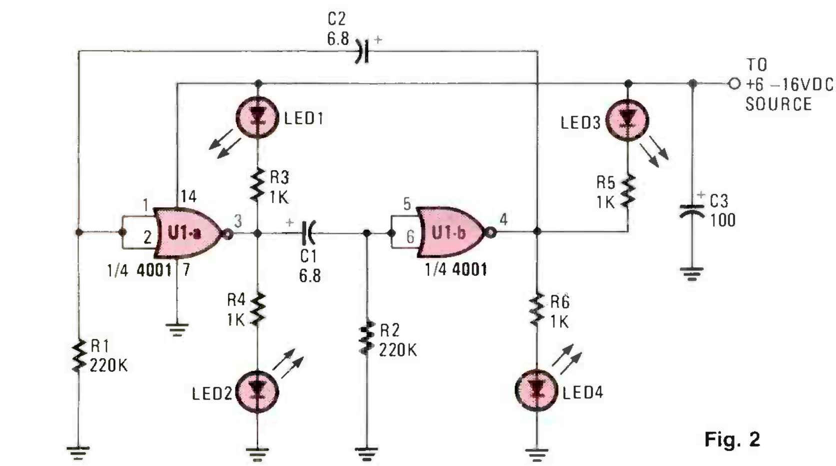

Fig. 2

PARTS LIST FOR THE LED FLASHER (FIG. 2)

C1, C2—6.8-µF, 25-WVDC, tantalum capacitor
C3—100-µF, 25-WVDC, electrolytic capacitor
LED1–LED4—Jumbo light-emitting diode (any color)
R1, R2—220,000-ohm to 1-Megohm ¼-watt, 5% resistor (see text)
R3–R6—1000-ohm, ¼-watt, 5% resistor
U1—4001 quad 2-input NOR gate

ADDITIONAL PARTS AND MATERIALS
Perfboard, 6- to 16-volt power source, IC socket, pins, solder, wire, etc.

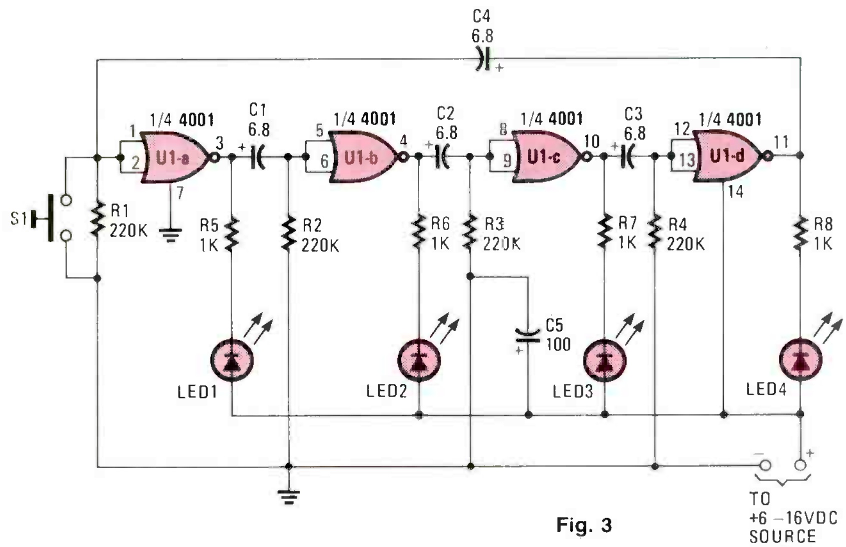

Fig. 3

PARTS LIST FOR THE CMOS QUAD RING-AROUND LED FLASHER (FIG. 3)

C1–C4—6.8-µF, 25-WVDC, tantalum capacitor
C5—100-µF, 25-WVDC, electrolytic capacitor
LED1–LED4—Jumbo light-emitting diode (any color)
R1–R4—220,000-ohm to 1-Megohm, ¼-watt, 5% resistor
R5–R8—1000-ohm ¼-watt, 5% resistor
S1—Normally-open, momentary-contact pushbutton switch
U1—4001 quad 2-input NOR gate

ADDITIONAL PARTS AND MATERIALS
Perfboard, IC socket, pins, wire, solder power source, etc

expense. Our first flasher circuit (see Fig. 2) uses a low-cost CMOS IC to turn the four LED's on and off at a rate that is set by the values of R1, R2, C1, and C2. The pulse rate for the component values given (for R1 and R2) is about one cycle every four seconds. By lowering the values of R1 and R2 to 220K, the pulse rate increases to 1 Hz.

The LED's flash in pairs, with LED1 and LED4 turning on together for one half of the time period, while LED2 and LED3 are on for the other half. The on/off duration of each pair of LED's can be increased or decreased by changing the value of *one* of the coupling capacitors (C1 or C2). Increasing either capacitor's value by a factor of 10 will also increase the on time of a pair of the LED's for about the same factor. Since we're using inexpensive parts, and there is really no reason for letting half the integrated circuit go to waste, let's use the remaining gates to expand our circuit.

Expanding the Circuit

The first circuit used only two of the gates contained in U1 to flash four LED's on and off in pairs. But by using the other two gates in a similar circuit, as we've done in Fig. 3, an unusual ring-around, eight-LED flasher circuit can be produced. Although the second circuit is an extension of the first (with inputs and outputs connected in series), the end results are not as we would expect.

When power is first turned on, two of the LED's are on and the other two remain

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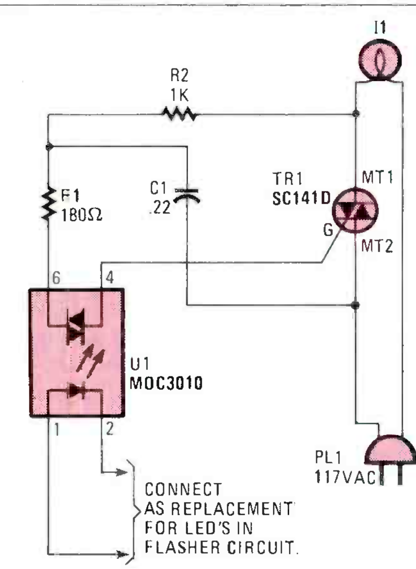
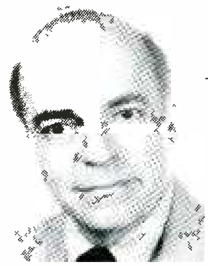


Fig. 4

PARTS LIST FOR THE BRIGHT LIGHT DRIVER (FIG. 4)

C1—0.22–muF, 600-WVDC, mylar capacitor
I1—100- to 200-watt lamp
R1—180-ohm, ½-watt, 10% resistor
R2—1000-ohm, ½-watt, 10% resistor
TR1—SC141D 6-A, 400-PIV triac
U1—MOC3010 optoisolator/coupler, integrated circuit

ADDITIONAL PARTS AND MATERIALS
Perfboard, 117-VAC power cord with plug, lamp sockets, pins, wire, solder, etc.



