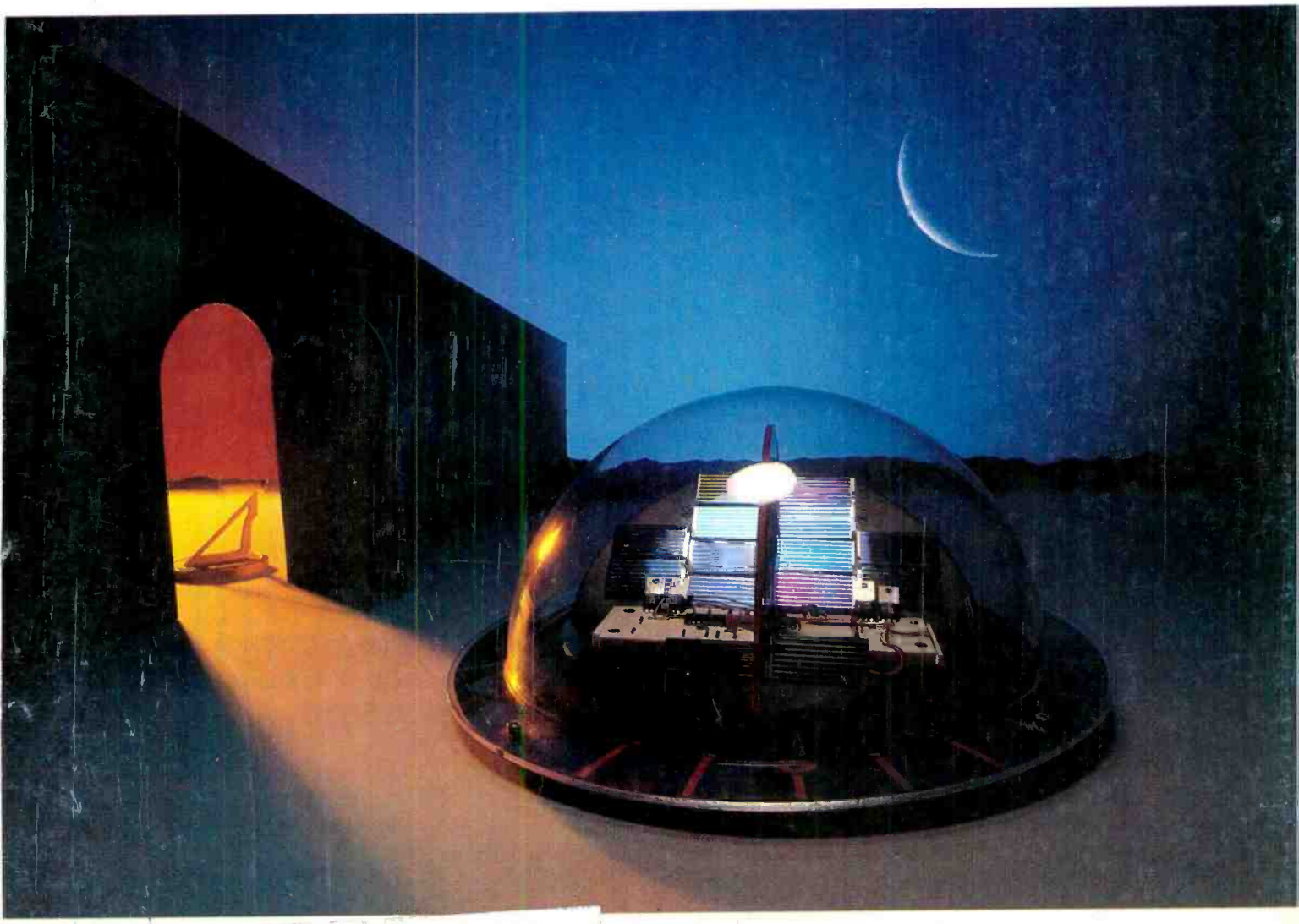
Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

MARCH 1980/95¢

Car Stereo Rating Standards
A Computerized Combination Lock
Planning a Home Electronics Workbench

Build a Solar-Powered Sundial



neer SR-303 Reverberation Amplifier
wn SA2 Stereo Power Amplifier
ard GT350ap Record Player

We're looking for the most original use of an Apple since Adam.

What in the name of Adam do people do with Apple Computers?

You tell us.

In a thousand words or less.

If your story is original and intriguing enough, you could win a one-week all-expense paid trip for two to Hawaii. Which is the closest we could come to paradise.

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To enter, drop by your nearest Apple dealer and pick up an entry blank. Fill it out. Then write an article, in 1000 words or less, describing the unusual or interesting use you've found for your Apple.

A jury of independent judges will cast the deciding vote for the grand prize: a week for two, airfare included, in Hawaii.

The judges will also choose 16 additional winners, two each from eight categories: graphics/music, entertainment, home, business, education, scientific, professional, and industrial. And each winner will choose from a long list of longed-after Apple peripherals—from Apple Disk II's to Graphics Tablets to printers. Or you can take a $250 credit towards the purchase of any Apple product.

The contest ends March 31, 1980. All winners will be notified by May 15.

Entry forms are available at your participating Apple dealer. Call 800-538-9696, (800-662-9238 in California), for the one nearest you.

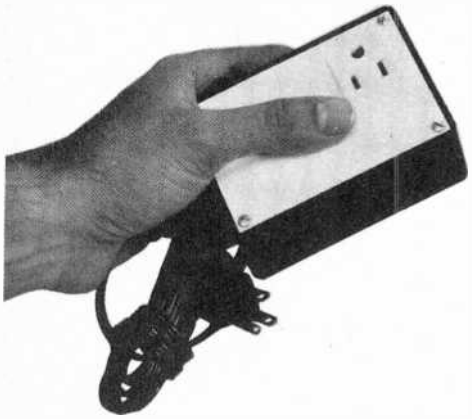
Mail the entry blank, your article and any photos to: Apple Computer, "What in the name of Adam" contest, 10260 Bandley Drive, Cupertino, CA 95014.

And may the juiciest application win.

apple computer

CIRCLE NO. 5 ON FREE INFORMATION CARD

NASA PATENT 4,052,648



Power Chopper T.M.

A new invention by America's space agency will help all Americans save energy and make some companies very wealthy.

Exxon has it. So does about a dozen other manufacturers. And if our hunches are correct, a new space-age product invented by NASA may not only save Americans millions of dollars but make fortunes for the companies that sell it.

The new NASA invention uses the latest space-age technology to save energy. Your refrigerator for example, is a major energy user. With this new device, your refrigerator compressor will run quieter, there will be considerably less heat generated from the motor, and it will run more efficiently saving up to 30% in energy.

The invention requires no installation. Just plug it into your outlet and plug your refrigerator into the device.

OVER PRICED UNIT

But there's a catch. Most manufacturers sell the device for as much as $200. Using it with your refrigerator, it will take many years before it will pay dividends. On a powerful motor, however, the device will pay for itself much quicker.

Manufacturers who have announced their units are selling them like hot cakes. Although you may have heard a great deal of publicity about the product, you may not have seen any advertising because most manufacturers are currently sold out.

Watch for it! We predict great success for all those associated with the product. The power-saving device invented by NASA is a big hit. It will grow in popularity and save energy and make many companies very successful.

A SMALL COMPANY

There is one small company however, that is credited with improving the device and developing it for the consumer market. Called ERI (Electronic Relays, Inc.) the company has developed several models to service specific products such as a refrigerator, a washing machine, dishwasher, swimming pool and a typewriter.

This small company actually improved the NASA invention by adding its own refinements. ERI had a great deal of experience in solid state relays which use TRIACs and integrated circuits–two important elements in the NASA invention. A TRIAC is a bidirectional thyristor which controls AC from a single control input. TRIACs also produce a great deal of heat.

ERI's experience taught them how to control the TRIAC and its heat dissipation and thus they were able to reduce the device's cost through more efficient handling of the heat problem. They were already one of the nation's largest purchasers of TRIACs–thus their costs were already low.

NATIONAL PUBLICITY

They called their product a Power Factor Controller and sent a sample to a national magazine for their review. In several tests, the device out-performed even the claims made by the manufacturer and the magazine ran a glowing article on their findings.

The manufacturer felt that the product might at first be misleading. Although it does save up to 30% on energy and in many cases up to 60%, ERI felt most consumers would expect a 30% reduction in their total electric bill–which of course the product will not do. Consumers will only get up to a 30% savings on the particular appliance used with the unit.

STILL PESSIMISTIC

The manufacturer also felt that the product was primarily for the industrial market–restaurants with large banks of refrigerators. The consumer must wait a few years before the device would pay for itself. And finally, the manufacturer did not feel that the consumer would respond in great numbers to the article which ran in the July, 1979 edition of *Popular Science* magazine.

Well, the consumer did respond. So much so that the small manufacturer, with absolutely no marketing staff, was buried with mail. The president of ERI called JS&A to help him out.

TEST ONE YOURSELF

We called it the Power Chopper and agreed to offer it to the consumer market for $29.95–a major price breakthrough.

Even if Exxon lowers their prices considerably, they'll never come close to the low cost of the Power Chopper. ERI's expertise with the TRIAC and JS&A's direct-to-consumer marketing, make the new NASA invention a practical power-saving accessory for every home.

The sophisticated electronics of the Power Chopper consist of a TRIAC, two integrated circuits and several solid-state devices.

We urge you to test just the refrigerator module. Order one from JS&A on a 30-day no-obligation trial. In the meantime, while you are waiting for your unit, feel the heat generated from the bottom of your refrigerator. Listen to the sound level of your compressor.

When the Power Chopper arrives, plug it in and notice how much quieter and cooler your refrigerator runs. See how much less time the compressor must run. The compressor not only will run more efficiently but will save energy every day you use it.

AWARD WINNER

If after 30 days you are not convinced that the Power Chopper will save you energy and money while making your refrigerator run smoother, then just unplug it and send it back for a prompt and courteous refund, including the $2.50 postage and handling. But if you've definitely noticed the difference, you'll want to purchase more units for the remainder of your motor-based appliances.

JS&A feels that ERI's technology, their improved NASA design and their low manufacturing costs will catapult them to the forefront of those introducing the new NASA invention. ERI's Power Chopper is one of the nation's major new innovative products and just recently won the Industrial Research IR-100 Award.

To order your Refrigerator Power Chopper, send **$29.95** for each unit plus $2.50 for postage and handling to JS&A Group, Inc., One JS&A Plaza, Northbrook, Illinois 60062. (Illinois residents please add 5% sales tax.) Credit card buyers may call our toll-free number below. We'll send your Refrigerator Power Chopper, one-year limited warranty and you'll be ready to save. If you wish to order additional units for other appliances at $29.95, you may, but we suggest you test the refrigerator module first and totally convince yourself.

GOVERNMENT REBATE

Purchase of the Power Chopper entitles you to a full 15% energy tax credit on your income tax return. It's like having the government give you a $4.50 rebate.

JS&A is America's largest single source of space-age products–further assurance that your purchase will be backed by service for years to come.

NASA technology was responsible for the development of the integrated circuit and many other space-age products. Their latest product could not have been developed at a better time. Start saving and order a Power Chopper at no obligation, today.

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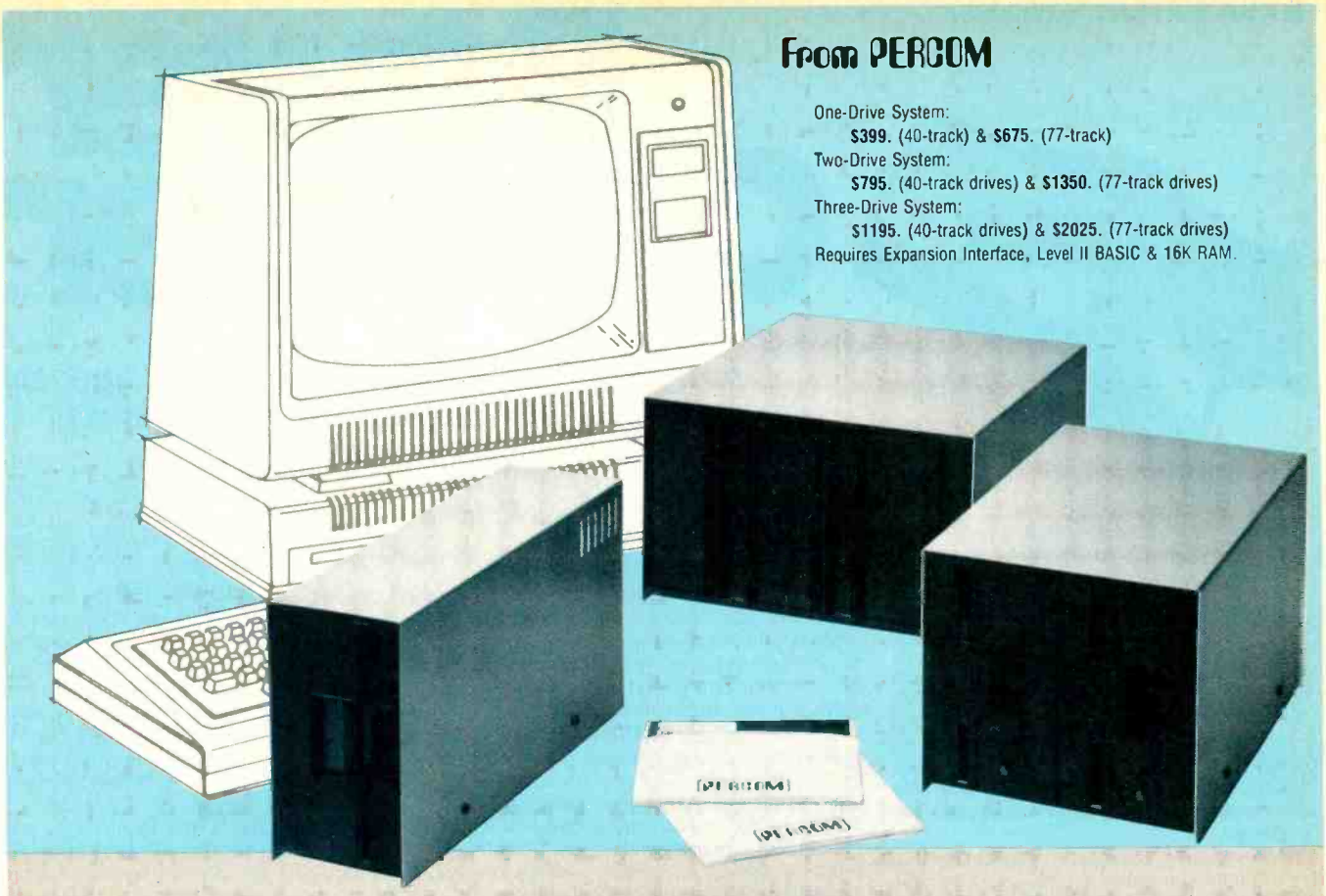

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Our TFD-100™ drive, for example, lets you store 102.4K bytes of data on one side of a disk — compared to 80K bytes on a TRS-80* mini-disk drive — and 102.4K bytes on the other side, too. Something you can't do with a TRS-80* drive. That's almost 205K bytes per mini-disk.

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PATCH PAK #1™, our upgrade program for your TRSDOS*, not only extends TRSDOS* to accommodate 40- and 77-track drives, it enhances TRSDOS* in other ways as well. PATCH PAK #1™ is supplied with each drive system at no additional charge.

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Orders may be paid by check or money order, or charged to Visa or Master Charge credit accounts. Texas residents must add 5% sales tax.

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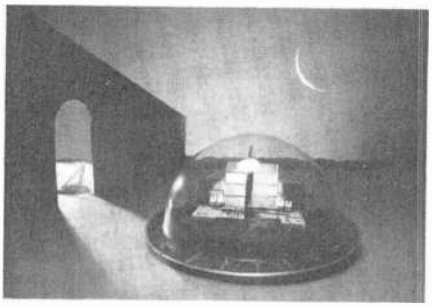
MARCH 1980

25TH ANNIVERSARY

Popular Electronics®

VOLUME 17, NUMBER 3

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE



About the cover:

Light-sensitive detectors and solar-powered battery charging are the heart of the electronic sundial pictured here.

Cover Photo by Don Carrol

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Editorial

ACTION & REACTION

"We have met the enemy and he is us."

Sometimes, technological advancements cause consequences that make one wonder why the latter weren't thought of beforehand. And why steps weren't taken to minimize them.

History is fraught with such examples: burning coal without considering how minimal harm to people and the atmosphere can be accomplished; designing vehicles without regard to damage-causing projections in the event of an accident; using CB radios with interference emissions initially so limited that they played havoc with TV receiver reception; and so on.