By Marc Ellis

ELLIS ON ANTIQUE RADIO

Vacuum-Tube Roundup—The Early AC Types

LAST MONTH YOU SAW THE FIRST IN A series on early radio tubes that will be presented from time to time in this column. At that time, I promised to try to review the major categories of tubes that you'll encounter in the sets you collect. While it would be impossible to review each individual tube type in the profusion that was produced as radio technology matured, we *can* touch on major design developments. With a knowledge of the developments during the vacuum-tube era, you'll be in a better position to understand—and date—the tubes and sets in your collection.

Last time, we talked about the tubes found in the first sets offered to the consumer during the dawn of radio broadcasting. Without exception, those tubes were lit either by automotive-style rechargeable storage batteries or by disposable dry cells. Other kinds of disposable dry batteries supplied the higher voltages needed for the tube plates. As the battery era came to a close, most radio sets—even the 5- and 6-tubers—were using a similar type of tube. And that tube, most often, was the ever-present '01A (discussed at length in the previous column).

Powering the Battery Sets

Recharging and/or replacing the array of batteries needed to operate five or six power-hungry '01A's was obviously inconvenient and expensive. Radio-minded families tended to shrug off those problems in the excitement of receiving the first broadcasts. But as radio listening began to become an everyday family activity, there was less patience for more-and-more frequent battery maintenance.

The first solution to that problem was offered by the battery chargers and eliminators (see photos). Dressed up a bit and manufactured in lighter-weight versions, the service-station battery charger moved into the home. That relieved the radio buff of the necessity for disconnecting his 40-pound, acid-filled storage battery and *manhandling* it (or more accurately, *it* handled you) to and from the corner gas station every week or so.

If a listener also wanted to avoid regular purchases of the dry batteries that were used for plate power, it was necessary to buy a battery eliminator. The battery eliminator replaced the batteries completely by converting alternating current (AC) from the house supply into well-filtered direct current (DC) of the proper voltage to power the plates. Also available for that purpose (though less commonly used) were multi-cell rechargeable storage batteries.

You needn't have "battery trouble"
During the battery-radio era, a home-battery charger eliminated the need for radio fans to make regular trips to the corner gasoline station.

By now, the progressive radio fan's living room was beginning to look like a cross between a service shop and an electronics lab. On the radio table was the set itself, with its array of knobs and dials and its separate horn speaker. Underneath was the storage battery, charger, and battery eliminator. Add the rat's nest of connecting wires, and you have a sight not exactly calculated to delight the heart of the average housewife. Radio had moved into the home, all right. But before the family could be really comfortable with it, a compact and more integrated set was needed: one with most, or preferably all, of its parts housed in a furniture-style cabinet.

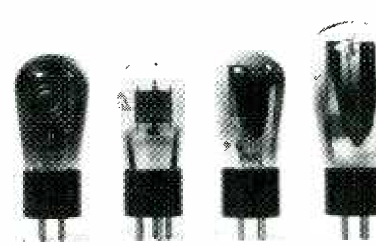
Enter the AC-operated Tubes!

Before the radio industry could provide that kind of a set, a new type of tube that could be lit directly from the AC line—eliminating the need for cumbersome storage batteries and chargers—would have to be designed. The problem with lighting tubes on AC, of course, was hum. The hum from the AC supply would mix with the signal being processed by the tube, which resulted in an ear-splitting rasp at the loudspeaker.

Then, in 1927, RCA released just the type of tubes that the industry was looking for: the UX-226 and the UY-227. Both types could operate directly from a low-voltage AC supply without introducing unacceptable hum; however, their principles of operation differed.

Physically and electrically, the '26 differed little from the '01A that it was designed to replace. However, the engineers had found that the AC hum could be minimized by running the tube filament at a lower voltage and higher current than usual. Its filament operated at 1.5 volts, 1.5 amperes (compare with the '01A's 5 volts, 0.25 amperes).

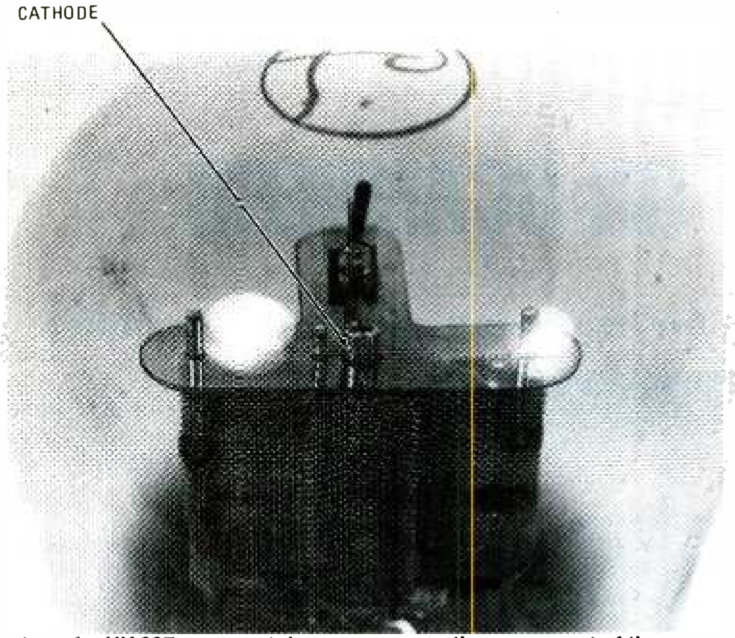
The design of the '27, however, represented a true breakthrough—and would become the prototype for all AC-operated receiving tubes produced thereafter. In the '27, the filament did not directly supply the stream of electrons necessary to operate the tube. It served merely as a heater for a surrounding structure (originally a ceramic tube with a metallic coating) that, in turn, generated the electrons. Produced by that indirect method, the electron stream was relatively free of the pulsations introduced by the AC power source—and the tube ran quietly.



The tubes that made possible the first AC-powered radios are (from left to right) the UX-226, -227, -171A and -280.

Because of the extra electrical connection required for the new electron-emitting structure, called the cathode, the '27 needed a new kind of base. An additional pin was added to the familiar "UX" base (see Feb. 1987's column) used on the '26 (which was used for so many years on the '01A). And it was because of that modified base that the original form of the '27 tube carried the prefix "UY."

For some reason, tube designers chose an operating voltage of 2.5 for the UY-227. And that value was to remain the



At the top of a UY-227 vacuum tube, you can see the upper part of the cylindrical cathode. That indirectly-heated element totally encloses the filament from the other elements, providing a stream of electrons free of AC hum.

standard for AC-operated tubes for the next several years.

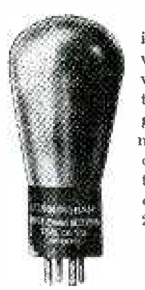
Power Amplifiers and Rectifiers

Before we take a look at the typical new-generation radio made possible by those design breakthroughts, we need to complete the tube lineup. Two additional tube types, the power amplifier and the rectifier, were important to the operation of the new sets.

The power-amplifier tube (already touched on in a previous column) was designed to occupy a set's final amplifier socket. Of heftier construction than its companion tubes, it provided the extra *kick* that was needed to obtain really comfortable volume from the loudspeaker. Several types of power amplifier tubes were introduced during the battery era, including the UX-120, -112, and -171. They were not widely used, however, because the extra power resulted in increased battery drain.