Technology should continue to be advanced, of course; but as it does, I foresee the creation of new occupations to attack problems that might be caused. Indeed, the whole field of environmental science grew up to wrestle with minimizing of air and water pollution. If manufacturers ignore such possibly deleterious effects, experience in recent years indicates that the government won't! And when this happens, overregulation quickly follows. The result is more costly products and services and reduced productivity; just what we don't need. The OSHA, for example, has a standards proposal to reduce environmental noise levels in plants. When implemented, it will cost $19,000 per worker. But $50 ear protectors would have done the job just as well.

Now the FCC has redefined Part 15 rules governing low power communication devices and the general requirements for a restricted radiation device (including computers, electronic games, tape recorders, calculators, and electronic watches). It has defined a computing device as any electronic device or system that uses digital techniques and has r-f energy exceeding 10,000 Hz or pulses per second. The standards set down are designed to head off TV interference problems caused by personal computers, which are escalating in sales, as well as by other products.

There's no doubt that tighter limitations on radiation are required. I just wish that the manufacturers had recognized the need and acted accordingly to correct the problem. The government's rules may be too stringent and the certification procedure too vexing for everyone's tastes. In any event, it's possible that digital electronic products will cost more next Christmas as a result of these rewritten rules.

Art Salsberg

The Personal Computer Line by OHIO SCIENTIFIC

Personal Computers

C1P: $349 A dramatic breakthrough in price and performance. Features OSI's ultra-fast BASIC-in-ROM, full graphics display capability, and large library of software on cassette and disk, including entertainment programs, personal finance, small business, and home applications. It's a complete programmable computer system ready to go. Just plug-in a video monitor or TV through an RF converter, and be up and running. 15K total memory including 8K BASIC and 4K RAM—expandable to 8K.

C1P MF: $995 First floppy disk based computer for under $1000! Same great features as the C1P plus more memory and instant program and data retrieval. Can be expanded to 32K static RAM and a second mini-floppy. It also supports a printer, modem, real time clock, and AC remote interface, as well as OS-65D V3.0 development disk operating system.

Professional Portables

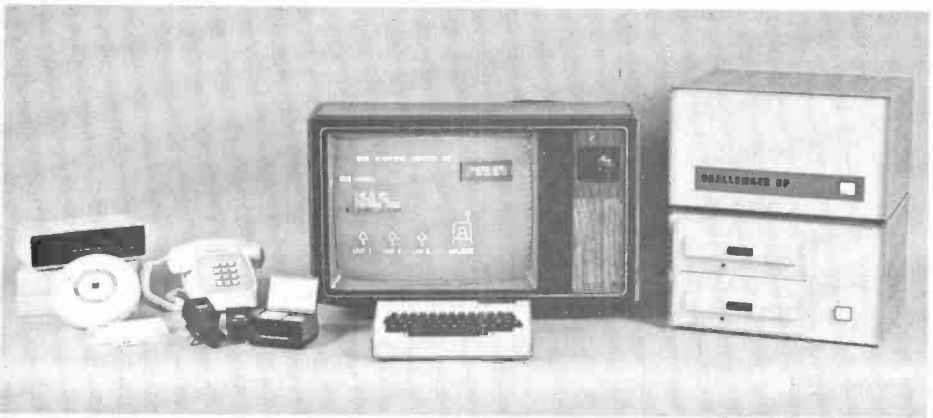
C4P: $698 The professional portable that has over three times the display capability of C1Ps. Features 32 x 64 character display in up to 16 *colors,* graphics, audio output, a DAC for voice and music generation, key pad and joystick interfaces, AC remote control interface and much more. Utilizes a 4-slot BUS (2 used in base machine), 8K BASIC-in-ROM, 8K of *static* RAM and audio cassette interface. Can be directly expanded to 32K static RAM and two mini-floppy disks.

C4P MF: $1695 The ultimate portable computer has all the features of the C4P plus real time clock, home security system interface, modem interface, printer interface, 16 parallel lines and an accessory BUS. The standard machine operates at twice the speed of currently available personal computers (with GT option it runs even faster!). The C4P MF starts with 24K RAM and a single mini-floppy and can be directly expanded to 48K and two mini-floppies. Available software includes games, personal, business, educational and home control applications programs as well as a real time operating system, word processor and a data base management system.

Computers come with keyboards and floppies where specified. Other equipment shown is optional.

Home/Small Business Systems

C8P: $895 Same great features as the C4P in a tremendously expandable "mainframe package." Features over three times the expansion capability of the C4P for advanced home and demanding business applications. Can be expanded to 48K RAM, dual 8" floppies, hard (Winchester) disks and multiple I/O devices such as Voice I/O and a universal telephone interface.



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Letters

OF RADS, REMS, AND RADIATIONS

I read "A Personal Radiation Monitor" in your January 1980 issue with great interest. However, it contained some inaccuracies with regard to units of measure that, in view of the large amount of misinformation about the subject in circulation today, I would like to clear up. What is described as the roentgen (R) is actually the rad (r), the standard unit of *absorbed* radiation dosage (1 erg absorbed per gram of matter). Absorbed radiation need not be gamma only. Rem is "rads equivalent to man," which gives a uniform scale to measure radiation harm to human beings. One rad of gamma is equivalent to only 0.05 rad of low-energy alpha radiation in rem dosage, calculated by multiplying absorbed rads by a constant RBE (relative biological effectiveness) factor.

The roentgen is actually a measure of radiation exposure or amount of radiation in any cubic volume of space. It is the amount of radiation required to release 1 coulomb of charge, by ionization, in 1 kg of air.

Harmful effects are not directly related to the energy of the radiation. They are more closely tied to the nuclear reactions that occur once the radiation is absorbed by the body. —*Peter L. Schestopol, New Paltz, NY.*

"PSEUDORANDOM" DEFINED?

With reference to Mr. Mims' "Pseudorandom Number Generator" ("Project of the Month," December 1979), it has been my experience that the term "pseudorandom" refers to an apparently random output that has been created by an algorithm, not the spectral purity of the algorithm's output. In other words, a collection of pseudorandom numbers might be as random as you could wish and indistinguishable from "true" random numbers. —*George R. Scott, Pensacola, FL.*

The article did not mean to imply that the spectral purity of the algorithm's output made it "pseudorandom." This quality comes from the design of the circuit itself. In any event, it now appears that the circuit presented is actually a great deal more random than was suggested. Mr. Mims will be taking up this subject in more detail in a future column.

HAS COME OF AGE

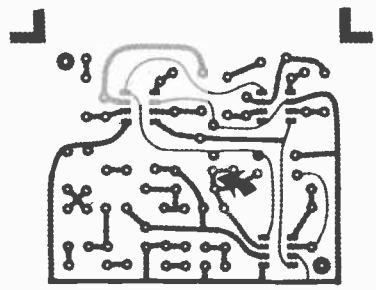
I noticed with delight Ray Wilkins' "LED Traffic Light" in the December 1979 issue of POPULAR ELECTRONICS. It seems to me that my electronic experimentation has "come of age" since I took up electronics as my hobby a couple of years ago. This past summer, I designed and built an identical-looking traffic light for my son. I run mine with just four 555 timers. —*Istvan Mohos, Phoenix, AZ.*

IN APPRECIATION

"Computer-Aided Morse Code Practice" (December 1979) is a beautiful article. It was refreshing to see a software article like this in POPULAR ELECTRONICS, especially since I own the correct hardware to take advantage of it. —*Steve Stanley, W2FQG, Latham, NY.*

Out of Tune

The etching and drilling guide of the "Audio Artist" (December 1979, p. 62) lacks one piece of connecting foil. The missing foil is indicated by an arrow in the half-size reproduction shown below. If you have already etched a circuit board, simply solder a jumper wire to take the place of the missing foil.



MORE CAPABILITIES THAN ANY OTHER PERSONAL COMPUTER UNDER $1,000*

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Run your own programs? Easy. Just plug in the 8K BASIC or optional Assembler language cartridge, and go. They're ROM based. That means more RAM for your programs.

Also included with the ATARI 800 is an internal speaker and four separate sound channels, FCC approval, a built-in RF modulator, the ATARI 410™ Program Recorder and a high speed serial I/O.

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Graphics programs? No problem. The ATARI 800 offers 128 color variations: 16 colors in 8 luminance levels. Plus 29 keystroke graphics symbols and 8 graphics modes. All controlled from a 57 character ASCII keyboard. With upper and lower case.

Or, program it our way. There are exciting programs available and many more on the way for the ATARI 800. Business programs. Home Management programs. Entertainment. And with the 410 audio/digital recorder, you can add Atari's unique Talk & Teach™ Educational System cassettes.

Your way or our way, you'll find that the ATARI 800 is probably the most powerful computer that $999.99* can buy.

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But if anything ever does go wrong, you'll find a complete network of computer-connected Atari service facilities waiting for you throughout the country.

Make your own comparison. Hands on. Anywhere computers are sold. Or, send for a free chart that compares the features of the ATARI 800 to other leading fully-programmable computers.

*Suggested retail price $999.99, includes computer console, program recorder and BASIC language cartridge.

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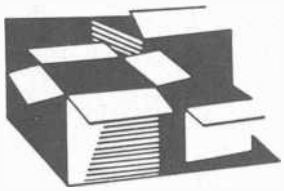


New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

Computer-Controlled Car Stereo

Kenwood's top-of-the-line Model KRC-711 in-dash car stereo AM-FM receiver-cassette player contains four power amplifiers. Two, rated at 5 W/channel, are intended for speakers at the front; the remaining pair, rated at 20 W each, are for

rear speakers. Among its micropocessor-controlled features are: automatic blending of FM channels, switching to mono, and hunting for a stronger station as more and more noise is encountered. If no station is available, the receiver can automatically switch to a cassette, which can be precued and left in standby mode with safety. Tuning is by means of a phase-locked loop with digital readout, and Dolby noise reduction is included for tape playback and FM. $449.

CIRCLE NO. 88 ON FREE INFORMATION CARD

Business-Computer Information Package

Heath is offering an educational package designed to help business people learn how computers can provide benefits for their operations. Entitled *Computer Concepts for Small Business*, the program includes three audio cassettes and a 160-

page workbook. Software, memory, storage media, and input/output devices are discussed in a way that presupposes no prior knowledge of computers. Also covered are personnel requirements, and the relative advantage of time-sharing vs. service bureau vs. owning. $50.

CIRCLE NO. 90 ON FREE INFORMATION CARD

NBS-Traceable Frequency Counter

Optoelectronics' Model 8010 is a frequency counter sold with NBS-traceable calibration. Its rated frequency range extends to 1 GHz, with a 1-ppm TCXO. Aging of the timebase is said to be less than 0.1 ppm per month. Sensitivity is rated at 1-10 mV from 10 Hz to 60 MHz, with 1-megohm input impedance, and 5-25 mV from 25 MHz to 1 GHz with 50-ohm input impedance. Resolution of 9 digits is available from a red LED readout 0.4" (10-mm) high. The unit is housed in a black anodized aluminum case that is shielded against r-f. $325.

CIRCLE NO. 91 ON FREE INFORMATION CARD

Stereo Headphones

Koss Corp. announces that its new HV/X headphones offer new psychoacoustic benefits to the listener by combining the auditory characteristics of a closed type of dynamic headphone with the free sound field of a hear-through, high-velocity type.

This was made possible, says Koss, by an exclusive, variable-density earcushion that remains transparent to high and middle frequencies while effectively forming a seal for the bass. HV/X stereophones also include dual suspension headbands and adjustable slide bars for a comfortable fit. Model HV/X sells for $70, and Model HV/XLC with individual balance controls for each earcup for $80.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Wireless Remote Control

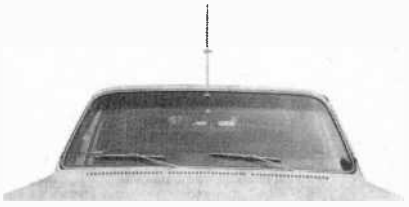
The Plug 'n Power Wireless Remote Control from Radio Shack handles up to 16 ac-operated devices without installation of special wiring. The control box is plugged into any standard ac outlet, while each

lamp or appliance plugs into a switch module that plugs into a nearby ac receptacle. Modules for incandescent lamps, rated for loads up to 300 watts, can be turned to on, dim, bright or off. Appliance modules handle devices rated to 15 amperes or incandescent loads to 500 watts. A switch module designed to replace wall switches is available for incandescent lights up to 500 watts total. "House code" settings on the control center allow up to 16 (256 circuits total) to be used at once. An "all-on" or "all-off" control can be used in case of emergencies. Dimensions are 4¾" × 3½" × 3½" (121 × 89 × 89 mm). Control center $40; switch modules $15.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Glass-Mounted UHF Antenna

Avanti is now offering Model AH450.5G, a mobile uhf antenna for ham radio applications. Said to give 5-dB gain, the new design is for work on 440-450 MHz and is tunable from 406-512 MHz. Its external



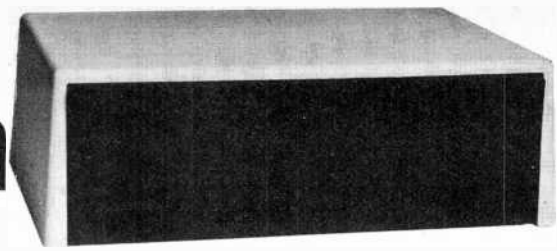
portion mounts to a glass surface by means of a special adhesive, and signal is fed to it via a "High-Q" impedance coupling device that includes a noise-reduction system. This eliminates the need for drilling holes in the vehicle and protects the feeder cable from deterioration. The 0.75-meter stainless steel whip is specially plated to reduce skin-effect losses; other external parts are triple-chrome plated for protection. Also featured in the system is a horizontal phasing loop to link two separate antennas.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Mini Recording Studio

Designed for musicians, composers, and recording enthusiasts, the new Portastudio 20 from Teac combines a four-in two-out

Burglar Alarm Breakthrough



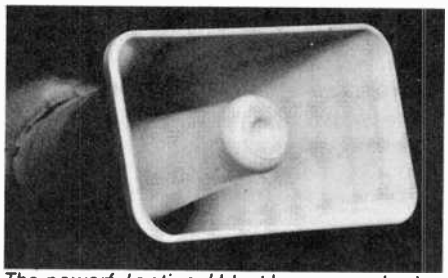
A new computerized burglar alarm requires no installation and protects your home or business like a thousand dollar professional system.

The Midex security computer looks like a handsome stereo system component and measures only 4"x 10½"x 7."

It's a security system computer. You can now protect everything—windows, doors, walls, ceilings and floors with a near fail-safe system so advanced that it doesn't require installation.

The Midex 55 is a new motion-sensing computer. Switch it on and you place a harmless invisible energy beam through more than 5,000 cubic feet in your home. Whenever this beam detects motion, it sends a signal to the computer which interprets the cause of the motion and triggers an extremely loud alarm.

The system's alarm is so loud that it can cause pain—loud enough to drive an intruder out of your home before anything is stolen or destroyed and loud enough to alert neighbors to call the police.



The powerful optional blast horns can also be placed outside your home or office to warn your neighbors.

Unlike the complex and expensive commercial alarms that require sensors wired into every door or window, the Midex requires no sensors nor any other additional equipment other than your stereo speakers or an optional pair of blast horns. Its beam actually penetrates walls to set up an electronic barrier against intrusion.

NO MORE FALSE ALARMS

The Midex is not triggered by noise, sound, temperature or humidity—just motion—and since a computer interprets the nature of the motion, the chances of a false alarm are very remote.

An experienced burglar can disarm an expensive security system or break into a home or office through a wall. Using a Midex system there is no way a burglar can penetrate the protection beam without triggering the loud alarm. Even if the burglar cuts off your power, the four-hour rechargeable battery pack will keep your unit triggered, ready to sense motion and sound an alarm.

ARRIVE HOME SAFE

There's personal danger in arriving home and finding a burglary in progress. And, if you surprise the burglar, you risk the chance of serious injury. With the Midex 55 protecting your home, you can open your front door with the confidence of knowing that no burglar lurks inside.

When the Midex senses an intruder, it remains silent for 20 seconds. It then sounds the alarm until the burglar leaves. One minute after the burglar leaves, the alarm shuts off and resets, once again ready to do its job. This shut-off feature, not found on many expensive systems, means that your alarm won't go wailing all night long while you're away. When your neighbors hear it, they'll know positively that there's trouble.

PROFESSIONAL SYSTEM

Midex is portable so it can be placed anywhere in your home. You simply connect it to your stereo speakers or attach the two optional blast horns.

Operating the Midex is as easy as its installation. To arm the unit, you remove a specially coded key. You now have 30 seconds to leave your premises. When you return, you enter and insert your key to disarm the unit. You have 20 seconds to do that. Each key is registered with Midex, and that number is kept in their vault should you ever need a duplicate. Three keys are supplied with each unit.

As an extra security measure, you can leave your unit on at night and place an optional panic button by your bed. But with all its optional features, the Midex system is complete, designed to protect you, your home and property just as it arrives in its well-protected carton.

The Midex 55 system is the latest electronic breakthrough by Solfan Systems, Inc.—a company that specializes in sophisticated professional security systems for banks and high security areas. JS&A first became acquainted with Midex after we were burglarized. At the time we owned an excellent security system, but the burglars went through a wall that could not have been protected by sensors. We then installed over $5,000 worth of the Midex commercial equipment in our warehouse. When Solfan Systems announced their intentions to market their units to consumers, we immediately offered our services.

COMPARED AGAINST OTHERS

In a recent issue of a leading consumer publication, there was a complete article written on the tests given security devices which were purchased in New York. The Midex 55 is not available in New York stores, but had it been compared, it would have been rated tops in space protection and protection against false alarms—two of the top criteria used to evaluate these systems. Don't be confused. There is no system under $1,000 that provides you with the same protection.

YOU JUDGE THE QUALITY

Will the Midex system ever fail? No product is perfect, but judge for yourself. All components used in the Midex system are of aerospace quality and of such high reliability that they pass the military standard 883 for thermal shock and burn-in. In short, they go through the same rugged tests and controls used on components in manned spaceships.

Each component is first tested at extreme tolerances and then retested after assembly. The entire system is then put under full electrical loads at 150 degrees Fahrenheit for an entire week. If there is a defect, these tests will cause it to surface.

PEOPLE LIKE THE SYSTEM

Wally Schirra, a scientist and former astronaut, says this about the Midex 55. "I know of no system that is as easy to use and provides such solid protection to the homeowner as the Midex. I would strongly recommend it to anyone. I am more than pleased with my unit."

Many more people can attest to the quality of this system, but the true test is how it performs in your home or office. That is why we provide a one month trial period. We give you the opportunity to see how fail-safe and easy to operate the Midex system is and how thoroughly it protects you and your loved ones.

Use the Midex for protection while you sleep and to protect your home while you're away or on vacation. Then after 30 days, if you're not convinced that the Midex is nearly fail-safe, easy to use, and can provide you with a security system that you can trust, return your unit and we'll be happy to send you a prompt and courteous refund. There is absolutely no obligation. JS&A has been serving the consumer for over a decade—further assurance that your investment is well protected.

To order your system, simply send your check in the amount of **$199.95** (Illinois residents add 5% sales tax) to the address shown below. Credit card buyers may call our toll-free number below. There are no postage and handling charges. By return mail you will receive your system complete with all connections, easy to understand instructions and a one year limited warranty. If you do not have stereo speakers, you may order the optional blast horns at **$39.95** each, and we recommend the purchase of two.

With the Midex 55, JS&A brings you: 1) A system built with such high quality that it complies with the same strict government standards used in the space program, 2) A system so advanced that it uses a computer to determine unauthorized entry, and 3) A way to buy the system, in complete confidence, without even being penalized for postage and handling charges if it's not exactly what you want. We couldn't provide you with a better opportunity to own a security system than right now.

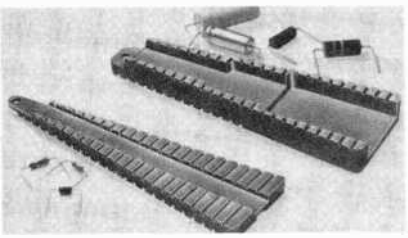
Space-age technology has produced the ultimate personal security computer. Order your Midex 55 at no obligation, today.

mixer with a multi-track cassette recorder. The recorder runs at 3¾ ips for greater dynamic range than possible at the normal cassette speed, and can record two tracks in sync or play back all four at once. Using simul-sync and "ping-pong" recording, the unit is said to be able to record 10 separate parts without dubbing any more than once. A pitch control of ± 15% is also included. Specifications include: S/N 68 dB weighted, for the mixer; S/N 50 dB (with Dolby), wow and flutter 0.04%, frequency response 20-18,000 Hz for the recorder. Total weight is under 20 lb (9.1 kg). $1,100.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Component Lead Bender

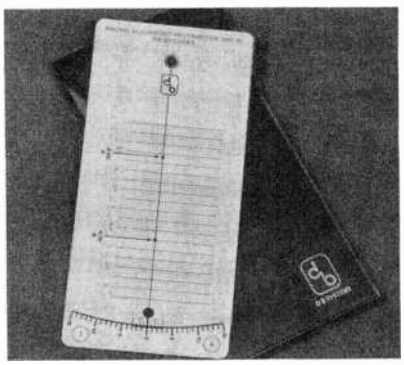
Companion to the familiar Model 801 Speedy Bend I, which handles ¼-W and ½-W resistors and diodes, the new Model 901 Speedy Bend II from Production



Devices forms the leads of 1- and 2-W resistors and components 1" (25.4 mm) and 1¼" (32 mm) long. Spacing between the bends can be adjusted in 0.050" (1.27-mm) increments. Speedy Bend I, $2; Speedy Bend II, $3. Address: Production Devices, 7859 Raytheon Rd., San Diego, CA 92111.

Phono Stylus Protractor

New from DB Systems is the DBP-10 Phono Alignment Protractor, an instrument said to be able to measure the lateral tracking error of a mounted cartridge to a precision of ±0.25°. The manufacturer states that, by using the recommended adjustment procedure, a user can align a phono cartridge for optimum geometry (a compromise in the case of pivoted tonearm) and achieve minimum playback distortion. This is accomplished without reference to tables and without measuring effective arm length. The unit is made of heavy plastic and comes with a carrying case. $20.



CIRCLE NO. 96 ON FREE INFORMATION CARD

Protection for Floppy Disks

"Floppy Saver" is a reinforcing ring of 7-mil Mylar with adhesive backing which is put on computer program disks to protect them from possible damage. A kit is available which includes a number of the reinforcing rings, a tool for putting them on the disks, and a centering post. The kit is $14.95. Address: Tri-Star Corp., P.O. Box 1727, Grand Junction, CO 81501.

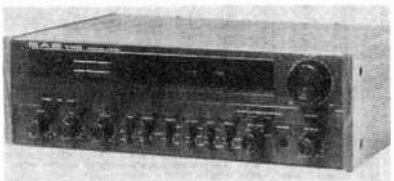
Automotive Air Freshener

Air pollution lurking in automobiles and trucks is the largest of Electrolert's new "Airbuster." Readily attachable to a vehicle's dashboard, the unit is said to freshen the air by causing an increase in the number of negative ions. The manufacturer claims, in addition, that the Airbuster cleans the air by causing precipitation of dust and particulate pollutants. $110.

CIRCLE NO. 97 ON FREE INFORMATION CARD

SAE Two Integrated Amp

The A7 integrated amplifier was recently added to the SAE Two line from Scientific Audio Electronics. Provided with full complementary output stages, the unit is rated to deliver 70 watts per channel to an 8-



ohm load, 20-20,000 Hz, with no more than 0.05% THD and IM. In addition to its low-noise phono section, the A7 includes an external processor loop to allow connection of external accessories. It also contains a fluorescent bargraph display of power output at the speaker terminals of voltage output at the tape monitor jacks. $400.

CIRCLE NO. 98 ON FREE INFORMATION CARD

TRS-80 Cassette Loader

GB Associates' C-LOADER is said to eliminate CLOAD and CLOAD? problems encountered in TRS-80 computers. The C-LOADER device connects between the EAR jack of the cassette deck and the cable to the TRS-80 keyboard. It requires no electrical power or batteries. C-LOAD is available in two models: Model 800 is for programs generated on the TRS-80 and most commercially available tapes, while Model 810 is for machine-language tapes recorded with inverted polarity. $12.95. Address: GB Associates, P.O. Box 3322, Granada Hills, CA 91344.

VTR Control Center

Superex's Model VTRS-4 is a switching center capable of accommodating four video tape decks. Dubbing can be performed

from one deck onto three others without the necessity of changing connections. An alternate camera input enables multiple recordings of live sources to be made. Insertion loss of the device is said to be unmeasurably low, with rated frequency response extending from dc to 10 MHz. $60.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Rugged Bookshelf Speaker

The Model V-6 from Genesis Physics is a compact bookshelf loudspeaker whose designation comes from the design of its low-frequency section (vented, with a 6-inch driver). Rated frequency response is 52-20,000 Hz, ±4 dB, with moderately high efficiency of 89 dB at 1 meter for a 1-W input. Said to be capable of handling a continuous 75-W input, the speaker should

be able to produce 107 dB SPL at 1 meter. The tweeter is designed to withstand repeated 1-kW pulses and, with the rest of the system, carries a lifetime warranty to the original owner. The manufacturer states that the enclosure, constructed of walnut-veneered ¾" particleboard, is optimized to work with the woofer. $116.

CIRCLE NO. 100 ON FREE INFORMATION CARD

NEW Scanners! NEW Prices! NEW Club!

Communications Electronics,™ the world's largest distributor of radio scanners, has new prices, on new scanner models and accessories. A scanner, when teamed up with your CB, will give you up-to-the-second information that you can't get elsewhere. If you don't have at least one scanner, the time to buy is now!

Since **CE** distributes more scanners worldwide than *anyone* else, we can give you rock bottom prices. Our warehouse facilities are equipped to process over 1,000 scanner orders per week and our order lines are always staffed 24 hours. We also export scanners to more than 300 countries and military installations. Almost all items are **in stock** for **immediate shipment**, so purchase your scanner from **CE** now!

NEW! Bearcat®† 300

Available April – May, 1980

List price $519.95/CE price $339.00

7-Band, 50 Channel • Service Search • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 32-50, 118-136 AM, 144-174, 421-512 MHz.

The new *Bearcat* 300 is the most advanced automatic scanning radio that has ever been offered to the public. The *Bearcat* 300 uses a bright green fluorescent digital display, so it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search.

Bearcat® 250

List price $419.95/CE price $269.00

50 Channels • Crystalless • Searches Stores • Recalls • Self-Destruct • AC/DC Priority Channel • 6-Band • Count Feature.

Frequency range 32-50, 146-174, 420-512 MHz.

The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring.

Aircraft Bearcat® 220

List price $419.95/CE price $269.00

Aircraft and public service monitor. *Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.*

The *Bearcat* 220 is one scanner which can monitor all public service bands plus the exciting AM aircraft band channels. Up to twenty frequencies may be scanned at the same time.

Bearcat® 211

List price $349.95/CE price $239.00

Frequency range: 32-50, 146-174, 420-512 MHz.

The *Bearcat* 211. It's an evolutionary explosion of features and function. 18-channel monitoring. With no-crystal six-band coverage. Dual scan speeds. Color-coded keyboard. Even a digital clock. All at a modest price. More scanning excitement than you bargained for.

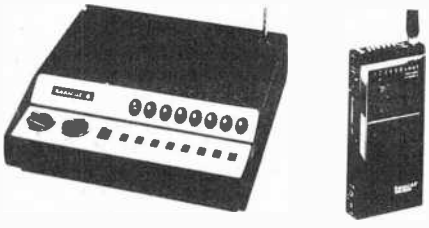
Bearcat® 210

List price $299.95/CE price $199.00

10 Channels • 5 Bands • Crystalless

Frequency range: 30-50, 146-174, 420-512 MHz.

Use the simple keyboard to select the 10 channels to be scanned. Automatic search finds new frequencies. The 210 features patented selectable scan delay, push button lockout, single antenna, patented track tuning, AC/DC operation. With no crystals to buy. Ever!



Bearcat 5 and 4-6 Thin Scan™

FREE Bearcat® Crystal Offer

Buy a *Bearcat* 12 between February 1 and March 31, 1980, and you'll get a coupon good for four free crystals sent directly to you from Electra Company. You'll get two free crystals with your purchase of the *Bearcat* 8-Track or any Hand-Helds. Offer valid only on purchases of *Bearcat* Crystal Scanners between February 1 and March 31, 1980. Restricted to one Free Crystal Offer per consumer regardless of number of scanners purchased. Void where taxed or prohibited by law. Requests must be postmarked no later than April 18, 1980. Allow four to six weeks for delivery. To qualify for this offer you must send proof of purchase and the *Bearcat* Stringed Card attached to the front of your new crystal scanner, along with the frequencies desired to: *Bearcat* Free Crystal Offer, Electra Company Box 29243, Cumberland, Indiana 46229.

Bearcat® 12

List price $179.95/CE price $119.00

10 Channels • 5 Bands • AC or DC

Frequency range: 33-48, 146-174, 450-512 MHz.

More features, more channels, more action. The *Bearcat* 12 has automatic squelch, individual lockout and more.

NEW! Bearcat® 5

Available April — May, 1980

List price $129.95/CE price $94.00

8 Channels • 4 Bands • AC only

Frequency range: 33-50, 146-174, 450-512 MHz.

The *Bearcat* 5 is a value-packed crystal scanner built for the scanning professional — at a price the first-time buyer can afford. Individual lockout switches.

Bearcat® 8 Track

List price $99.95/CE price $79.00

4 Channels • 2 Bands • Plays off any AC or DC Powered 8 Track Tape Player.

Frequency range: 36-44, 152-162 MHz.

This incredibily compact 4-channel/2-band crystal scanner plugs into the tape player where an 8 track cartridge normally goes.

Bearcat® Four-Six

List price $179.95/CE price $119.00

The first 4 Band, 6 Channel, Hand-Held Scanner.

Frequency range: 33-47, 152-164, 450-512 MHz.

The *Bearcat* Four-Six offers "hip pocket" access to police, fire, weather and special interest public service broadcasts. Lightweight. Extremely compact.

NEW! Bearcat® Four-Six ThinScan™

List price $179.95/CE price $119.00

Frequency range: 33-47, 152-164, 450-508 MHz.

The incredible, new *Bearcat* Four-Six Thin Scan™ is like having an information center in your pocket. This four band, 6 channel crystal controlled scanner has patented Track Tuning on UHF. Scan Delay and Channel Lockout. Measures 2¾ x 6½ x 1." Includes rubber ducky antenna.

Bearcat® ThinScan™

List price $149.95/CE price $99.00

World's smallest scanner!

There are now three models available. The **BC 2-4 L/H** receives 33-44 and 152-164 MHz. The **BC 2-4 H/U** receives 152-164 and 450-508 MHz. The Aircraft ThinScan™ model **BC 2-4 AC** receives 118-136 and 450-470 MHz. The *Bearcat* ThinScan™ measures 2¾ " across. Just 1" deep. And 5⅝" high.

INCREASED PERFORMANCE ANTENNAS

If you want the utmost in performance from your scanner, it is essential that you use an external antenna. We have six base and mobile antennas specifically designed for receiving all bands. Order **#A60** is a magnet mount mobile antenna. Order **#A61** is a gutter clip mobile antenna. Order **#A62** is a trunk-lip mobile antenna. Order **#A63** is a ¾ inch hole mount. Order **#A64** is a ⅜ inch snap-in mount, and **#A70** is an all band base station antenna. All antennas are $25.00 and $3.00 for UPS shipping in the continental United States.

OTHER SCANNER ACCESSORIES

SP50 AC Adapter	$12.00
SP51 Battery Charger	$12.00
SP55 Carrying Case for *Bearcat* Four-Six	$15.00
SP57 Carrying Case for *Bearcat* 2-4 only	$15.00
FB-E Frequency Directory for Eastern U.S.	$15.00
FB-W Frequency Directory for Western U.S.	$15.00
B-31.2 V AA Ni-Cad's for Four-Six (Pack of 4)	$15.00
B-41.2 V AAA Ni-Cad's for ThinScan™ (Pack of 4)	$15.00
B-5 Replacement memory battery for Bearcat 210	$5.00
A-135cc Crystal certificate	$4.00

Add $3.00 shipping for all accessories ordered at the same time.

TEST ANY SCANNER FREE

Test any scanner purchased from **Communications Electronics™** for 31 days before you decide to keep it. If for any reason you are not completely satisfied, return it in new condition with all parts in 31 days, for a courteous and prompt refund (less shipping and handling charges).

NEW! Improved Regency K500

CIRCLE NO. 1 ON FREE INFORMATION CARD

NEW! Regency®‡ K500

CE price $269.00

40 Channel • Synthesized • Service Search Digital count • Weather with tone alert Search/Store • Priority Channel • AC/DC

Frequency range: 30-50, 144-174, 440-512 MHz.

The new *Regency* Touch K500 is an advanced synthesized scanner with many new features.

OTHER REGENCY® SCANNERS

Touch K100	$189.00
Aircraft Touch 720-A	$239.00
NEW! Touch M100	$189.00
E-106	$109.00
R-106	$95.00
R-804	$89.00

World Scanner Association™

The WORLD SCANNER ASSOCIATION is sponsored as a public service by **Communications Electronics.™** When you join, you'll receive a quarterly newsletter with scanner news and features. You'll also get a wallet I.D. card, an Official Personalized WSA Membership Certificate, and the latest FCC news affecting monitoring such as frequency allocations. FREE classified ads for members so you can contact other scanner owners when you want to sell or buy a scanner. FREE membership in the WSA Buyer's Co-op. Your Co-op membership will allow you to get special discounts on scanners and scanner related products. Since the WSA Buyer's Co-op gives you group purchasing power, you can easily pay for your membership dues the first time you make a Co-op purchase. WSA is your united voice to governmental and public service agencies as well as scanner manufacturers. You'll get inside information on the latest scanner products before the general public. Since WSA is *not* affiliated with any scanner manufacturer, you can rely on accurate product reports. You get all this for only $12.00 annual dues! And if you join before June 30, 1980, **CE** will pay $2.00 of the cost of your first year's dues as a "charter member." You can charge your "charter membership" on Visa or Master Charge so join now! Add $5.00 for foreign memberships.