CX-313: 5 VOLT

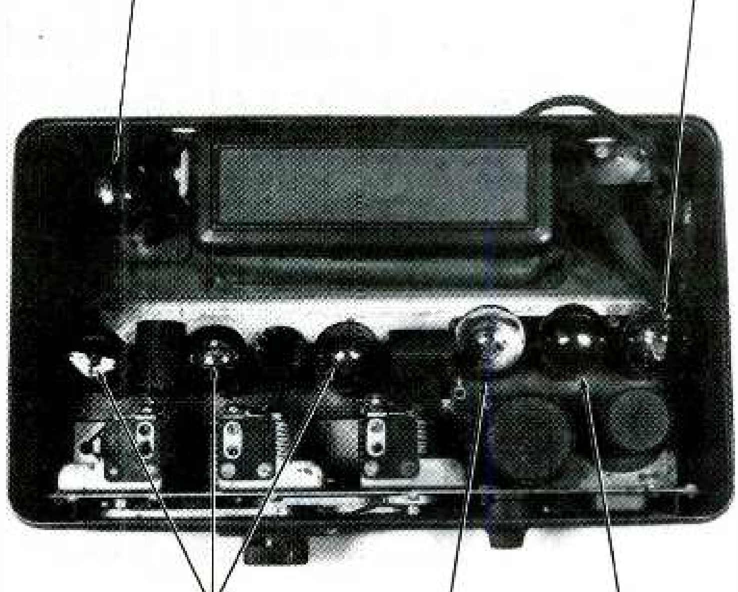
2 Ampere Full Wave Rectifier



This full wave rectifier tube is equivalent to two single wave tubes, being constructed with two plates, or anodes, and two filaments. It is capable of giving an output of approximately 65 milliamperes, and is designed for use in "B" battery eliminators. It is capable of rectifying voltages up to 220 volts AC.

Price $6.00

Early advertisement introducing type '213 tube. Since that's a Cunningham tube, the prefix used is "CX." RCA called the same tube a UX-213.



Straight-down bird's eye view of the Atwater Kent Model 42 with cover removed. Note that only one rectifier vacuum tube (the type '80) is used, and that the '26 vacuum tube serves as both an RF and audio amplifier.

But with the advent of AC-operated sets, power was no longer an expensive commodity. And it turned out that the final audio stage was not critical as to hum. Battery-powered amplifier tubes in that position could be lit from an AC source with no ill effects—and were regularly designed into the new sets. An especially popular type during that era was the UX-171A, an improved version of the original '171.

With the tube filaments lighting nicely on AC power, bulky batteries and chargers were eliminated. The other development that was needed for a completely integrated plug-in radio was a compact power unit that could replace the batteries that were formerly used to provide the plate and (where necessary) grid voltages. If those voltages were to be derived from the AC line, the AC would have to be first rectified (changed to DC), and then well filtered to virtually eliminate all traces of hum.

For the resulting DC to be as pure as possible, a *full-wave* circuit had to be used for rectification. Since the early 1920's, vacuum-tube rectifiers had been available to do that job. Those were simple diodes (containing a filament and plate only—no grid). And two of them were necessary for the full-wave rectifier circuit. In 1925, the first tube expressly designed for full-wave rectification was released. Called the UX-213, it was a dual diode—containing two plates in one bulb, operating from a common filament. That meant that now only one tube was needed for full-wave rectification, which resulted in a considerable space savings.

Though the '213 was used in some of the earliest plug-in radios and battery eliminators, it became obsolete fairly soon. Developments in AC-operated sets were coming so quickly that, almost from the first, most of those sets used too many tubes for the '213 to power. (Radios using the '213 are rare and—so far—I haven't run into one of them.)

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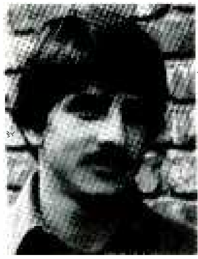


Marc Saxon

SAXON ON SCANNERS

A modest-priced scanner for beginners and oldtimers alike!

☐For those who hanker to enjoy the thrill of monitoring police, fire, federal, emergency, railroad, and other similar communications without shelling out big bucks for a top-of-the-line scanner, Regency Electronics recently announced a modest-priced alternative.

Their R1070 scanner (see photo) is nifty for individuals just getting started in the scanner game; and it's also a good bet for oldtimers looking for a back-up unit. In other words, it's a scanner that can meet a multitude of requirements.

The ten-channel scanner can receive more than 15,000 frequencies from six of the most popular public-service bands, including 30 to 50 MHz (VHF-low band), 144 to 148 MHz (2-meter ham band), 148 to 174 MHz (VHF-high band), 440 to 450 MHz (UHF ham band), 450 to 470 MHz (UHF public-service band), and 470 to 512 MHz (UHF-T band). No crystals are required; you program in the desired frequencies using the scanner's front-access keyboard. The R1070 comes pre-programmed with ten commonly monitored frequencies, which you can change quickly and easily.

Built-in Memory

Programming requires touching a few pushbuttons, and a dual-level, fluorescent digital display flashes messages to aid in the programming process. Once a frequency is entered into a channel slot, a special test key automatically verifies the frequency, while checking microprocessor functions.

In addition to scanning as many as ten channels, the R1070 can be placed in a search/scan mode that permits it to sweep across an entire frequency range to find active new frequencies. Other features of the unit include a *channel lockout* for skipping over channels not of current interest, manual and scan controls, plus volume and squelch. During a power failure, a built-in capacitor will retain your programmed features for several hours (without batteries).

The Regency R1070, housed in a rugged cabinet that features an attractive walnut finish and a built-in top-mounted speaker, is supplied complete with an AC power-supply cord, telescoping antenna, and an easy-to-follow instruction manual.

Regency's ten-channel R1070 programmable scanner covers six of the most popular public-service bands and is pre-programmed with ten popular frequencies.

Best of all, its suggested retail price is only $159.95. Complete details on R1070 and other scanner products are available from Regency Electronics Inc., 7707 Records Street, Indianapolis, IN 46226.

What's That I Hear?

Reader Whitney Reynolds of Houston, TX writes to ask for identification of communications he hears on 130.575 MHz. Whit says that a base station called *Air Center 1* is heard communicating with various aircraft and discussing everything from car rentals to reserving hotel rooms. Since there is no airport near Houston called Air Center 1, those communications have stirred his curiosity.

Air Center 1, just for the record, is a coast-to-coast (Canada, too) division of the Beechcraft aircraft company. With facilities at numerous airports, Air Center 1 services and obtains parts for Beechcraft aircraft. Air Center 1 will also make arrangements for accommodations and ground transportation for those who are arriving (by air) to use their services. In most parts of the nation, the chit-chat takes place on 130.575 MHz. But at their Canadian facilities—as well as their offices in Mass., New York, New Jersey, Ohio, Minn., and Washington (state)—frequency 130.6 MHz is used instead of 130.575 MHz.

Skyway Communications

Recently someone was getting on the airwaves and posing as an authentic FAA air-traffic controller. In the Associated Press (AP) coverage of the Miami-area incident, it was observed that "the culprit was familiar enough with airline jargon to fool the pilot, and had access to a special transmitter.

AP neglected to mention that every airline pilot and many private pilots, as well as thousands of present and former air-traffic controllers, are familiar with the jargon. Also, every airliner and the majority of private aircraft have communications equipment aboard that can operate on the frequencies that were used!

What's Up Doc?

A doctor associated with the National Institutes of Health at Bethesda, Md., writes to say that many different services connected with that facility have communications, but nobody seems willing or able to divulge the frequency used.

More than one frequency is used and, so far as we know, none have ever (until now) been published anywhere. The guards and security forces are on 411.45 MHz; the fire department use 419.80; the messenger and couriers are dispatched on 36.225 MHz; paging is on 164.525; maintenance crews use 36.75 MHz, and transportation services operate on 41.83 MHz. Thanks for asking, Doc.

Scanner Buying

Leon Nelson, DDS, of Redding, CA, asks for advice on what features to look for in a scanner that will be used for combined base/mobile operations. First, determine the frequency bands that you want to receive, since not all scanners cover the full spectrum.

Next, determine how many different frequencies you'll be wanting to monitor, because different model scanners will receive anywhere from 10 to 50 or more different frequencies. Then, eliminate those scanners that aren't designed to operate from mobile power supplies (12 to 13.8 VDC).

We are always on the lookout for your comments, questions, photos, and information. Send them to Marc Saxon, *Saxon on Scanners*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. We'll be looking forward to hearing from you soon. ■

OPTICAL DATA STORAGE—THE CD-ROM

(Continued from page 43)

ies is easy. You can find word-processing programs, database managers, spreadsheets, many utilities for un-copy-protecting various commercial programs, assemblers, compilers, debuggers, and special programs like one that prints a text file in the proper format for a screen play, and a database containing the characteristics of various types of structural steel.

The PC-SIG CD-ROM costs about $200; purchase of it and a player would be a great idea for a computer club.

Others

If you've ever tried to order a book from a bookstore, you've probably seen the clerk consult a reference called "Books In Print." It contains listings by title and author of every book in print; numerous supplements detail other types of information. Bowker Electronic Publishing has released the entire database in CD-ROM form; use of it should help bookstores and libraries greatly.

The Federal Code has also been reduced to CD-ROM form, and the IRS and various states are considering doing so. Lawyers and tax consultants will love the ease of use that electronic publishing provides.

Many corporations pay large sums of money to access on-line databases containing information about trends in business and similar data. Those databases are also being transferred to CD-ROM, and, although cost will still be high, the advantage of having the information in-house and accessible will greatly outweigh the cost.

Some years ago, the entire canon of ancient Greek literature (including the New Testament) was put on magnetic tape for use at large universities with mainframes. Now the 250-megabyte database has been transferred to CD-ROM, and it can be used by scholars in small colleges and universities without mainframes and high budgets.

Brown University, in collaboration with Harvard University and the University of California at Irvine, has developed a complete system that is customized for working on-screen in both Greek and English. Their system contains complete software for linguistic analysis, including, for example, finding all occurrences of a given word; in addition, a complete, high-quality bi-lingual word-processor is also part of the package.

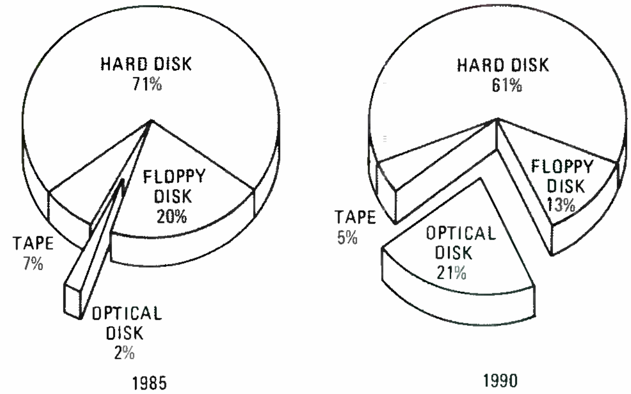


Fig. 5—As of 1985, optical storage accounted for only 2% of computerized storage needs. But in 5 years, it is likely that optical storage will account for more than 20%.

Conclusions

As shown in Fig. 5, by the year 1990, use of optical storage devices is expected to increase by a factor of 10. The most likely form that storage will take is CD-ROM, which is here, now. There are many real, live databases available for specialized uses, and several for more popular uses. And more and more databases are being released all the time.

Someday Junior will do the research for his school reports on a CD-ROM or CD-I machine. A lawyer can have instant on-line access to thousands of legal precedents. For hard-to-diagnose diseases, a doctor can input a set of symptoms and find similar cases. Writers can keep reference works (full-text dictionaries and thesauri) on-line, as well as the texts of works that might be useful in their fields. Supply companies could keep their often huge catalogs on-line. The list goes on and on. Just imagine any field that requires use of a large body of reference material—you've got a potential CD-ROM application. Find a way to bring that application to CD-ROM before anyone else does, and you'll make a fortune. ■

TESTING THE FLUKE LCA-10

(Continued from page 70)

receptacle. Judging only by the connections, the adapter appears to connect the DMM in series with the device under test. (How else would you read current?)

Current Through the Meter

Does that mean that the line current passes through the meter? Yes and no. The line current *does* go into the meter, but not through the meter circuits. As shown in Fig. 2—a simplified generic version of DMM's that measure relatively high AC current—there is really a very low-value resistor, labeled R_x, between the 10A and COM jacks of the meter. R_x, called *a multimeter current shunt*, is usually nothing more than a short length of rather thick wire whose resistance is somewhere around 0.5 ohm, or even less.

Since the appliance's current passes through R_x, there will be a very slight voltage drop across the resistor. As indicated by the dashed lines in Fig. 2, when the meter is set to read current, the FUNCTION/RANGE switch effectively connects the 10A jack to the meter's VOLT/OHM test jack so that the meter actually reads the voltage drop across R_x. The meter's calibration automatically interprets the voltage drop into a current reading for the display.

A 20-Ampere Limit

The Fluke LCA-10 is rated for a maximum current of 10 amperes continuous, 20 amperes for 30 seconds, because that's what resistor R_x is rated for in Fluke and

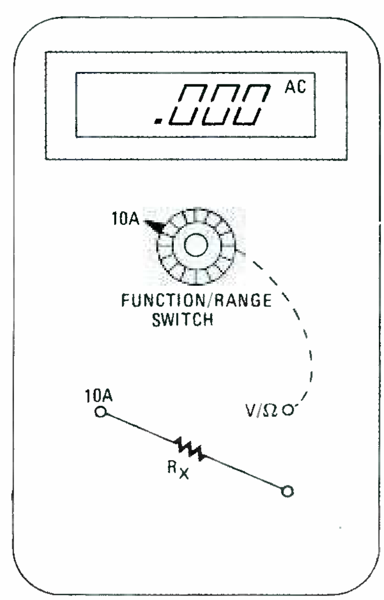


Fig. 2—The adapter allows resistor R_x, which is located within the DMM, to be connected in series with the powerline. The current reading is actually an interpretation of the voltage drop across the resistor.

many other DMM's having a 10-A current range. If you apply 20 amperes for a minute or more, it's not the adapter but the meter that will suffer damage. That point is not made quite clear in the instructions supplied with the adapter.