BUY WITH CONFIDENCE

To ***get the fastest delivery from CE*** of any scanner, send or phone your order directly to our Scanner Distribution Center." Be sure to calculate your price using the CE prices in this ad. Michigan residents please add 4% sales tax. Written purchase orders are accepted from approved government agencies and most well rated firms at a 10% surcharge for net 30 billing. All sales are subject to availability. All sales on accessories are final. Prices and specifications are subject to change without notice. Out of stock items will be placed on backorder automatically unless CE is instructed differently. International orders are invited with a $10.00 surcharge for special handling in addition to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Personal checks require three weeks bank clearance.

Mail orders to: **Communications Electronics,™** Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $5.00 per scanner for U.P.S. *ground* shipping, $9.00 for faster U.P.S. *air* shipping or $30.00 for *overnight delivery* to most major U.S. cities via Federal Express or Airborne Air Freight. If you have a Master Charge or Visa card, you may call anytime and place a credit card order. **Order toll free** 800-521-4414. If you are outside the U.S. or in Michigan, dial 313-994-4444. You may also order via TWX 810-223-2400. **Dealer inquiries invited.** All order lines at **Communications Electronics™** are staffed 24 hours.

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‡*Regency* is a federally registered trademark of Regency Electronics Inc.

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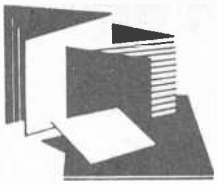
We're first with the best.℠



New Literature

INFORMATIONS SYSTEMS CATALOG

A 52-page catalog of minicomputer, computer, word-processing, and microfilm supplies and accessories is available, featuring brand-name diskettes, cassettes, and storage and retrieval systems. Address: Computer Resources Co. of NY, Suite 1500, 2 Penn Plaza, New York NY 10001.

BASICS OF HI-FI

"An Introduction to Stereo," is the title of a 16-page booklet giving the fundamentals of high fidelity—without being too technical. Its chief purpose, according to the sponsors, is to enable the consumer to understand a manufacturer's technical specifications and make intelligent comparisons. Send self-addressed stamped envelope to: Yamaha Audio, P.O. Box 6600, Buena Park, CA 90620.

COMMUNICATIONS ANTENNA CATALOG

Cushcraft's new Proline PL-8 catalog provides detailed electrical and mechanical data on over 25 different antenna models that are broadbanded or field tunable and cover from 30 to 512 MHz. It also depicts both 5- and 10-element CATV/MATV single-channel Yagis and information on phasing. Address: Cushcraft Corp. Box 4680, Manchester, NH 03108.

APPLE SOFTWARE CATALOG

Rainbow Computing's 45-page Apple Software Catalog includes software, accessories, and peripherals listings as well as over 100 programs. The latter cover games (a "Pot O' Gold" special is 49 games and demos on a single cassette for $49); fifteen business applications; and software development programs. Address: Rainbow Computing, Inc., 9719 Reseda Blvd., Northridge, CA 91324.

DX LISTENING LITERATURE

The WTFDA (Worldwide TV-FM DX Association) has released a new pamphlet of interest to TV, FM, and V-UHF-utility DXers. In it is a description of WTFDA and the organization's monthly journal, *VHF-UHF Digest*, membership information, and brief summaries on the advantages of TV, FM, and V-UHF DXing. Send a self-addressed stamped envelope for a free pamphlet. For $1, a sample copy of *VHF-UHF Digest* may be obtained. Address: WTFDA, Box 97, Calumet City, IL 60509.

ENCLOSURE KIT DATA SHEET

A 2-page data sheet published by Pac Tec describes its six lines of electronics enclosures kits for prototype designers, model builders, and hobbyists. The enclosures using ABS material with molded-in color, come with hardware and parts to permit custom work on the user's part. Address: Pac Tec Div. of LaFrance Corp., Enterprise and Executive Aves., Philadelphia, PA 19153.

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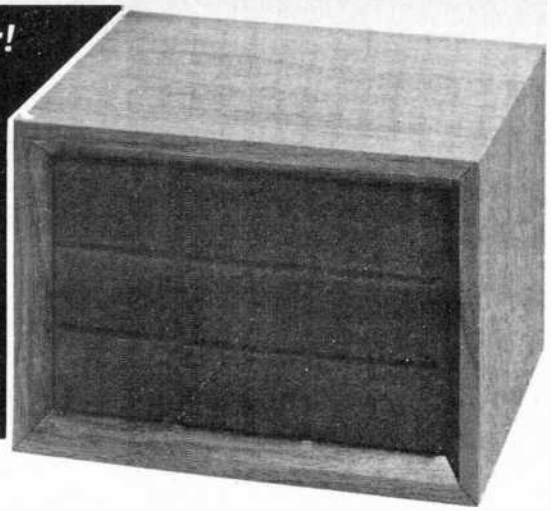

Low Cost Computerized Burglar Alarm System Home - Office - Business

The Guardex 8000 Alarm System is walnut grained and disguised to look like a small stereo speaker (6¾" × 9¾" × 8") and weighs less than 6½ pounds.

NO INSTALLATION

Just plug the Guardex 8000 alarm system in, make several simple control adjustments to suit your particular building and it works! There are no other wires to run. This totally self-contained burglar alarm can completely seal off every square inch of the surface of your building. It protects doors, windows, and what most alarms miss... your roof, walls and floors.

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Guardex 8000 Alarm System works on the principle of audio discrimination. This, put simply, is the process of electronically separating normal everyday sounds, such as voices, telephones, etc. from break-in type noises such as breaking glass, prying metal, or forcing a door open. The Guardex 8000 protects one story homes and offices up to 2000 square feet and open commercial buildings up to 10,000 square feet. The Guardex 9300 with wireless remote sensor capability is available for multi-story homes and offices or single story with more than 2000 square feet. Call the factory for more detailed information.

TURNS ON LIGHTS AUTOMATICALLY

When the first break-in type sound is detected, the system will instantly turn on lights, radio, or other electronic equipment that you have plugged into the back of the alarm. These lights or other equipment will remain on for a period of five minutes, then automatically turn off.

POWERFUL ELECTRONIC SIREN

The Guardex 8000 alarm is equipped with a loud built-in siren. If during the five minute period the lights or other electronic equipment has been activated, a second break-in sound is detected, (it can be only a second or two after the first break-in sound) the built-in siren will start blasting for 90 seconds. At the end of approximately 90 seconds the siren will shut off and the alarm listens again. If another break-in sound is heard, the siren will come on for another 90 seconds. If no other break-in sound is detected, the siren will stay off and at the end of the five minute period the lights will shut off and the alarm instantly resets.

The rear control panel contains two standard AC plug receptacles for a table lamp, spot lights, radio, etc.; terminals for connecting optional outside siren and back-up battery (not included); entry delay time control and sensitity control.

EXIT AND ENTRY DELAY

The Guardex 8000 alarm has a built-in exit delay allowing you approximately one minute to lock up and leave the building before the alarm is armed. When you enter your building you may find that just your normal entering sounds activate the siren. You may delay it from starting for up to 30 seconds by turning up the siren entry delay control.

BATTERY BACK-UP

Burglars rarely cut power. However, to give you total protection from a burglar and possible power failure, our alarm has provisions for a battery back-up. (Batteries not included). 12 volt lantern batteries are available at most hardware stores.

THE BURGLARY PROBLEM

The F.B.I. statistics show that at the present rate, one out of every four Americans are going to be burglarized. That is not a very pleasant fact, but it is true. You have a greater chance of being burglarized than being a victim of a fire or automobile accident. The time is now to help protect yourself and your valuables with a Guardex 8000 alarm system.

OUTSIDE SIREN

The Guardex 8000 alarm is equipped with a loud, built-in siren, but if you desire an additional siren to mount outside or in an area away from the main alarm, they are available with 50 feet of wire for $24.95. (Connecting terminals are provided on the back of the alarm).

30 DAY NO RISK TRIAL

This is your opportunity to purchase an alarm system directly from the factory for only $199.95. Try it in your home or business for thirty days without risking one cent. Put our Guardex 8000 alarm to your own test. See for yourself! It will protect every window and door from break-in. If you are not completely satisfied, return the alarm within 30 days for a complete refund. To order your Guardex 8000 alarm, CALL TOLL FREE to charge your credit card or send your check to Guardian Electronics, Inc. in the amount of $199.95. If you want the optional outside siren, add $24.94. (California residents add 6% sales tax.)

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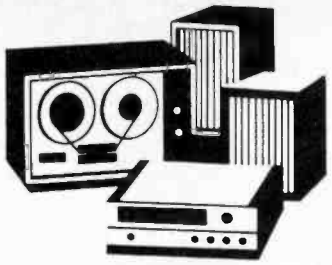


Stereo Scene

By Harold A. Rodgers
Executive Editor

CASSETTE TOPICS

METAL-PARTICLE tape and hardware are receiving a good deal of attention these days, and deservedly so. The new tape offers considerable advantages in performance over earlier types and seems capable of circumventing what had been considered some built-in pitfalls of the cassette format.

Yet there are those who have amassed evidence to demonstrate that the advantages of metal tape are not consistently delivered in practice and may not be needed anyway. An opposing camp holds that the advantages are obvious. From what I've heard, I'd have to go along with the second group, especially when program material rich in high-frequency content is involved, and in live recording situations where the headroom requirements cannot be known in advance. The key feature of metal tape is the high-frequency headroom that it delivers to a format in which there was previously a dire shortage. But the holders of this second view do grudgingly admit that the benefits are not always there in practice.

According to these partisans, the reason is that metal tapes, instead of adhering to a standard coercivity and remanence, are becoming too variable, leaving hardware manufacturers in a quandary as to how to set their bias and equalization adjustments as decks leave the factory. The net effect is that if Brand X tape gives excellent results on a particular deck, Brand Y probably will not. Rigid adherence to standards, it is claimed, will solve this problem. That is probably true to a degree, but certainly not completely. The cry for standards has been heard before concerning other tape types, and yet the millenium has perversely refused to arrive.

Some of the difficulty can be blamed on the fact that tape manufacturers have traditionally been less than eager to establish standards. This is understandable if one considers that each company, at least in its own eyes, sees advantages in its own product and is reluctant to change it just because one or more of its competitors has a different opinion. Additionally, virtually no manufacturer will tolerate the prospect of adjusting his product to parameters established first by a competitor—the loss of face is just too great. But all of this notwithstanding, there are technical reasons, in my opinion, why standards will never foster total harmony between tape and recorder.

The Time-Honored Conundrum. As many a recordist has learned to his chagrin, mating a tape to a particular recorder has never been easy. In general, you must use a tape identical in coercivity and retentivity to the one for which the deck's bias and equalization were adjusted if you are to achieve the results the designers of the deck and the tape intended. If the coercivity is off, the high-frequency response will be as well, and retentivity affects low-frequency output in a similar way. As the low-frequency output defines the sensitivity of the tape, it controls the overall output level as well. That is, the bias level can be varied to a degree in order to match the high-frequency output to that available at low frequencies. More bias depresses high-frequency output and sensitivity, and vice versa.

Bias also has an effect on distortion; there is a definite level at which distortion is minimized. Generally, more bias depresses low-frequency output, too, though not as markedly as it does the highs. One common compromise between distortion and output level is to use 2 dB more bias than that which gives maximum output at low frequencies.

Assuming then, that you know what tape the manufacturer set the recorder for, you should be home free. In actuality you are no better than in the ballpark (stiff standards would keep you well in the ballpark). But matters are rarely that simple in the real world—there are manufacturing tolerances to be dealt with. To my knowledge, no tape manufacturer claims uniformity between different batches of tape better than ±1 dB. This is pretty close, but it can cause audible differences in frequency response, especially when Dolby noise reduction (which can double such errors) is used. It is entirely possible that a recorder adjusted for tape A might sound better with a particular sample of tape B, provided that B's nominal bias and EQ requirements are not too different, all because of manufacturing tolerances.

Sometimes, unfortunately, information as to the identity of the reference tape for a given machine is not disclosed, or if it is, the tape is unavailable. What is to be done then?

One solution, advocated by some, is to record and play back a wide variety of music on your machine, using different cassettes and noting which are best for different kinds of music. This approach is taken very seriously in Japan, where audio critics have been know to make extensive listening tests with an assortment of decks and tapes in order to advise audiophiles about the sound character to be expected from each combination. It is entirely possible that by such a method you will arrive at some tape formulations that you prefer on your particular machine, but the problem of consistency remains. There is no

(Continued on page 20)

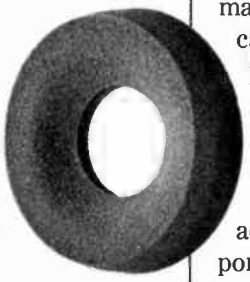
Introducing a totally new concept in stereophones.

The new Koss HV/X high velocity stereophone represents a remarkable breakthrough in hear-thru stereophone design and performance. For the first time, Koss engineers have been able to create a lightweight, hear-thru stereophone that combines the transparency of high velocity phones with the superior bass performance of closed-type phones. The result is a breathtaking musical experience.

Koss HV/XLC

CONTOURED VARIABLE-DENSITY EARCUSHIONS

While most lightweight, hear-thru stereophones have earcushions that fit against the ear, the new Koss HV/X features a unique, contoured, variable-density cushion that fits around the ear. Not only does this unique earcushion design create a far more comfortable stereophone but it has also allowed Koss engineers to create a dramatically better element design as well.



These new variable-density earcushions are made up of a very porous material that is acoustically transparent at the perimeter of the earcushion yet compressed toward the center region. This varies the pattern of acoustic resistance over portions of the earcushions creating the proper seal for specific bass frequencies while allowing the flow of middle and high frequencies at the perimeter of the earcushions.

LIGHTWEIGHT ELEMENT

The uniqueness of the new variable-density earcushions made it possible for Koss engineers to design a lightweight element that reproduces a Sound of Koss you have to hear to believe. Incredibly, even though the overall weight of the element was reduced, Koss engineers were able to develop a magnet with enough magnetic density to drive an extra large diaphragm. With a response range of 15 to 35,000 Hz, the new Koss HV/X will drive you into ecstacy and our competitors nuts.

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Slip into the new Koss HV/X or HV/XLC with volume/balance controls at your audio dealer soon. You'll like the best of both worlds: the open, airy, up-front sound of hear-thru stereophones and the deep, rich bass performance of closed-type stereophones.

And while you're with your audio dealer, listen to our full line of Koss stereophones and CM loudspeakers. There's no sound quite like the Sound of Koss.

For more information on the HV/X, our full line of stereophones and loudspeakers or our new Koss K/4DS digital delay system, write c/o Virginia Lamm.

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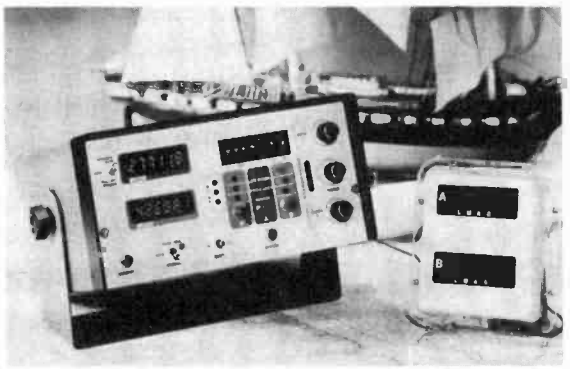
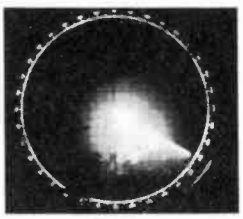


Direction Finders, Loran



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way you can be sure that two cassettes of a particular brand will sound exactly alike.

It should be clear by now that since cassettes will give results that can be objectively verified as optimum only when treated as individuals, we will have to be able to adjust the deck. Some manufacturers have recognized this by introducing models on which the recording bias (or sometimes equalization) and Dolby level controls are easily accessible to the user. One or two of these decks also include high- and low-frequency oscillators. The procedure is quite simple: One adjusts the bias until the recording sensitivity is the same for the high- and low-frequency tones. Record a low-frequency tone and check the level of the high-frequency tone against it. If the high tone is too weak, back off the bias a bit; if it is too strong, turn the bias up. Finally, the recording Dolby level is set to match the level used by the playback decoder.