Also, the adapter's connections to the meter are 16-gauge, which has a continuous current-capacity of 10-A. So there are really two limitations on the maximum current capacity: that of the connecting wires and resistor R_x.

Table 1 shows how the LCA-10 Line Current Test Adapter coupled with a DMM faired against a service-grade clamp-on meter, and a conventional service-grade analog AC current/watt meter (having 3% accuracy)—a model still being used in quality service shops. As you can see, the adapter and DMM appears to have the performance of the analog meter, rather than the clamp-on model. (We did not get a chance to check several models of the clamp-on meter.)

About the only complaint we had with the adapter was that it was too "stiff" and inflexible, a common problem with SJT (plastic) cords. In general, rubber cords are easier to handle, particularly when they are short. ■

TABLE 1
CURRENT READING COMPARISON

LCA10 W/DMM	Clamp-on Meter	Current/wattage Tester
0.48	0.55	0.5
4.27	4.0	3.8
9.0	7.5	9.0
12.4	10.5	12.0
15.6	12.5	15.5
Note: All readings in amperes		

AFGHAN AIRWAVES

(Continued from page 48)

station is hearable in this part of the world but it is hardly a "snap" logging.

A great deal of the program time is devoted to attempting to "sell" the government and its policies, and to convincing the population that the Soviet presence is a good thing.

David Vs. Goliath

The *mujahidin* are fighting a modern, well-equipped Soviet army of more than 100,000 men, and doing so with essentially antiquated equipment and limited supplies. They've been at it for more than seven years now. In Vietnam, the Viet Cong fought basically for their country and to install a particular political system. In Afghanistan, the *mujahidin* have no real notion of what kind of government should be in Kabul and, for many, Afghanistan as a nation is an idea not easily grasped. The *mujahidin* fight because they do not like Russians. They do not like *any* invader, or having any way of thinking forced upon them. They fight because they like to fight. Every death they suffer brings an historic, almost inborn need to avenge that death. Most of all, they fight the *jihad*, the holy war, and that is the most powerful call.

They will almost certainly continue until they win or until they simply cannot continue. So it may be a long while before the land of Afghanistan, and the airwaves above it, are peaceful again. ■

FRIEDMAN ON COMPUTERS

(Continued from page 89)

can substitute an inexpensive composite chrome or color monitor for an otherwise relatively expensive TTL monochrome or RGB color monior.

The problem of the wrong monitor comes about because IBM initially decided that monochrome would be used for word processing, and the monochrome adapter, which plugs into the system unit, had a special font (character style) especially designed to be easy to read. It also had graphics capability, that was really intended for word processing, such as on-screen underline and 4-step true highlighting. The adapter was also intended for a TTL monitor with a faster horizontal scan-rate than that used for conventional TV (which is needed to provide the higher resolution of the monochrome character set), and external vertical and horizontal drive signals.

The graphics adapter—also a plug-in—was intended for a high-performance RGB color monitor, which requires separate color signals. It also contained a character set, but to ensure good readability on a color screen—which is somewhat coarse—the characters were made as large as possible. Some users find that uncomfortable for extended word processing.

Now all that would work out fine if everyone used the computer as originally intended, and had the budget to cover two expensive monitors. But many users wanted both mono and color capability without having to mortgage the family homestead, and here they were in luck because IBM had provided a composite output on the color adapter.

Just Like TV

A composite output is exactly the same kind of signal used in your TV set. The red, blue, and green color components of the video signal are mixed—so to speak—and are separated within the receiver (monitor). Composite color can also provide a monochrome representation by simply turning down the TV's color control. A composite color signal can provide either color or monochrome on inexpensive closed-circuit TV monitors. Tighten up the screen formatting of a TV-type composite monitor, and we end up with an inexpensive *computer monitor*.

It is the composite-type monitor that allows *complete IBM-compatible systems* to be sold at rock-bottom prices. The dealer provides a non-IBM color adapter that has a composite output, and a monochrome composite monitor. The user sees a mono screen with characters that work with a word processor or spreadsheet. The same monitor also runs graphics programs in monochrome (hey, how 'bout that). As far as the user is concerned, he is getting an *IBM-type computer* at a considerable savings (in the hundreds of dollars) compared to an *official* IBM computer.

Or, the dealer provides a low-cost composite-type color monitor, which allows the user to run either color or monochrome programs. The user gets color, can run programs in mono through the DOS's MODE BW40 or B80 command, and thinks that he's really got a savings.

Problems come in only when software requires the higher definition of RGB color monitors, or the special word-processing-graphics capability of the TTL monochrome adapter.

Of course, some dealers are legitimate: They pass along savings made possible by using low-cost IBM clones, such as a true IBM-type with non-IBM mono adapter and a non-IBM TTL mono monitor, or a non-IBM graphics adapter and a non-IBM RGB color monitor. While the savings aren't quite as spectacular as with the dealer running everything through the color-composite output, they can be substantial.

Compatible All The Way

Like the compatibility of the system unit itself, if you want to be certain that you can run all possible software, you need the correct monitors (and there associated adapters). There is much monochrome software that won't run through a composite monochrome monitor, just as their is color software that can't be run on a monochrome monitor. If 100% IBM compatibility is important, then the monitor system(s) as well as the unit must be truly 100% IBM-compatible. ■

SUPER STROBE

(Continued from page 78)

to last for any great length of time, as that will ruin the project.

In Fig. 9, we have a comparator configuration for a magnetic pickup. The pickup you should use is dependent on how much sensitivity you desire. Telephone pickup coils used to record phone conversations are fine for most applications.

As you can see in Fig. 10, even mechanical switches can be used if debounced as shown.

All of the circuits are simple and easy to apply, but they represent just a few of the possibilities. Let your imagination be your guide!

There's nothing critical about construction of the project itself; however, be sure not to use a metal case or to allow metal hardware to come in contact with the high-voltage portions of the circuit. The circuit, if used improperly, can cause harm, for that reason it uses a common not a ground!

A perfboard can be used for the mounting of parts, or a PC board can be developed and used.

Low inductance bypass capacitors should be used between IC's along with at least one 10- to 47-μF tantalum capacitor from $+V_{dd}$ to the common. Wires to the LM311 comparators should be kept as short as possible to keep them from breaking in oscillation. However, LM311's are pretty stable as high-speed comparators go, and substituting other types may cause some problems.

Virtually any sensitive gate SCR that will switch the voltage, will work as SCR1. The flashtube pulse transformer, plastic case, etc., can be purchased at most surplus outlets, or even Radio Shack for that matter. ■

CIRCUIT CIRCUS

(Continued from page 97)

off until the timing cycle reverses. The LED's flash in pairs just like in the first circuit; but by pressing and holding S1 closed until only one of the LED's is on, and then releasing it, the four LED's can be made to flash in sequential order.