Obviously, if a two-head deck is being used, you'll have to record, rewind, and then play back, and you won't have a meter to look at while doing the actual tweaking. Nevertheless, it's quite easy to do, and you may be surprised at the level of performance that can be extracted from even garden-variety ferric tapes this way.

If your deck doesn't include a test oscillator, any signal source that can supply reasonably clean sine waves to the recorder's line inputs can be used. The low frequency should be between about 333 and 1000 Hz, and the high frequency in the neighborhood of 8 to 10 kHz. Lacking instructions to the contrary from the deck manufacturer (decks with built-in oscillators may set recording test levels automatically), be sure to run the test at −20 dB. A convenient alternative to doing all this yourself is to purchase one of the new recorders in which a microprocessor does it for you.

Bias and Headroom. As we noted earlier, a fixed bias is a compromise between the conditions needed to record high and low frequencies optimally. Good performance at the low end and in the middle require some sacrifices at the top, or vice versa. What would happen if the bias could change on a dynamic basis dependent on the character of the signal being recorded? Dolby Laboratories has looked into this question, and the answer has formed the basis of the company's Headroom Extension System (HX).

What the system does is sample the program material and reduce the bias when it is rich in highs, thereby extending the overload characteristics of the tape. Done by itself, this would also boost high-frequency response, so a compensating change in record equalization is made simultaneously. The price paid for the increased headroom at the highest treble frequencies is a modest increase in midrange distortion, but since the extraneous products fall, for the most part, in the high part of the spectrum, the program material masks them. When highs are absent, the bias can be totally optimized for the midrange and bass frequencies, giving even cleaner reproduction than does a compromise bias.

A part of the attractiveness of the system, as far as Dolby is concerned, is that the control signal used to effect signal-dependent pre-emphasis for noise reduction has the characteristics necessary to vary the bias and EQ. Once HX has been applied to a tape, however, playback can be executed by any Dolby equipped cassette deck. HX itself requires no additional playback processing.

I have heard brief demonstrations of the system, and it seems to work very well indeed. It is being offered to Dolby licensees at no additional charge. Thus, manufacturers including it in their decks will incur no costs beyond those of providing the extra electronics. If cassette decks incorporating Dolby HX are not yet available, they should be soon.

An additional possibility that I hope is not overlooked is that commercial duplicators could apply HX to prerecorded, Dolby-encoded tapes. These, remember, could be played back by the majority of decks now in use. More high-frequency headroom and sparkle might go a long way in helping these tapes to compete with discs.

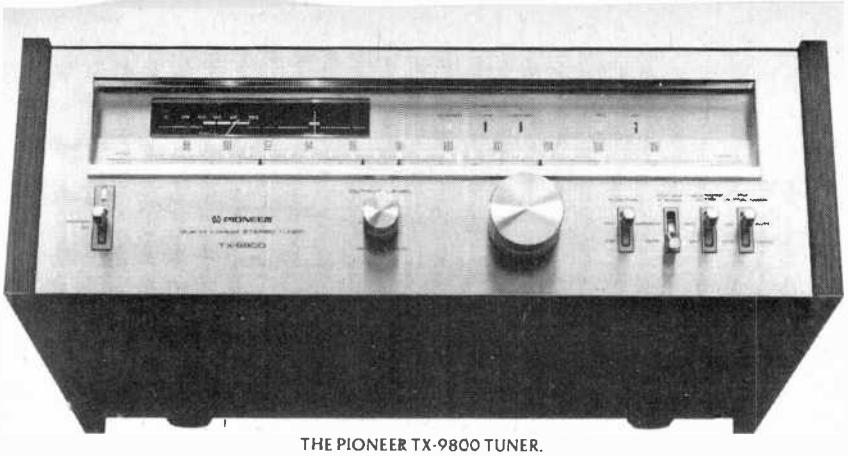
Audiophile Recordings

Continuing briefly with tape before going on to discs, it has come to my attention that RVC of Japan, a company known for its directly mastered discs, is distributing, in Japan, prerecorded cassettes on metal-particle tape. These are not yet available here, though I suspect that they will be before long. As soon as I get my hands on any, they'll be written up in this column. Metal tapes, of course, can play back on any machine that can handle chromium dioxide. Now for some new discs:

LIVE IN TOKYO, **Archie Shepp Quartet.** Denon PCM YX7538. Denon, an early pioneer of PCM recording, has produced a winner with this disc. The recording is of a live concert that obviously pumped Shepp and sidemen up for some truly inspired playing. Two selections are on the long side—almost 16 minutes in one case—but they keep on unfolding to give a nearly hypnotic effect. And the recording (and the pressing) are essentially free of nasties that would shock you out of musical concentration.

TCHAIKOWSKY: 1812, CAPRICCIO ITALIEN, "COSSACK DANCE" FROM MAZEPPA, **Cincinnati Symphony Orchestra, Erich Kunzel conducting.** Telarc DG-10041. This disc, clearly, was recorded to be a spectacular, and the feature presentation is, naturally enough, the "1812" Overture, Op. 49 of Tchaikowsky. The recording was made in three stages—orchestra, bells, cannon—and the three were then mixed digitally. Total dynamic range is awesome (on the order of 64 dB), and frequency components down to 6 Hz are present as a result of the cannon shots. If your system can handle this (particularly the problem of keeping the stylus in the groove) it can play just about anything—until fully digital discs come along. Actually, I think the engineers went a bit overboard in leaving the 6-Hz material in. No speaker can reproduce it at a meaningful level, and well-tuned tonearm/cartridge combinations (resonant frequency at 9 to 13 Hz) will just about filter it out. If the resonant frequency fulls at 6 Hz or below—watch out! Still, this disc is a tour-de-force of production and a fearsome challenge to an audio system. Not only is it a lease-breaker, it may be a voice-coil popper as well. ◇

PIONEER WINS THE AMP & TUNER BATTLE WITH A TECHNICAL KNOCK-OUT.



THE PIONEER TX-9800 TUNER.

At one time the struggle between amplifiers was won by the amp that had the most muscle. And the tuner that brought in the most stations also brought in the most acclaim.

Today, there's one series of amplifiers whose technology has put it in a class by itself. And only one series of tuners that is its match.

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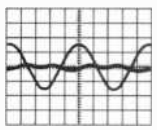
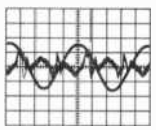
Until Pioneer's SA-9800, you had two choices when selecting an amplifier. Either you paid through the nose for a heat producing Class A amp. Or you paid through the ear for a distortion producing Class B.

Pioneer's SA-9800 offers the efficiency found in the finest Class B amplifiers. With a distortion level found in the finest Class A. An unheard of 0.005% at 10-20,000 hertz.

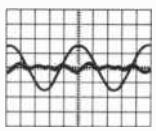
What's more, instead of slow-to-react VU meters that give you average readings or LED's that give you limited resolution, the SA-9800 offers a Fluroscan metering system that is so precise and so fast, it instantaneously follows every peak in the power to make sure you're never bothered by overload or clipping distortion.



CLASS A AMPLIFIER. LEAST DISTORTION BUT MOST HEAT.



CLASS B AMPLIFIER. MOST DISTORTION BUT LESS HEAT.



SA-9800. LESS DISTORTION, LESS HEAT, AND MORE POWER.

And while you're certain to find conventional power transistors in most conventional amplifiers, you won't find them in the SA-9800. Instead you'll find R.E.T. transistors that greatly increase frequency response. So instead of getting distortion at high frequencies, you get clean clear sound. Nothing more. Nothing less.

Obviously, it took revolutionary engineering to build Pioneer's new series of amplifiers. But that same technology and skillful engineering also went into Pioneer's new line of tuners.

While other tuners offer features that just sound great, every feature in Pioneer's new TX-9800 helps to produce great sound.

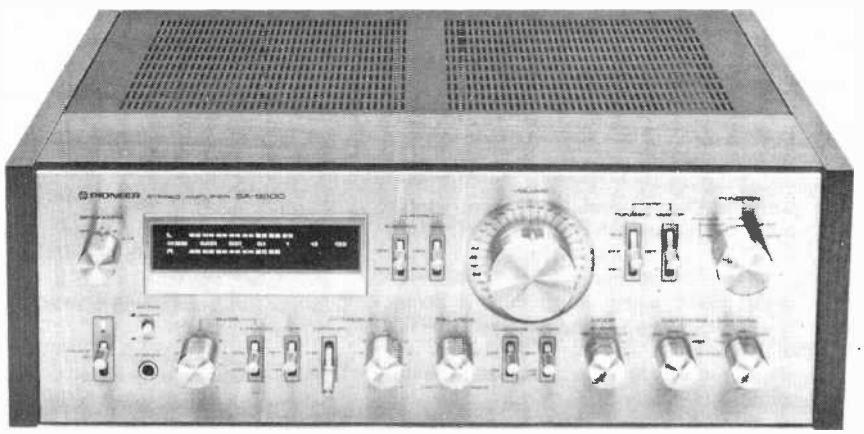
Like Pioneer's new Quatrature Discriminator Transformer that helps reduce distortion to 0.05% at 1 KHz and raise signal-to-noise ratio to 83 dB. A specially designed Quartz Sampling Lock Tuning System that automatically locks onto your desired broadcast. And automatically eliminates FM drift. And two band widths for both AM and FM stations.

By now it must be quite obvious, that when it comes to engineering only a few amps and tuners are in Pioneer's class.

But when it comes to value there's no contest.

PIONEER
We bring it back alive.

THE PIONEER SA-9800 AMPLIFIER.



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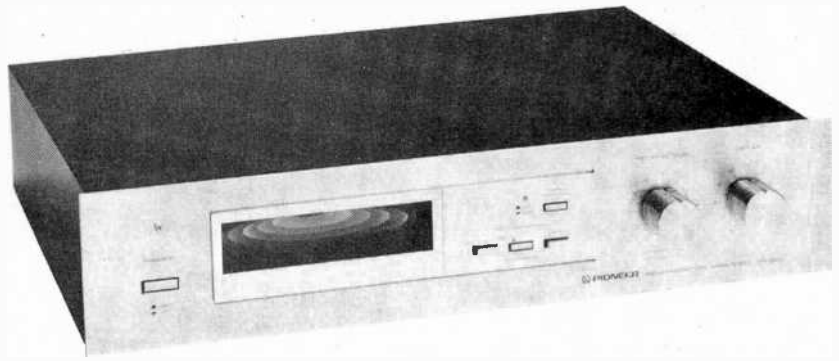

Pioneer Model SR-303 reverberation amplifier uses bucket-brigade time-delay integrated circuit

HIRSCH-HOUCK LABS REPORT

The Pioneer Model SR-303 is the first home reverberation unit we have tested that uses a bucket-brigade IC device (BBD) time-delay system. The BBD provides a time delay by analog means without the unpleasant distortions, limited and irregular frequency response, and tendency to add a "twangy" coloration to the sound that were characteristic of consumer spring-type reverb units.

The Model SR-303 has a single initial time delay that is continuously adjustable between nominal limits of 25 and 100 ms. A switch recirculates a fixed percentage of the delayed signal output back to the BBD input to obtain longer reverb times. Delayed signal is recombined with undelayed input signal in a proportion that is adjustable from zero to a maximum of about 30 dB less than the undelayed signal level.

External dimensions of the SR-303 are 16 9/16"W × 13 1/4"D × 3 7/8"H (420 × 335 × 100 mm); weight is 9.5 lb (4.3 kg). Suggested retail price is $195.

General Description. Two control knobs are found on the SR-303, one for setting REVERB TIME and the other for setting DEPTH, the latter being the amount of delayed signal mixed with the input signal. With REVERB TIME pushed in, the delayed signal is recirculated to give what Pioneer calls EFFECT 1, a long reverberation time of about 3 seconds maximum. Pulling out the knob slightly gives EFFECT 2, a single time delay of up to 100 ms with no reverberation.

There are also several pushbutton switches. Pressing REVERBERATION ON connects the SR-303's active circuits in the signal path, but the tape-recording outputs on the rear panel of the reverb unit carry only the undelayed signal. (The tape-recording jacks on the SR-303's rear panel replace those occupied by the reverb unit on the rear of the amplifier to which it is connected, thus restoring the taping facility to the system.) If the RECORDING button is pressed instead, the tape recorder in the system receives the combination of undelayed and reverberant signals being heard. The OFF button bypasses all delay circuitry and directly connects the input to the output terminals, even when the reverb unit is turned off.

On the front panel is a rectangular window behind which is a series of concentric ellipses, each on a separate layer of acrylic plastic, forming a three-dimensional "time/depth" display. When signal input is zero, the display glows blue. When a signal is present, the edge of each ellipse changes color according to signal level. The greater the level, the "deeper" the display flashes in green.

On the rear of the SR-303 are the various input and output jacks, an unswitched accessory ac outlet, and a pushbutton switch that permits input sensitivity to be reduced by 6 dB.

Laboratory Measurements. This is a nominally unity-gain device for undelayed input signals. The level of the delayed signal in the output was never less than 28.5 dB down, referred to the undelayed signal. It could be reduced to zero with the DEPTH control.

Frequency response was within +0/−1 dB from 15 Hz to 100 kHz. Although rated maximum input and output levels are 2 volts, actual clipping at 1 kHz was 5 to 8 volts, depending on the DEPTH control setting. Unweighted noise was 100 microvolts (80 dB below 1 volt). With A weighting, the noise was below our minimum measurement limit.

The 1-kHz distortion was nearly unmeasurable with the DEPTH control set to 0 (no delay signal in the output). It was less than 0.003% up to more than 1 volt output and reached 0.008% at 5 volts. With maximum DEPTH, distortion was about 0.06% up to more than 1 volt and 0.45% at 3 volts.

Maximum delay time was 100 ms in the EFFECT 2 mode, as rated. However, at minimum REVERB TIME, minimum delay was only 1 ms instead of the specified 25 ms, which constitutes an extension of the reverb unit's capability rather than a limitation.

Separate signal paths are maintained from input to output for the left and right channels, but the two are summed to form a monophonic signal that passes through the single time-delay channel. The delayed signal is then split into two paths and recombined with the undelayed signal before going to the output.

User Comment. As with any signal-processing device, the best way to evaluate the SR-303 was to connect it into a music system and use it. We found that the controlled amount of "liveness" it added to programs greatly enhanced our listening enjoyment. Adjustment was easy and not at all critical, although it was possible to impart an unpleasant sound to many programs using a combination of maximum reverberation time and level in EFFECT 1. Reducing the level of the reverberant signal or using a shorter delay time cured this problem.

With EFFECT 2, it was possible to use maximum control settings without introducing unpleasant side effects on the music. On voices, however, it was usually desirable to use less reverberation or delay time to avoid a hollow, ringing quality.

Although instructions are given for using the time/depth display as a metering device, lacking calibrations, it did not strike us as particularly useful. We find it easier to detect excessive reverberation by ear. The display does, however, produce visual effects some users may find appealing.

The SR-303 should not be compared to conventional time-delay boxes that use four channels of amplification. This modestly priced model does, however, provide a sense of space and "life" to excessively "dry" program material and it does it with a minimum of expense and inconvenience to the user.

CIRCLE NO. 101 ON FREE INFORMATION CARD

(More Reports on page 24)

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CIRCLE NO. 25 ON FREE INFORMATION CARD

Crown Model SA2, "indestructible" stereo power amplifier, delivers 220 W/channel

HIRSCH-HOUCK LABS REPORT

Crown International's SA2 stereo power amplifier, a component of its "Distinction Series" and a companion to the Crown DL2 Control Center, is rated to deliver 220 watts per channel to 8-ohm loads, 20 to 20,000 Hz with no more than 0.05% total harmonic distortion (THD). It features extensive protection circuitry for its output transistors and an input-output-comparator system (IOC) that warns of nonlinearity in operation.

In addition, the SA2 is rated to deliver 350 watts per channel to 4-ohm loads, 20 to 20,000 Hz with no more than 0.08% THD. With a 2-ohm load, the SA2 can deliver 600 watts per channel at 1000 Hz with no more than 1% THD. A switch on the rear of the amplifier converts it for mono operation, in which it can drive 700 watts into 8 ohms from 20 to 20,000 Hz with no more than 0.12% THD, or 1200 watts into 4 ohms at 1000 Hz with 1% THD.

The Crown SA2 has a standard EIA-slotted panel 19" × 7" (484 × 178 mm), and extends 14¾" (375 mm) behind the panel. Optional handles extend 2⅛" (54 mm) in front of the panel. The weight of the amplifier is 57 lb (25.8 kg). Suggested retail price is $1595.

General Description. The two channels of the SA2 have separate power supplies and power transformers. The output transistors are mounted within an airduct heat-sink system, through which air is blown by a two-speed fan mounted in the rear of the amplifier. Normally the fan runs at a low speed, but if thermal sensors detect excessive temperatures, the fan speed increases. Air is drawn in at the rear and exhausts through front panel grilles.