The number of LED's flashing in a sequential ring can be easily increased to eight by adding another 4001 quad NOR gate. Just repeat the circuit in Fig. 3 and connect the additional circuit in series with the first (input to output) as an extension of the first circuit. When power is connected to the eight-LED Flasher circuit, four LED's will turn on at once and then flash off with the four remaining LED's coming on. As before, just press S1 and hold closed until all but one LED turns off, and then the LED's will begin their sequential march around in a circle. You can connect as many circuits in series as you like.

A sequential mirror image of the one LED on at a time to all but one on at a time can be accomplished by connecting each unit the way LED1 and LED3 are shown in Fig. 2. Or you can add the extra LED per stage, as in Fig. 3, and double the number of flashing LED's.

Illumination Intensifier

If the light output of the LED's isn't bright enough for you big timers, take a look at the high-intensity driver circuit shown in Fig. 4. Replace each of the LED's in any one of the flasher circuits with that circuit and really turn on the bright lights. Of course by adding the bright-light circuit, the cost will go way up; but if it can be used for commercial purpose, it could be a bargain.

Always be careful when working with any potential over 12-volts: many careless people don't have the opportunity to do so any more. ■

SCR'S, TRIACS, DIACS, AND QUADRACS

(Continued from page 38)

You could use a triac to replace the SCR in Fig. 3, but you'd find that the circuit's operation isn't as smooth as you'd like. The reason is that neon only fires once during all 360 degrees of the incoming AC. But don't worry, semiconductor manufacturers took care of that problem by coming up with a part they decided to call a *diac* or a *bilateral trigger diode*. In reality it's nothing more than a triac without internal gate circuitry, and you can see that by looking at Fig. 5.

In order to turn our circuit into an efficient light dimmer, you would replace the original SCR with a triac, and trash the neon lamp in favor of a diac. You'd think we've finally gotten to the point where it was okay to get your hands on some parts and put together the light dimmer. Well,we have—almost.

Light dimmers are popular items and the people who make them are always looking for a way to save a couple of bucks. One day someone realized that triacs always needed diacs and it would be a lot more cost efficient to put both of them in one package.

This, of course, sets the stage for the *quadrac*.

Enter: the Quadrac

The one unique feature of the quadrac is that there's absolutely nothing to say about it. As you see in Fig. 6, the symbol for a quadrac says it all. If you connect a diac to a triac, you don't get something *like* a quadrac, you get the genuine article. There's a basic electronic difference between SCR's and triacs, but the only place you'll find a difference between triacs and quadracs is your checkbook. And it's not what you think!

Quadracs are cheaper by the dozens of dozens, but when you try to buy them in *onesies*, they're actually more expensive than the triacdiac combination. It's simply a matter of availability since few mail order houses stock them.

Now you can build the light dimmer—finally! Just put a diac and triac (or quadrac, if you can get one) in place of the neon and SCR and that, as someone once said, is that.

Parts Selection

The choice of parts should be made with a careful eye to maximum current and voltage requirements. Don't ever forget that you'll be connecting the circuit up to the 117 volt AC line! You'll do some really serious damage to yourself if you don't properly insulate all the wires. You can't get a new finger at Radio Shack!

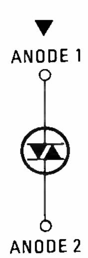
The two important numbers for SCR's and triacs are the peak power and peak voltage. The former is a measure of how much power the part can handle; while the latter is the maximum *peak* voltage that can be handled before the device breaks down. Be aware that since you're dealing with AC voltage, there's a big difference between peak and maximum voltage. Maximum voltages are given in RMS volts and that's the number that tells you how much power you can expect the part to safely handle. The relationship between peak and RMS voltage can be seen by the formula:

$$V_{RMS} = .7V_{peak}$$

If you're not big on mathematics, you can guarantee safe operation by using parts with about twice the rating you really need, if not more. If you want to control 117 volts with our light dimmer, it's pretty safe to use a 200-volt rated part, but a 400-volt rated part only costs a few cents more and, believe me, that's a really cheap safety margin.

Working with the AC line requires that an extraordinary amount of care and attention be spent on what you're doing. A common 15-amp line can supply more than 1500 watts of power and that's more than enough to blow up a lot more than a faulty light dimmer! ■

Fig. 5—The diac is useful as a trigger for a triac since it will output at both sides of the input waveform. Without such a trigger, full advantage of the triac's construction can't be taken and it will only be active half as often.



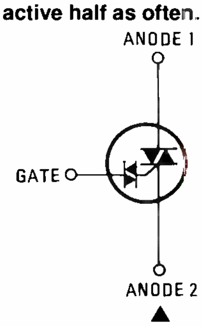


Fig. 6—Of course someone saw the advantages of having a triac and a diac in one package; thus the quadrac was born allowing for more efficient cooling and design.

BETTER SOUND FROM YOUR BOOM-BOX

(Continued from page 64)

Feel the integrated circuit to see if it's operating red-hot.

Keep in mind that a problem in the audio power-amplifier can disable the entire audio section, and vice-versa, because the entire audio system—the pre-amplifier, booster, and output stages—might be part of a single integrated circuit.

Comparable voltage measurements can isolate a leaky or open power-amplifier integrated circuit. If the radio or tape player uses two of the same kind of integrated circuit, measure the voltage on the same terminals of similar devices for comparative voltage measurements. If the voltages vary by a few volts, suspect a leaky integrated circuit.

Either channel may appear dead, weak, noisy, or distorted if its speaker is defective. Exchange the wires of the suspected speaker with those of the other channel.

You can even connect another speaker across the suspected one with test leads to determine if the speaker, earphone jack contacts, and the amplifier are working. In fact, a speaker with leads can be used to signal-trace the sound from the audio power-amplifier's output capacitor to the dead speaker.

A distorted or noisy speaker may have foreign objects poked into, or adjacent to, the speaker's cone. Simply press down on the speaker cone while the unit is playing to locate an intermittent or noisy speaker.

Inspect the speaker's terminals for poorly soldered connections. Replace the defective speaker with one that's the same size, impedance, and magnet weight.

Before you replace the back or front cover, remember to check the dial-cord movement, clean the tape heads and switches, and possibly replace the batteries. Make certain that each lever or pushbutton of the cassette player is working.

Clean up the whole cabinet with a common household window spray after replacing the covers. Replace all the knobs. If you have the equipment—pressurized air in cans or from a compressor—spray a jet of air into the corners and brush out the dirt with a small paint brush. ■

HANDS-ON MARKETPLACE

FOR SALE

35-70%savings—Bargain catalog for 39 cent stamp. **APEX ELECTRONICS MOD**, 8909 San Fernando, Sun Valley, CA 91352.

Restricted technical Information: Electronic surveillance, schematics, locksmithing, covert sciences, hacking, etc. Huge selection. **Free brochure: MENTOR-T,** 135-53 No. Blvd., Flushing, NY, 11354.