The protective circuits of the SA2 have been designed to work with the minimum of audible side effects. By means of computer analysis, Crown engineers have established the safe operating limits of collector voltage and current, as well as temperature, for the eight output devices used in each channel of the SA2. A built-in analog computer monitors these parameters and reduces the drive to the output stage if the safe operating limits are approached. This is done without any interruption of the signal, and the full drive is automatically restored when the stress clears.

The complex protective system of the Crown SA2 probably accounts for an appreciable part of the total cost of the amplifier. However, it allows the SA2 to drive almost any conceivable load at the highest possible power level without risk of damage to the amplifier and without transient distortions caused by the protective circuits.

Two vertical rows of green LEDs light in sequence at 3-dB intervals as the instantaneous power output of each channel varies over a 42-dB range. In addition, the light showing the highest level reached in each channel remains on for four seconds. The 0-dB light corresponds to rated power and the −42-dB light to less than 15 milliwatts. Virtually any listening level will excite the visual display.

Amber STANDBY lights below each column of LEDs glow during the 7-second turn-on delay; a red POWER pilot light is located between them. Above each display column is a red LED marked IOC. These are operated from comparator circuits that detect any difference between input and output waveforms.

On the front panel are individual continuously variable level control knobs for the two channels, and a knob-operated POWER switch. On the rear apron, in addition to the cooling-fan air intake (which has a washable filter) there are four heavy-duty multi-way binding posts on ¾-inch centers. Standard twin banana plugs can be used for speaker connections, even for a single mono speaker connected across the two "hot" amplifier output terminals. A slide switch above the speaker terminals connects the amplifier for mono operation by inverting the phase of one channel and driving both channels from one input. A second switch disables the turn-on delay, and a third bypasses the low-frequency protection circuit that disconnects the output of either channel if it contains excessive dc or infrasonic signal energy. The two input jacks are standard phono connectors. The heavy-duty, three-wire line cord (five feet long) is fitted with a 20-ampere, 120-volt male plug. A short adapter cable is furnished for plugging into a standard household (15-A) receptacle.

Laboratory Measurements. During preconditioning (one-third rated power to 8-ohm loads for one hour, and full power for five minutes), the exterior of the amplifier became only moderately warm. It remained so during our high-power tests, which occasionally caused the fan to switch to its high speed (it usually returned to the lower speed within 30 seconds). In normal operation in a home music system, temperature rise was not appreciable.

Power output at clipping into 8-ohm loads with both channels driven at 1000 Hz was 282 watts per channel. Into 4 ohms and 2 ohms, respectively, clipping occurred at 458 and 650 watts per channel. IHF Clipping Headroom was 1.08 dB for 8 ohms and 1.17 dB for 4 ohms. IHF Dynamic Headroom was 1.68 dB and 2.17 dB for 8 and 4 ohms, respectively.

Harmonic distortion was extremely low at all power outputs short of clipping. At 1000 Hz, THD was just over 0.001% at low power and just under 0.001% from 10 to 100 watts. It increased only to 0.0014% at 270 watts, just before the output clipped. The IOC light came on just at clipping.

THD was slightly higher for 4- and 2-ohm loads, but still extremely low. At 4 ohms it typically peaked at 0.005% from 0.1 to 440 watts output. The 2-ohm distortion was about the same up to about 500 watts, increasing to 0.008% at the rated 600 watts and 0.07% at 650 watts, where the output clipped. Intermodulation distortion, which is rated at not more than 0.01% into 8 ohms, was between 0.002 and 0.003% up to the rated 220 watts, reaching 0.08% at clipping (about 280 watts).

Distortion varied with frequency in accordance with Crown's published data. At rated power, the THD was under 0.001% from 50 to 700 Hz, rising smoothly to 0.027% at 20,000 Hz. It was about 0.002% between 20 and 30 Hz. At reduced outputs, the THD characteristic was similar.

Reference power output of 1 watt was reached with an input of 0.14 volts, corresponding to the rated 2.1 volts for 220

(Continued on page 31)

SAVE $60 ON REALTIME'S MIRACULOUSLY THIN, WATER TESTED ALARM CHRONOGRAPH.

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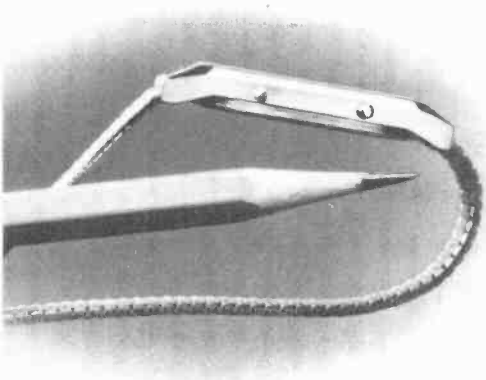

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You probably know that most watches under $200 are made of chrome over brass, or "silvertone." Perspiration causes them to pit, and they're literally eaten up by salt water. And the so called water resistant one's don't take kindly to water; even their manufacturers don't recommend them for swimming.

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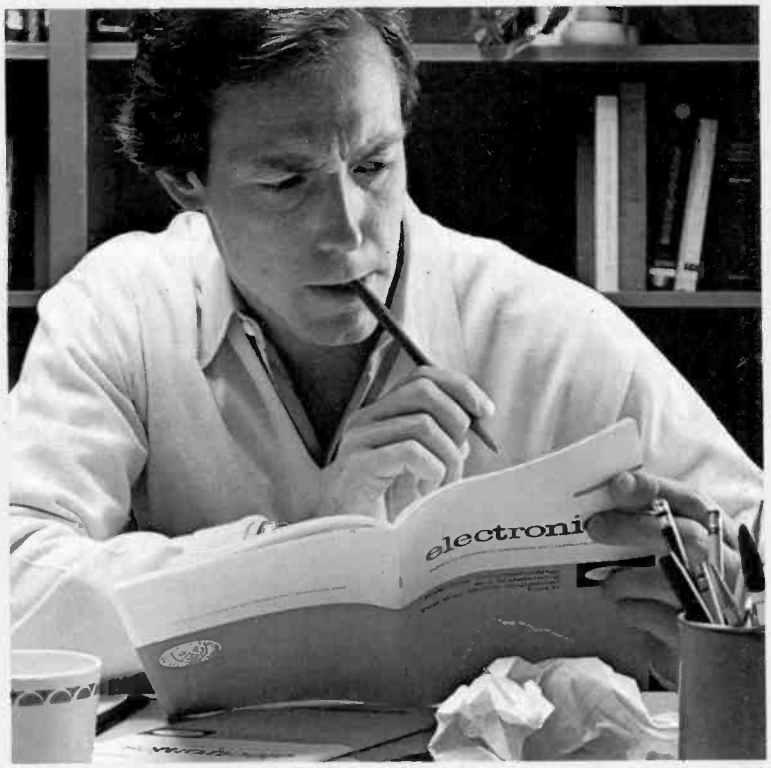

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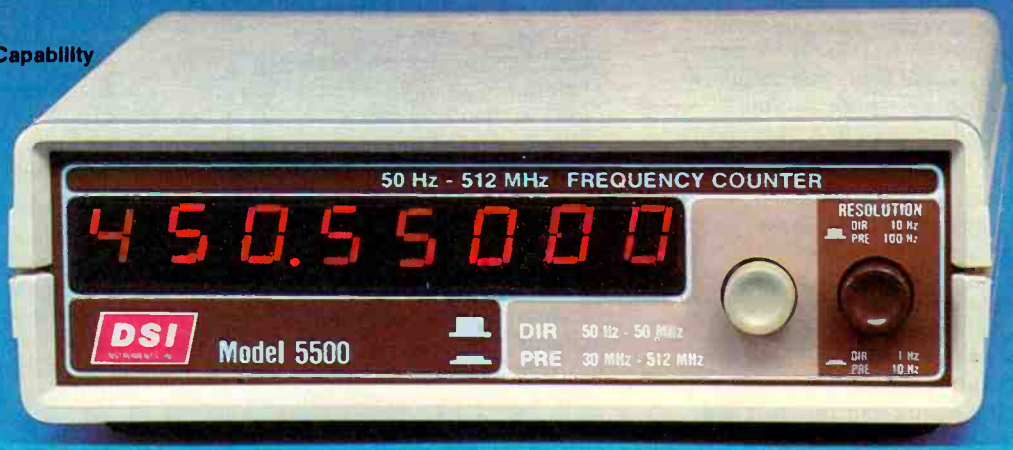

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FREQUENCY COUNTER STRAIGHT TALK

There are only three functional requirements for a frequency counter: 1. Good accuracy over temperature 2. Resolution 3. Sensitivity

Good accuracy over temperature. Crystal oscillators drift with temperature changes. This change is specified in parts per million (PPM). The 5500 TCXO (temperature compensated crystal oscillator) holds an accuracy of 1 PPM from 17° to 40° C. This corresponds to ± 450 Hz at 450 MHz. Counters with 2 PPM accuracy would read to ±900 Hz at 450 MHz. Counters with 10 PPM accuracy would read to ±4500 Hz and so on.

Resolution. What is the value of the least significant digit displayed? A counter with 10 Hz resolution would display 146.52000 MHz as 146.52000 i.e. with the last digit left off. A counter with 100 Hz resolution would display 146.5200. The 5500 with *8 Digits* is capable of resolving 1 Hz from 50 Hz to 50 MHz and 10 Hz from 50 MHz to 500 MHz. Counters with only 7 digits usually can only resolve 10 Hz to 50 MHz and 100 Hz to 500 MHz. The above effects, accuracy and resolution are cumulative. Example: a seven-digit counter with 1.5 PPM accuracy reading 450 MHz would only be accurate to ±675 Hz ±100 Hz (last digit error) or ±775 Hz. The 5500 with eight full digits and 1 PPM accuracy would be accurate to ±450 Hz ±10 Hz (last digit error) or ±460 Hz maximum. Not bad for $99.95. You really need that eighth digit to achieve real accuracy.

Sensitivity. The 5500 requires only 10-15 mv of signal to stabilize and achieve an accurate reading. A one watt hand-held can be read with accuracy at a distance of 15-20 ft. from the counter using the T600 antenna. Counters with 150 mv sensitivity will only stabilize at distances of less than a foot.

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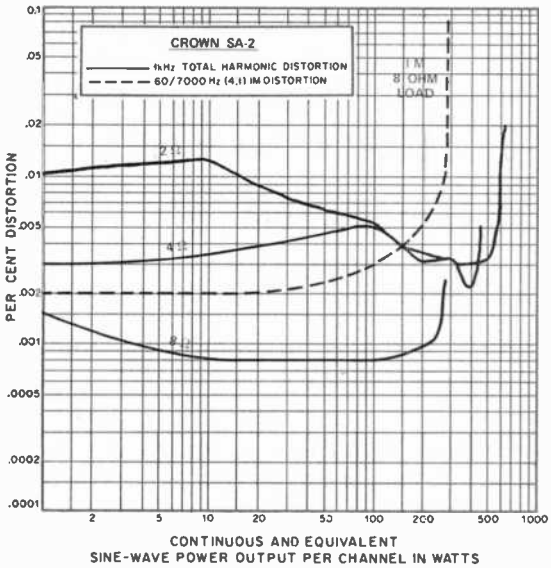


1000-Hz THD, both channels driven, left measured and IM distortion into 8-ohm load.

watts output. A-weighted noise was 80.4 dB below 1 watt. Amplifier rise time was 4 microseconds, and slew rate, specified at 30 V/μs, was 25 V/μs. IHF slew factor was 2.5, with the waveform collapsing suddenly at 50 kHz when we drove the amplifier with the voltage sufficient to develop the rated output at 1000 Hz.

We observed that the harmonic distortion, oddly, consisted of a large number of nearly equal-strength harmonics. This spectrum is typical of so-called "crossover distortion," which consists of a very brief spike generated when the output waveform crosses the zero-voltage axis. The lower trace of Fig. 1, an oscilloscope photo of the distortion waveform, highly amplified, confirms the acicular shape without pinpointing the cause. The spectrum analyzer photograph (Fig. 2), taken under the same conditions, shows the first 10 harmonics of the input frequency, all with nearly uniform amplitude, about 90 dB below 1-watt output. The THD + N reading (all harmonics plus noise) of 0.012% helps to underscore the fact that this distortion is, despite its unusual characteristic, inconsequential in listening.

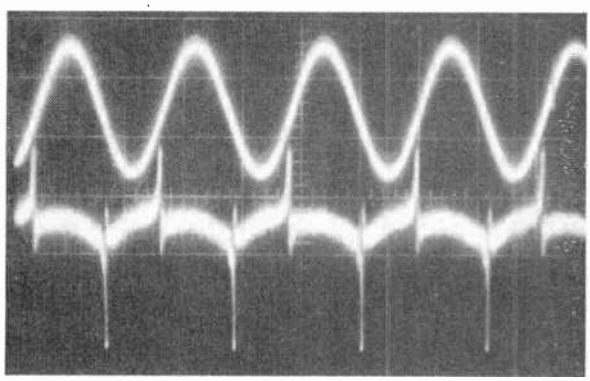


Fig. 1. A 5-kHz output at 1 watt (upper trace) with an amplified version of its distortion content below.

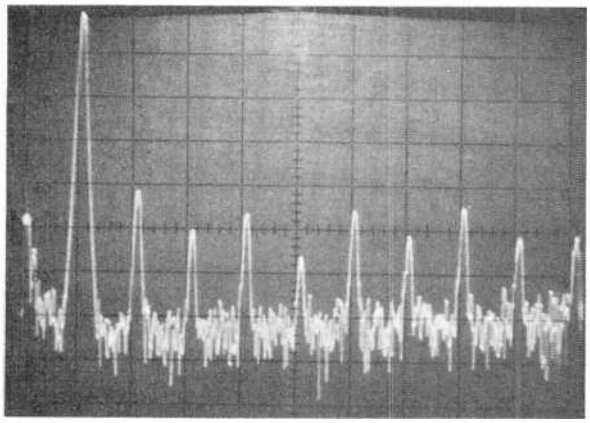


Fig. 2. Spectrum analysis of distortion shows nearly uniform amplitude out to the 10th harmonic. Fundamental (leftmost trace) has been attenuated by 40 dB. Harmonics are about 90 dB down.

User Comment. Normally, the testing of a high-power amplifier is worrisome, in that the stresses applied in determining its performance limits all too often prove destructive. Crown's emphasis on total protection of the SA2 against overload damage ultimately proved reassuring, as we confirmed their claims to our satisfaction.

The temperature-rise problem has certainly been solved by the cooling system used in the SA2. It was not possible to make its exterior surfaces more than slightly warm in our tests, and as soon as that happened, the fan switched to high speed and rapidly cooled the amplifier.

As the flow of cooling air in the SA2 is from back to front, there is no harm in blocking its top, bottom, or sides, as can occur in some kinds of cabinet or rack installations. Never is the air emerging from the front more than slightly warm.

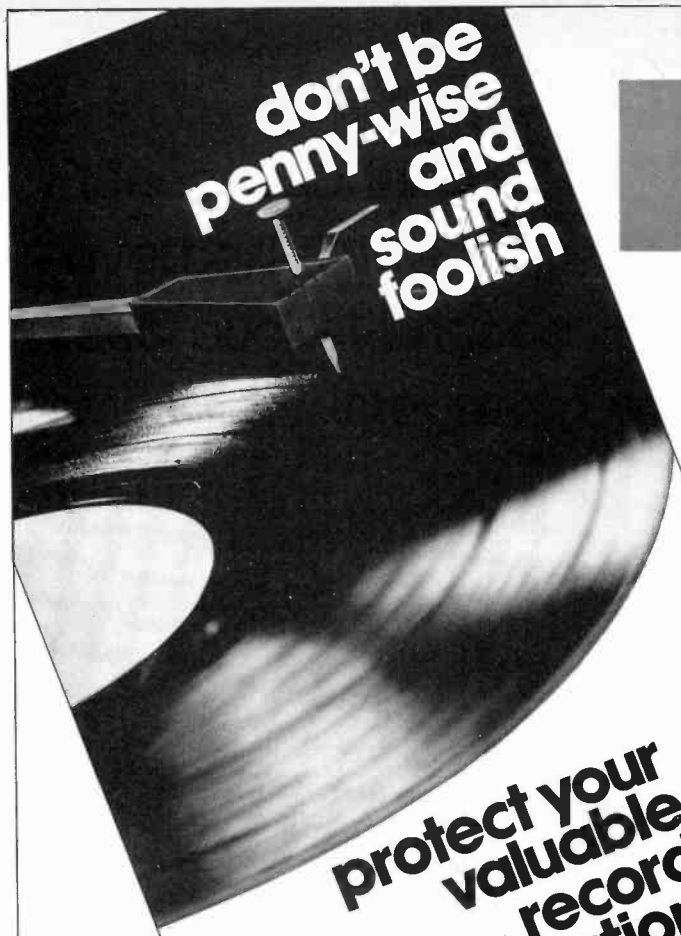
At normal speed, the fan is relatively quiet, but it can be heard in a reasonably quiet room within about 5 feet of the amplifier. This is about par for the course in the case of a fan-cooled amplifier. Still, if the music is played at more than a background level, it will mask the fan noise. When the fan goes into its high-speed mode (and we cannot imagine how that could happen in a home installation) it is loud and gives an unmistakable warning of the high-temperature condition. Fortunately, it is unlikely to stay in that mode for more than a few seconds.

Overdrive to the point of fairly hard clipping did not harm the amplifier. At one point, the output of one channel became shorted while being driven at full power. This condition persisted for perhaps a minute, after which removing the short instantly restored the amplifier to normal operation, none the worse for the abuse.

The LED power display, although seemingly similar to those used in other amplifiers, is unique. Its range is wide enough to cover any listening level, and its four-second "hang time" ensures that even a brief transient exceeding the average program level will be detected. It responds rapidly enough to give accurate readings of the 20-millisecond tone bursts used for dynamic headroom measurements.

As far as we are concerned, the Crown SA2 has no characteristic sound. It is about as distortionless and free of internally generated noise as an amplifier can be or has to be—and by a very wide margin. Further, it can deliver prodigious power to any imaginable speaker load without distortion or overheating, and seems to be indestructible. In view of these qualities, its price seems quite reasonable!

(More Reports on page 33)



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CIRCLE NO. 58 ON FREE INFORMATION CARD

Garrard Model GT350ap plays single record manually or automatically

HIRSCH-HOUCK LABS REPORT

Heading Garrard's "Advance Design Group" of four record players is the Model GT350ap, powered by a dc servo motor and designed to play only single discs manually or fully automatically. It has a cast-aluminum platter, weighing about 3 lb (1.4 kg), including rubber mat, with stroboscope markings cast into its rim and lit by an LED. A vernier speed control offers a nominal ±3% variation about the player's 33⅓- and 45-rpm speeds. All controls, except the speed vernier are located on the front edge of the base, where they are accessible even with the cover lowered.

Overall size, with cover lowered, is 17¾"W × 14¾"D × 6"H (450 × 375 × 152 mm), and weight is approximately 13¼ lb (6kg). Suggested retail price is $210.

General Description. The black-finished, low-mass aluminum tonearm tube, slightly "J" shaped, terminates in a universal four-pin plug-in carbon-fiber headshell. The headshell has been trimmed for minimum mass and has a novel and convenient means of adjusting stylus overhang. The removable finger lift contains ½" (12.7-mm) spaced cartridge mounting holes; the body of the headshell is narrow enough to fit between the holes. A groove on top of the headshell mates with a protrusion on the bottom of the finger lift to maintain the cartridge parallel to the shell axis as it is moved longitudinally to adjust overhang. The correct setting places the stylus 50 mm from the end of the connector on the arm tube. As a check on this, the reverse side of the soft rubber turntable mat has groups of parallel lines against which the edges of the headshell can be visually aligned to verify tangency.

The threaded counterweight of the tonearm is calibrated for tracking force from 0 to 3 grams in 0.25-gram intervals. Pivoted on low-friction jewel bearings, the arm cues automatically or by means of a front-panel cuing lever. Next to the base is a calibrated antiskating control. Extending forward of the base is the arm rest, with an integral safety lock.

The molded player base is black, contrasting with a silver-colored front panel strip that contains all operating controls. These are horizontally operating levers, except for a pushbutton that trips the auto-return mechanism. One lever selects the turntable speed and adjusts the stylus set-down diameter for 45-rpm 7" (178-mm) or 33⅓-rpm 12" (305-mm) records. Nonstan-

dard combinations must be played manually. The AUTO START lever has OFF/MAN/AUTO positions. MAN simply turns on the motor, leaving the arm to be cued by hand. AUTO turns on the motor and indexes the arm to the appropriate diameter. In either mode, the player returns the arm to its rest at end-of-play and shuts off automatically. The CUE lever is clearly marked to show that moving it to the right lifts the arm.

The GT350ap features the company's Delglide automatic mechanism, which is claimed to be exceptionally quiet during automatic cycling.

Laboratory Measurements. We tested the player with a Shure M95HE cartridge installed in its headshell. Installation was relatively easy and uncomplicated, although the mounting screws furnished may not fit all of the cartridges. (The longest were barely long enough for the M95HE, and the shorter pair would have been too long for cartridges having thin metal mounting flanges.)

When the arm had been balanced according to instructions, the actual tracking force was slightly less than indicated on the counterweight. The error was minor, typically 0.1 gram or less, but it would be advisable to operate any cartridge in this arm slightly above its minimum rating (that is good practice in any case). With stylus overhang properly adjusted, tracking error did not exceed 0.33°/in., and was typically much less than that.

Platter speed could be adjusted over a range of +6% to −3.7% at 33⅓ rpm and +8.9% to −4.7% at 45 rpm, more than specified, and did not change detectably with large line voltage shifts. Weighted peak flutter (DIN or CCIR) was ±0.08%, and weighted rms (JIS) flutter was 0.06%. Unweighted rumble was −30 dB, reduced to −59 dB by ARLL weighting. (This is not inconsistent with the −68-dB DIN B rating, but there is no way to compare the two.) A discrete rumble peak appeared at about 20 Hz. Automatic cycling times were typical of most record players: 11.5 seconds for the pickup to reach the lead-in groove after the AUTO cycle was started, 9.5 seconds for the tonearm to return to its rest after lift-off.

Capacitance from arm signal-cable wiring to ground was about 125 pF/channel. Effective tonearm mass, after subtracting the 6 grams of the cartridge, was 11 grams; it resonated with the compliance of the Shure cartridge at a nearly ideal 9 Hz with an amplitude of 5 dB.

Antiskating compensation had to be set to its 3-gram maximum with a tracking force of 1.5 grams to obtain equal distortion from both channels when tracking very high level records. The player has a very high friction contact between the lift bar and underside of the tonearm, preventing any detectable arm drift during cuing. The mechanism lowered the arm with a slow, damped motion, but had to be moved slowly on lift to avoid bouncing the arm.

The entire player is supported on four softly sprung feet that give it exceptional isolation from conducted vibration in the audio range. Its major conducted response was at 100 Hz, with low-level responses up to 400 Hz. Overall, the immunity of the GT350ap to vibration transmitted through its feet rivals the top ranking belt-driven models we have tested and far surpasses the direct-drive turntables.

User Comment. The handling characteristics of the Garrard GT350ap were excellent. Its controls worked smoothly and logically, and setting up (including the cartridge installation) was a relatively simple operation. The tonearm mechanism's operation was inaudible. Our only criticism concerns the lifting action of the cuing control, which can toss the arm into the air if moved too rapidly. Once one is aware of the problem, however, it is easy to move the lever slowly, in which case the cuing action is just fine.

The mass of the Garrard arm complements the compliance of most high-quality cartridges, such as the Shure M95HE we used in our tests. The 9-Hz resonant frequency we found would provide an excellent combination of insensitivity to record warps and ability to track the lowest frequencies recorded on discs. Installations that have proven susceptible to acoustic feedback may benefit from the use of the GT350ap, whose mounting feet give it virtual immunity to conducted audio-frequency vibration. Overall, this is a neatly conceived design at an attractive price.

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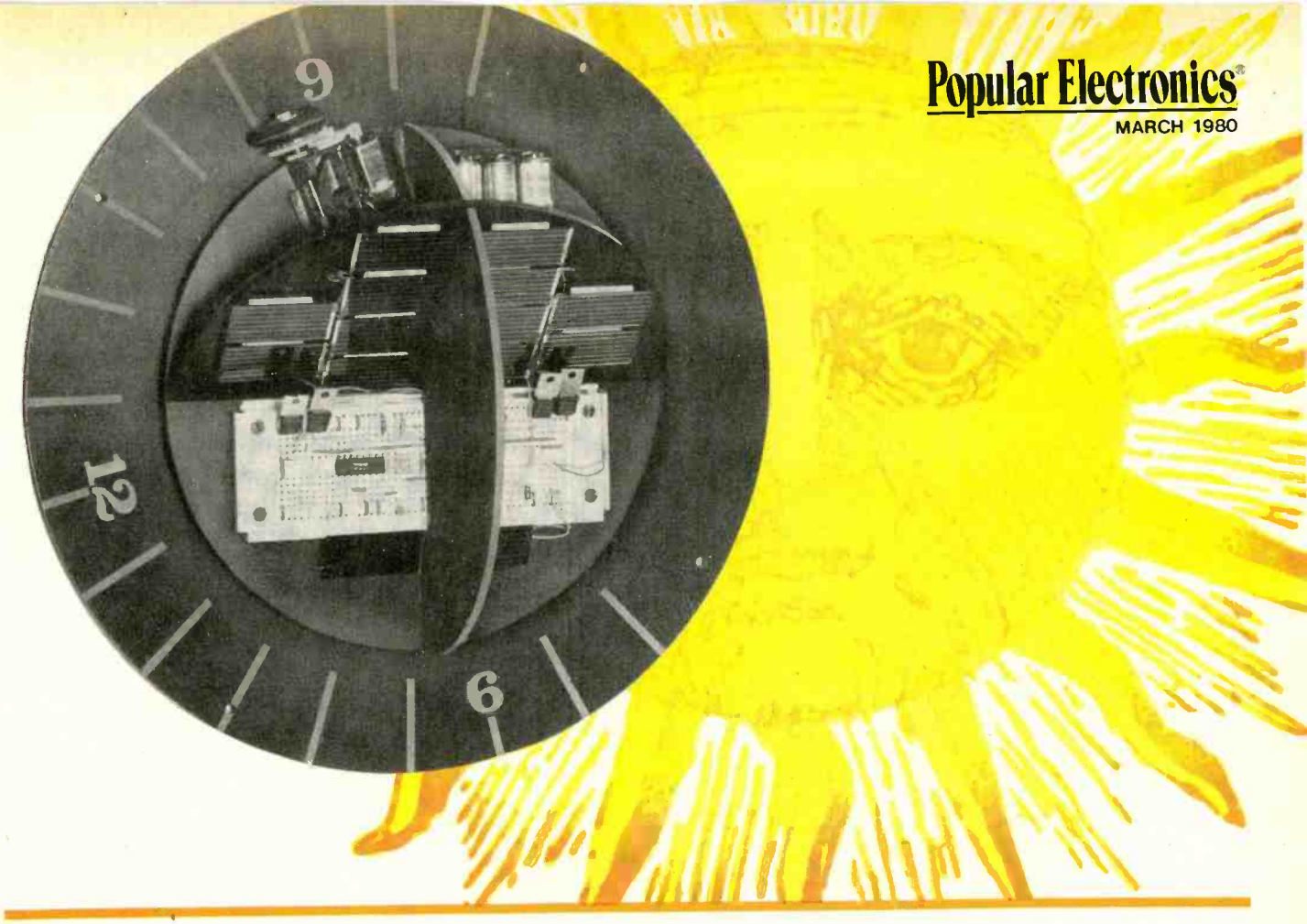

BUILD A SOLAR POWERED SUNDIAL

BY WINN L. ROSCH & MARTIN BRADLEY WEINSTEIN

State-of-the-art sundial built around semiconductors follows the sun and indicates passing hours

LONG BEFORE the invention of the mechanical clock, man used a sundial to keep tabs on how much of his day was left, or approximately what time of day it was. Other than cosmetic changes, the main elements of a sundial have remained unchanged over the years.

Now, recent developments in techniques and devices—solar cell electricity generators, light-sensitive detectors and amplifiers, power semiconductors, rechargeable batteries and small dc motors—have made it possible to design a truly modern sundial. As described here, the sundial is a solar-powered, servo-controlled heliotropic (sun following) mechanism that not only indicates solar time, but also uses the sun as the source of its operating power.

Unlike the standard sundial, that has a fixed time scale and gnomon (shadow-casting element) to indicate the time, the solid-state sundial's gnomon is servo controlled to "follow" the sun, which it can do even under limited overcast conditions. The passing hours are indicated as the gnomon moves across a fixed time scale.

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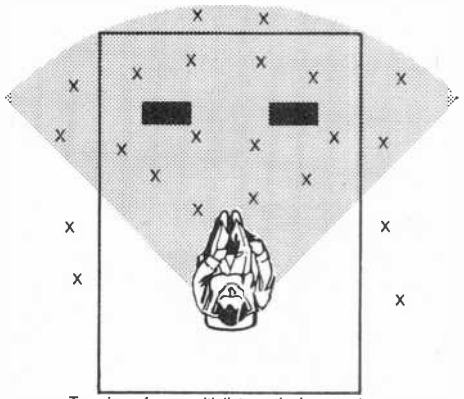
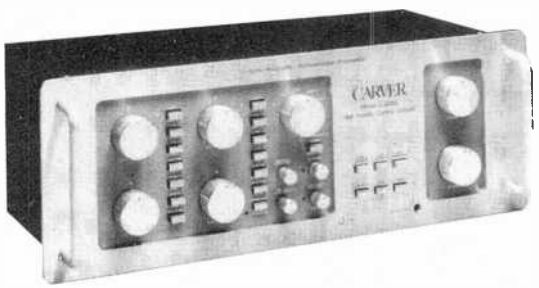


Top view of room with listener facing speakers

The holographic image places instruments in a broad proscenium arc. Primary sound images (x) clearly emerge from beyond the room boundaries each in a fixed and totally natural position. There is no spatial distortion in size or location of the instruments. Such holographic imaging is not possible with conventional stereophonic or time-delay enhanced reproduction.



Here's what the experts said about Carver Sonic Holography:

"The results were positively breathtaking. . . . With the lights out, we could almost have sworn we were in the presence of a real-live orchestra."

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Senior Editor, *Popular Electronics, May 1979*

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Stereo Review May 1979

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Larry Klein, Technical Director
Stereo Review, May 1979

"In sum, listening to the C-4000 in its hologram position was a thrilling sound experience for me. Plain old stereo will never be the same."

Arthur Salsberg, Editorial Director
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Sonic Holography is now available in the Carver C-4000. It is a versatile control console that also includes a sophisticated preamplifier, third generation Autocorrelator for noise reduction, Peak Unlimiter for restoration of dynamic range & Time Delay with built-in power amplification. For copies of the complete reports write to the Carver Corporation or use the reader service card.

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and a Science Fair project, the solar-powered sundial will teach you how servo systems operate, how light-sensitive circuits work, and the elements of solar-powered battery charging.

How It Works. As shown in Fig. 1, the opaque gnomon is placed between a pair of light-to-current converters so that if the gnomon is not pointing directly at the sun, one of the light detectors is shielded and the other receives more of the sun's light.

Since the outputs of the light-to-current converters used in this project reduce with increased illumination, they are cross-coupled, inverted and applied to a commutating bridge formed from four VMOS power FETs that simulate a double-pole, double-throw switch. This "switch," in turn, controls the operation of a small dc motor. When current flows one way through the dc motor, it rotates in one direction. When the current flow is reversed, so is the rotation. A small rubber wheel is attached to the dc motor shaft so as to rotate the bearing-mounted platform that carries the electronics and the gnomon.

Operation of the system shown in Fig. 1 is such that the motor-driven rotating platform is kept aligned and each light-to-current converter receives equal amounts of illumination. Thus, the gnomon will track the sun and can be used to indicate the passing hours on an arc scribed on the fixed baseplate.

Fourteen solar cells provide a charge for a set of nickel-cadmium cells that power the circuit and the dc motor. The solar array is tilted to face the sun at the local latitude angle so that the cells receive maximum light and thus generate maximum output.

Circuit Operation. The "heart" of the electronic sundial is the LM1890 Light-to-Current Converter shown in Fig. 2. This new IC is designed as a general-purpose building block for use in both visible light and infrared applications (its output peaks at 700 nm). The device includes a built-in light sensor, and provision is made to add fixed, light-independent comparator bias. The chip is monolithic, linear over several decades of light level, and can be operated with supply voltages down to 2.5 volts. The case is fabricated from clear plastic and has a recess for an optical filter. An internal zener diode regulator adds to the stability.

The outputs of both the light sensor and comparator can be converted into a voltage by using a resistor as the load and extracting the signal across this resistor.

As shown in Fig. 3, the light sensors are cross-coupled to the inputs of each comparator. Resistors *R1* and *R2* serve to convert the light-sensor output current to voltage. Since the comparator within the light sensor has an uncommitted collector output, resistors *R3* and *R4* are used to develop the output signal. Capacitors *C1* and *C2* combine to insert a pause (hysteresis) before allowing the circuit to change states. This prevents the rotating platform from moving in small erratic spurts.

The outputs of both light-sensing ICs are fed to inverters (in IC3) whose outputs are coupled to a motor control circuit formed by power FETs *Q1* through *Q4*. These FETs control the direction of current flow, hence rotation, of motor *M1*. This circuit then forms a basic light-sensitive servo system.