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( ) ______________________

Special Category: $10.00

PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.
(No refunds or credits for typesetting errors can be made unless you clearly print or type your copy.) Rates indicated are for standard style classified ads only. See below for additional charges for special ads. **Minimum: 15 words.**

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15 ($18.75)
16 ($20.00)	17 ($21.25)	18 ($22.50)	19 ($23.75)	20 ($25.00)
21 ($26.25)	22 ($27.50)	23 ($28.75)	24 ($30.00)	25 ($31.25)
26 ($32.50)	27 ($33.75)	28 ($35.00)	29 ($36.25)	30 ($37.50)
31 ($38.75)	32 ($44.00)	33 ($41.25)	34 ($42.50)	35 ($43.75)

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PRINT NAME ______________________ / SIGNATURE ______________________

IF YOU USE A BOX NUMBER YOU MUST INCLUDE YOUR PERMANENT ADDRESS AND PHONE NUMBER FOR OUR FILES. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

CLASSIFIED COMMERCIAL RATE: (for firms or individuals offering commercial products or services) $1.40 per word prepaid (no charge for ZIP code)...**MINIMUM 15 WORDS.** 5% discount for same ad in 6 issues within one year; 10% discount for 12 issues within one year if prepaid. **NON-COMMERCIAL RATE:** (for individuals who want to buy or sell a personal item) $1.15 per word, prepaid....no minimum. **ONLY FIRST WORD AND NAME** set in bold caps at no extra charge. Additional bold face (not available as all caps) **25¢ per word additional (20% premium).** Entire ad in boldface, **add 20% premium** to total price. **TINT SCREEN BEHIND ENTIRE AD: add 25% premium** to total price. **TINT SCREEN BEHIND ENTIRE AD PLUS ALL BOLD FACE AD: add 45% premium** to total price. **EXPANDED TYPE AD: $1.85 per word prepaid.** All other items same as for STANDARD COMMERCIAL RATE. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD: add 25% premium** to total price. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD PLUS ALL BOLD FACE AD: add 45% premium** to total price. **DISPLAY ADS:** 1" × 2¼"—$160.00; 2" × 2¼—$320.00; 3" × 2¼"—$480.00. **General Information:** Frequency rates and prepayment discounts are available. **ALL COPY SUBJECT TO PUBLISHERS APPROVAL. ADVERTISEMENTS USING P.O. BOX ADDRESS WILL NOT BE ACCEPTED UNTIL ADVERTISER SUPPLIES PUBLISHER WITH PERMANENT ADDRESS AND PHONE NUMBER. Hands-on Electronics** is published monthly, therefore copy to be in our hands for April 87, 12/17; May 87, 1/17.

LASERS: Surplus parts, and units, "the source for laser surplus"! Free catalog, **MEREDITH INSTRUMENTS**, P.O. Box 1724, Glendale, AZ 85311.

LINEAR parts—Transistors: MRF454 $15, MRF455 $12, MRF477 $11, MRF492 $16.75, MRF421 $22.50, SRF2072 $13, SRF3662 $25, 3800 $18.75, 2SC2290 $19.75, 2SC2879 $25. **Tubes**: 6KD6 $10.50, 6LQ6 $9.75, 6LF6 $9.75, 8950 $16.75. Best prices on Palomar Road Noise Mics, Ranger AR3300. New 16 page catalog listing radio/amplifier tricks—channel modification, PLL-Sliders, peaking for range, hard-to-find linear parts—mail $1.00 to: **RFPC**, Box 700, San Marcos, CA 92069. For same day parts shipment, call (619) 744-0728.

TUBES 59 cents. Year guarantee. Free catalog. Tube Tester $8.95. **CORNELL,** 4219 University, San Diego, CA 92105.

IMPORT electronics, 12,864 other products. 1,568 Asian sources revealed. Free details. **MERCANTILE,** 1023/115B Adams, Olympia, WA 98501.

PLANS/KITS

BUILD this five-digit panel meter and square wave generator including an ohms, capacitance and frequency meter. Detailed instructions $2.50. **BAGNALL ELECTRONICS**, 179 May, Fairfield, CT 06430.

CRYSTAL radio sets, plans, parts, kits. Catalog $1.00. **MIDCO**, 660 North Dixie Highway, Hollywood, FL 33020.

JERROLD gated pulse theory. Twelve information packed pages covering DI & DIC converter operation. Includes introduction to trimode system. $6.95 plus $1.50 postage and handling. **ELEPHANT ELECTRONICS INC.**, Box 41865-H, Phoenix, AZ 85080. (602) 581-1973.

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CATALOG: Hobby, radio broadcasting, CB, lowfers, transmitters, linears, active antennas, converters, scramblers, bugging devices, more! **PANAXIS**, Box 130-HO3, Paradise, CA 95969.

FM transmitter kit, matchbox size, super sound sensitivity, adjustable frequency/gain. Board, parts, educational instructions, $19.95. **PERSHING TECHNICAL,** P.O. Box 1951, Fort Worth, TX 76101.

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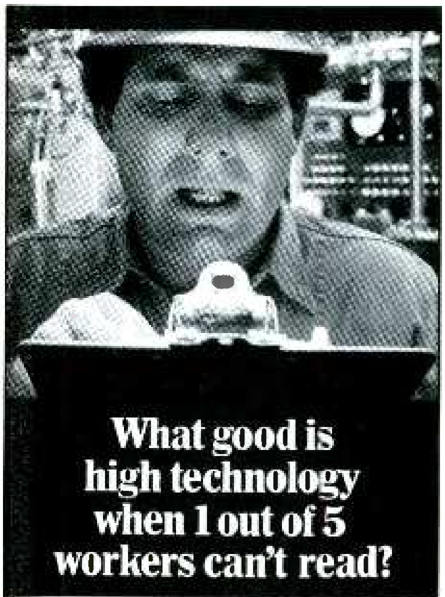

ELLIS ON ANTIQUE RADIO

(Continued from page 99)

Less than two years after the introduction of the '213, a new full-wave rectifier was released. The UX-280, as it was called, had almost twice the power-handling capability of the '213. That was ample—not only for the early sets, but for those that would be developed for many years thereafter. In fact, the '80 probably remained in production longer than any other tube ever made. It was continuously manufactured for a period of at least 50 years.

Putting It all Together

Now that we've introduced the tube types that were used in the design of the earliest plug-in radios, let's take a look at a set that used all of them. It's the Atwater Kent Model 42, manufactured in 1928. In the accompanying photograph, I've opened the top of the cabinet and given you a look inside. Notice that '26's are used both for radio-frequency and audio-frequency amplifiers. However, a power-amplifier tube, the '71A, was used as the final audio amplifier. And a type '80—with its associated power pack (containing power transformer and filter components)—supplied all of the necessary DC operating voltages.

The entire set, with the exception of the speaker, was housed in a compact and attractive cabinet that was unobtrusive and harmonized well with other furniture. It was far easier to operate than the multi-knobbed battery sets of the previous generation and surpassed them in sensitivity and volume. Simply plugging it into a wall socket permanently took care of all power requirements. No wonder that radio enthusiasts bought such sets as quickly as they could afford them—relegating battery sets to the basement, or junk heap!

Well, that's all we have room for this month. See you next time, when we'll wrap up a few loose ends concerning early radio tubes before moving on to other topics. We'll also take a look at some of the mail that has started to come in from readers. In the meantime, write to me C/O **Hands-on Electronics**, Gernsback Publications, Inc., 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

JENSEN ON DX'ING

(Continued from page 90)

UTC; 11,925 kHz at 0000 UTC, or 17,790 kHz at 1500 UTC.

Those, and other frequencies of the Scandinavian outlets, are correct at the time of writing, but remember that many international broadcasters change channels seasonally. If you don't find the stations on the listed frequencies, tune around a bit. Often you'll easily locate the stations in the same SW bands on their new dial locations.

Station Profile

Radio Japan is one of Asia's major overseas broadcasters and a ready target for SWL's. Each week, it airs from 1,645 programs—40 separate hours of programming each 24-hour-day—in 21 different languages, including, of course, English.

Around the world, the shortwave service of Japan Broadcasting Corporation, commonly called by its Japanese name, *Nippon Hoso Kyokai*, or NHK, has an estimated 15 million listeners.

Oldtime SWL's may recall the WWII broadcasts of "Radio Tokyo," which ended with the war. After seven years, an overseas shortwave service was resumed, in 1952, under its current name, *Radio Japan*.

Over the years since then, it has built a solid reputation as one of the world's foremost broadcasters. News and commentary fill nearly three-quarters of its program slots, with entertainment features completing the schedules.

Programming originates from the sixth floor of NHK's broadcasting center in Tokyo's Shibuya district. Here, *Radio Japan* has five studios and an operations center, plus a 24-hour-a-day newsroom.

One floor up, other programs are produced in languages other than English and

Japanese. *Radio Japan*'s staff of 500, who work in Tokyo and at news bureaus around the globe, includes about 200 non-Japanese announcers, writers and translators. Programs are sent by landline and microwave to the Yamata transmitter site at Sanwa, about 40-miles northeast of Tokyo. While NHK is responsible for programming another communications agency, Kokusai Denshin Denwa (KDD) controls the transmitting facilities.

At the Yamata center, *Radio Japan*'s programs are aired by eight 100-kilowatt and two 50-kilowatt shortwave transmitters. Sometimes the big units are used in tandem to pump out a signal with 200 kilowatts of *umph*! Like other international broadcasters, *Radio Japan* learned some years ago that solid worldwide, shortwave coverage requires signals to be relayed by overseas transmitters to augment the signals from homeland facilities.

In 1979, *Radio Japan* began leasing time from *Radio Trans-Europe* at Sines, Portugal—a transmitting complex designed specifically to rebroadcast the programs of several international stations. Since 1984, it also has leased a half-dozen hours of air time daily from the Africa Number One relay stations in Moyabi, Gabon in West Africa. For the past few months, a similar arrangement has been in operation with *Radio Canada International* for relay of *Radio Japan* programming to North America.

Programming from the Japanese studios is sent from the Yamaguchi earth station of KDD via Intelsat communications satellites to the rebroadcast links in Portugal, Gabon, and Canada. (And plans were announced earlier to establish other SW relays from Panama and southeast Asia.)

While *Radio Japan* can be heard on a number of frequencies at various times of day, here are a few spots to try: 0200 UTC on 15,195 or 15,420 kHz; 0400 UTC on 9,595 kHz, or 0500 UTC on 15,235 or 17,810 kHz. And Radio Japan will confirm reception reports with attractive QSL cards. Letters may be sent to *Radio Japan*, NHK, 221 Jinnan, Shibuya-ku, Tokyo, Japan.

Down the Dial

Tell the world what you're hearing on shortwave these days. Drop me a line with info on your loggings, including the programming you heard, the frequency and time, and you can join the others featured in this column. The address is *Jensen on DX'ing*, **Hands-on Electronics**, 500-B Bi-County Boulevard, Farmingdale, NY 11735.

Here are this month's reports. Remember that all times are given in UTC (Universal Coordinated Time):

Falkland Islands—2,380 kHz, the *Falkland Islands Broadcasting Service* at Port Stanley in the far south Atlantic used to be the toughest-of-tough DX. Fortunately, the odds of hearing this one have improved—to just plain tough! Still, sometimes it can be heard in North America with reasonable signals. Try around 0330, and good luck!

Papua New Guinea—4,890 kHz, *NBC* in Port Moresby can be heard with fair signals around 1000 with time signals and an English newscast.

Luxembourg—6,090 kHz, *Radio Luxembourg* is the granddaddy of the European pop music stations. Unfortunately, on its 49-meter band frequency, it's often crowned by interference. If the interference eases up a bit, look for it in English about 0015.

Ireland—6,910 kHz, *Radio Dublin* began life as an unlicensed pirate operation, but apparently it is, today, broadcasting legitimately. It isn't the easiest station in the world to hear in North America, but it can be done. Try during the evening hours from 0000 until late night.

United Arab Emirates—9,640 kHz, *Radio Dubai* from this Persian Gulf nation faces competition from Germany's *Deutsche Welle* on this frequency after 0330 sign on. Or you could try Dubai's parallel frequency 11,940 kHz at the same time.

Venezuela—9,660 kHz, *Radio Rumbos*, Caracas. Not too long ago there were quite a number of Venezuelan stations operating on shortwave. Today, for some reason, the number has diminished significantly. (That is one of the better signals from the South American nation.) Look for it in Spanish around 1130.

Syria—12,085 kHz, *Radio Damascus* has been reported here broadcasting in English at 2000. ■

ADVERTISING INDEX

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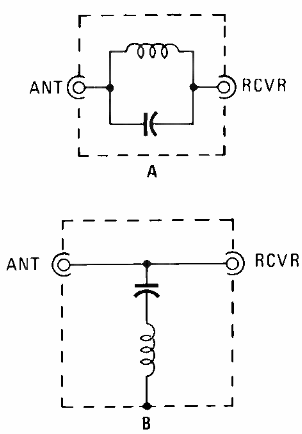
THE HAM SHACK

(Continued from page 95)

elsewhere. Thus, it serves much like the coax stub shown in Fig. 1. In Fig. 3C we see a combination wavetrap that uses both series and parallel resonant elements. (Several editions of the ARRL's Radio Amateur's Handbook had construction projects for AM broadcast-band wavetraps of this type.) For interference caused by an FM broadcaster most video shops and electronic parts stores carry *FM traps* for 75-ohm antenna systems.

Intermod problems can cause you to curse the designer of your rig (unless you homebrewed it, in which case the defect is a forgivable error). Fortunately, the methods given above are easily implemented and work well more often than not.

(Joe Carr, K4IPV, can be reached at POB 1099, Falls Church, VA 22041; he would like to have your comments and suggestions for this column). ■



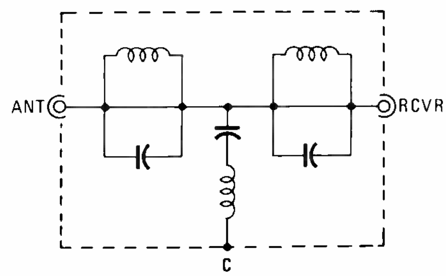


Fig. 3—When attenuation is needed for one or a narrow range of frequencies the most effective types are resonant-filters, which are tuned to the unwanted frequency. If necessary, series and parallel types can be combined.

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