VMOS-type FETs are used because their very low gate current requirements, low voltage drop, and low "on" resistance make them directly compatible with CMOS inverter *IC3*. Assume that *IC3A* has a high output and *IC3B* a low output. In this case, both *Q1* and *Q4* will turn on and allow current to flow from the power supply through *Q1*, the motor and *Q4* to the return circuit. The motor then rotates.

When the output of *IC3B* is high, and that from *IC3A* is low, the current flow is through *Q2*, the motor and *Q3*. Since current flow through the motor is now reversed, it rotates the other way. When

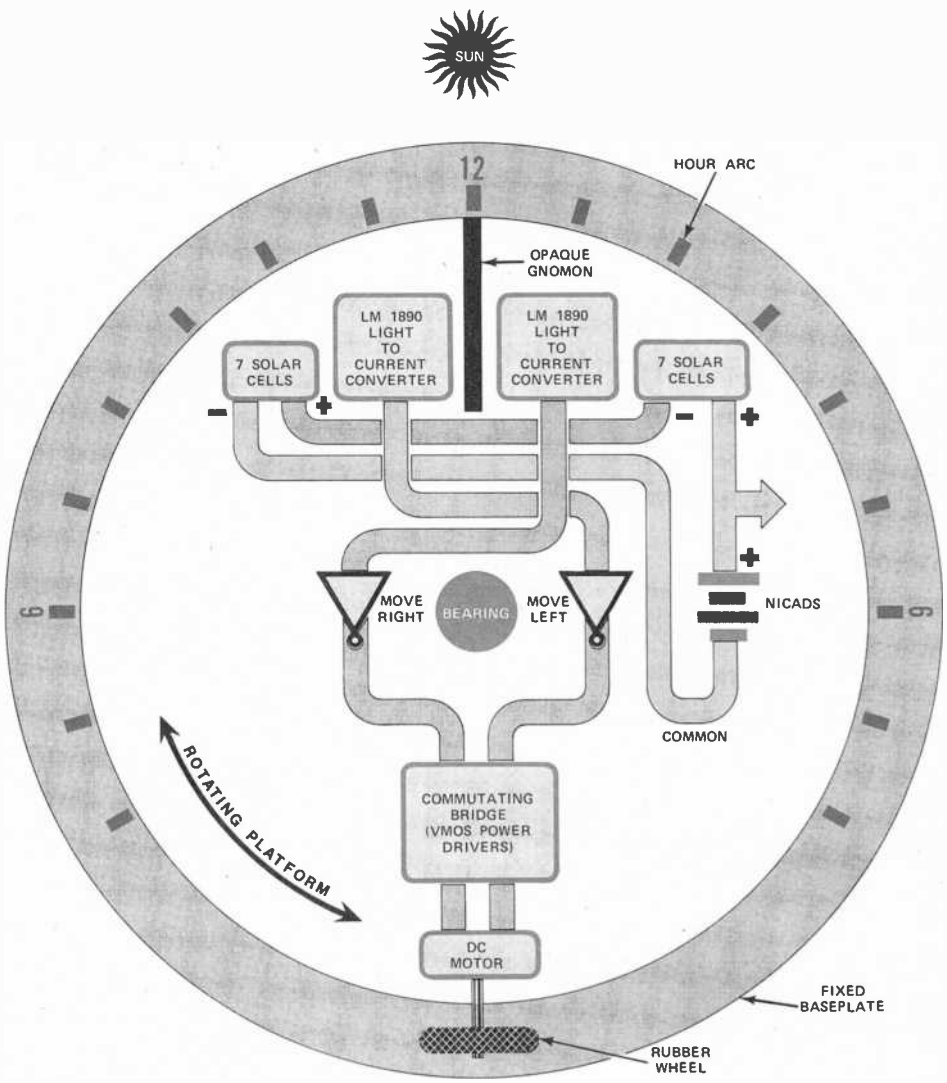


Fig. 1. Diagram showing general operation of solid-state sundial. The servo loop keeps the gnomon (shadow caster) pointed at the sun.

both light sensors receive equal illumination, the voltage generated across the FET "bridge" is equal and the motor remains stationary. When both light sensors are in the dark (nighttime), the voltage applied to the FETs is low, thus turning off the power semiconductors.

Power for the sundial comes from five AA-size NiCd cells that are recharged by 14 solar cells connected in series. Since each solar cell can generate 0.5 volt at 100 mA in bright sunshine, about 7 volts at 100 mA is available for the cells. If you live under a perpetual overcast, add an extra solar cell or two in series with the original 14. Diode *D1* is used to isolate the solar cells electrically from the battery.

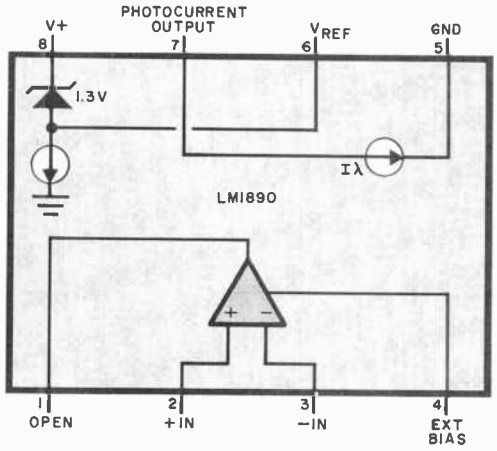


Fig. 2. Pinout guide and internal schematic of the LM1890 light-to-current converter used in sundial.

Construction. Other than the solar cells, battery and motor, all the electronic components can be mounted on a solderless breadboard. (This will be done later.) The physical placement of the two light-to-current converters *IC1* and *IC2*) is contingent on the particular design you select. However, two considerations should be observed: some form of shadow caster must be used between the two light sensors and the solar cells must be facing the sun at all times to generate their maximum output.

The sketches on succeeding pages show some ways that the sundial can be physically arranged. Final design is left up to the individual builder.

The following explanation covers the author's prototype and can provide some help in building your own version.

A photo of the prototype sundial is shown in Fig. 4. The 12" stationary baseplate and the 8" rotating platform were made of ⅛-inch plexiglass. In the prototype, a conventional bicycle ball-bearing race was used to mount the rotating platform in the center of the baseplate. A hole, large enough to form a press-fit over the bearing, was cut at the center of the moving platform. When fitted together, the moving platform rotated smoothly on the bearing.

In assembling the remainder of the sundial, use the following procedure: Before finally mounting the rotating platform to the baseplate, mount the solderless breadboard so that one long side is adjacent to, and just clearing, the bearing hole. Use four 4-40 screws and nuts to secure the breadboard in place.

Obtain another 8-inch diameter circle of plexiglass and cut it in half. One of these sections will form the solar-cell support while the other half will be used as the gnomon. Opaque the gnomon section with matte-black paint.

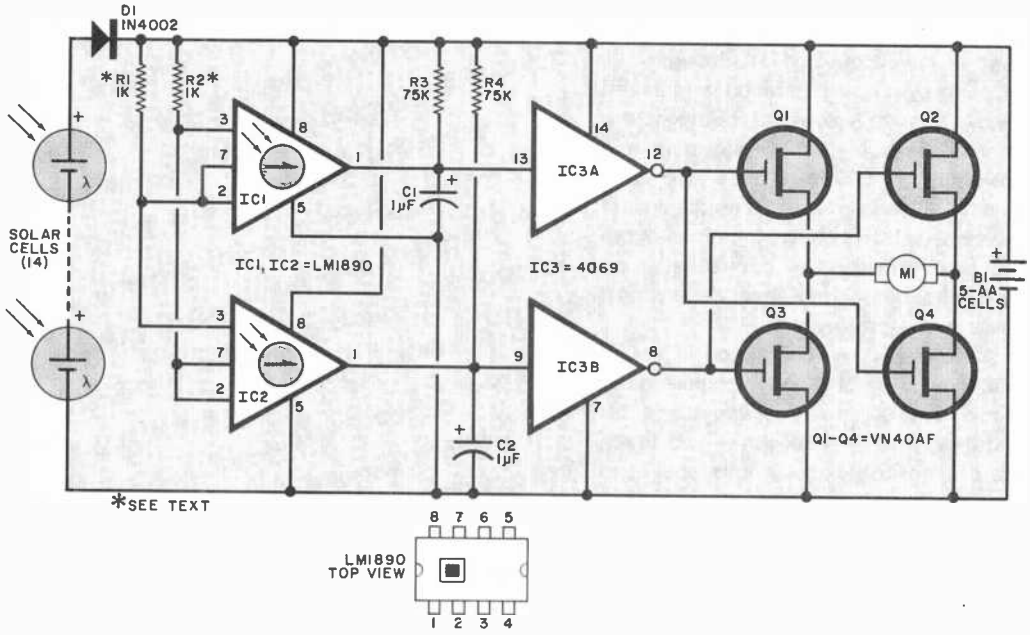


Fig. 3. Light-sensitive circuits drive a commutation bridge formed from four VMOS devices. These act as a dpst switch to change the direction of current flow through the platform motor.

PARTS LIST

B1—Five AA NiCd cells
C1,C2—1-μf, 25-V tantalum
D1—1N4002
IC1,IC2—LM1890 light-to-current converter (National)
IC3—CD4069 hex inverter
M1—1.5-to-3-V dc motor with reduction gear and rubber drive wheel
Q1 through Q4—VN40AF VMOS FET (Siliconix)
R1,R2—1000-ohm, ¼-watt resistor (see text)
R3,R4—75,000-ohm, ¼-watt resistor
Solar cells—0.5-volt, 100-mA (14) (Radio Shack 276-120 or similar)
Misc.—Solderless breadboard (CSC Experimentor 300), battery holder, silicone adhesive, double-sided pressure-sensitive tape, masking tape, transparent bubble dome, opaque plastic sheet or plexiglass sheet and black paint, bearing, interconnecting leads, mounting hardware, etc.

Hold the solar-cell support section against the back of the solderless breadboard closest to the bearing hole. You may have to make a small cutout so that the solar-cell support will clear the bearing. Tilt the support to the approximate latitude of your location. Now, cut a wedge shape out of the gnomon half circle to hold the solar-cell support at the latitude angle. The latitude wedge should be at right angles to the solar-cell support.

Using epoxy or plastic cement, carefully affix the solar-cell support to the platform and to the latitude wedge, and the bottom of the latitude wedge to the platform. Allow the cement to dry.

The remaining section of the gnomon half circle will form a continuation of the latitude wedge and is mounted at right angles to the solar-cell support. After cutting a slot large enough to clear the solderless breadboard, and possibly a slot for the bearing, cement the opaque gnomon in place.

The mechanical construction is now complete. Allow all cement to dry. Make sure that the gnomon (and if desired, the remainder of the plastic) is opaque and that the platform rotates easily.

Six solar cells are mounted on one side of the support and another six on the other side of the gnomon. Double-sided tape, or silicone adhesive can be used to mount the cells. A seventh cell on each side of the gnomon is mounted (using silicone adhesive) between the front of the solderless breadboard and the rotating platform. These two cells must be at the same angle as the rest of the solar-cell array. (The locations of the two seventh cells are necessitated by lack of space on the regular cell support piece in the prototype.)

All 14 cells are connected in series and terminated in a pair of color-coded leads—red for positive and black for negative. The ends of these two leads are brought to the solderless socket to form the "plus" and "minus" lines.

As shown in Fig. 4, the battery holder is cemented to the platform "under" the solar-cell support. Leads to the battery are coded with the same colors as those to the solar cell array.

The platform positioning motor can be taken from a battery-operated toy car and will often have its own reduction gear and rubber wheel. Such 1.5-to-3-volt dc motors can be found in many discarded toys or can be purchased at most hobby stores.

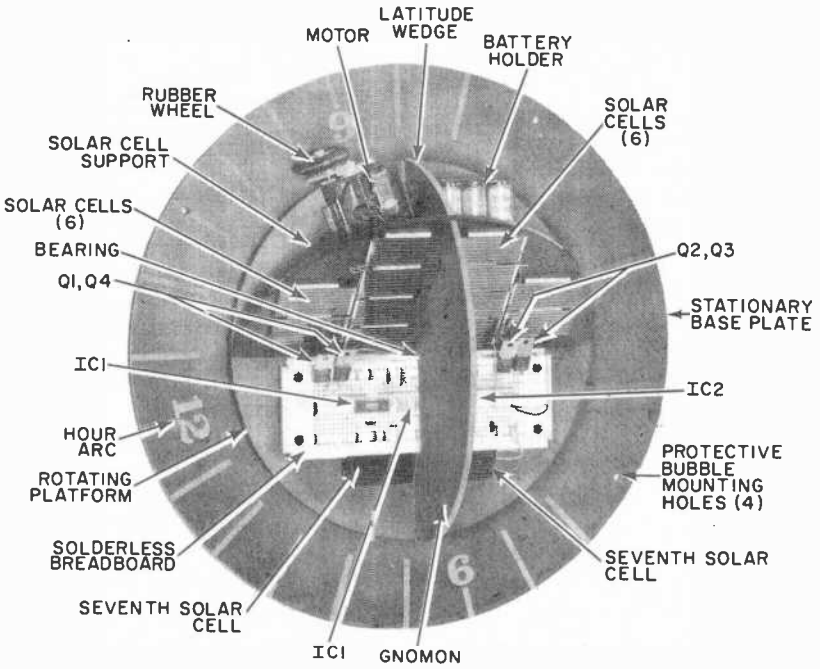
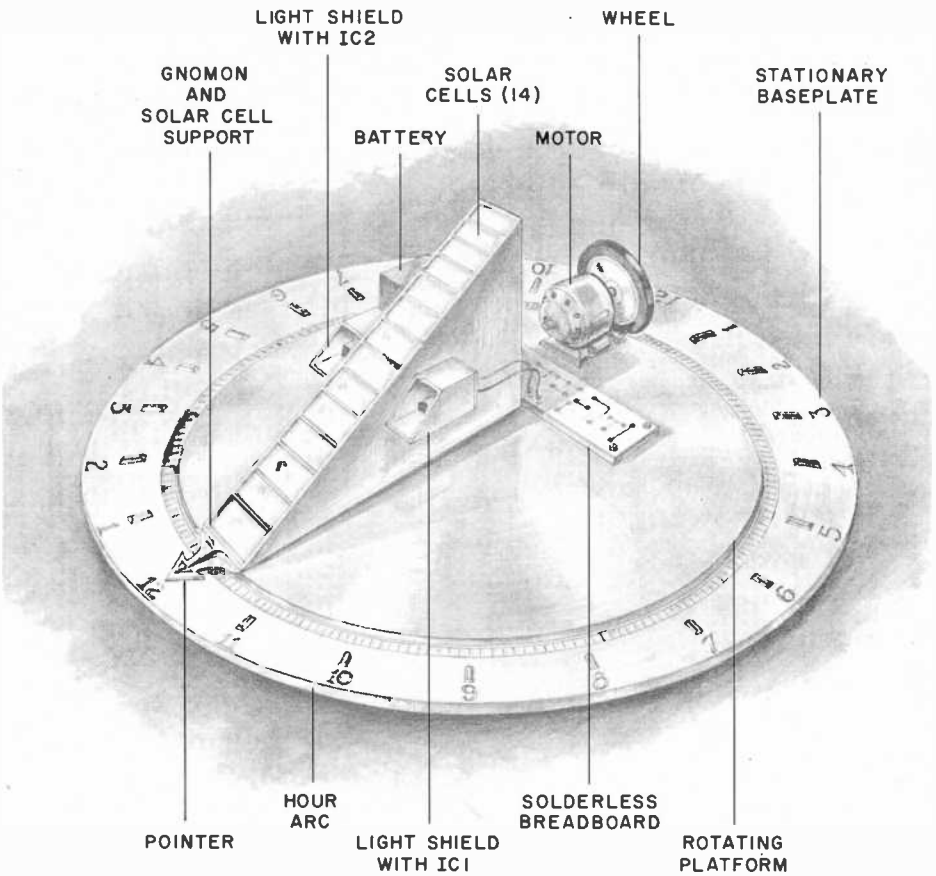


Fig. 4. Photo of the author's prototype sundial showing construction details. Any configuration can be used as long as the two light-sensitive ICs have the gnomon between them.



This artist's conception of a possible sundial design shows the solar cells actually mounted on the gnomon.

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The motor is attached to the rotating platform so that the wheel makes contact with the fixed baseplate. If the wheel is large, the motor assembly can be mounted on a block. The two leads from the motor are also brought to the solderless breadboard.

Final Assembly. All that remains now is to build the circuit of Fig. 3 on the solderless breadboard and make the necessary connections between the circuit board, battery, solar-cell array and servo motor.

Install *IC1* and *IC2* on the solderless breadboard, one on each side and as close to the gnomon as possible. Refer to the top view of this IC shown in Fig. 3 to determine the correct pin-out. The IC has a cutout at each end, and only the location of the indentation on the upper surface of the chip correctly identifies the position.

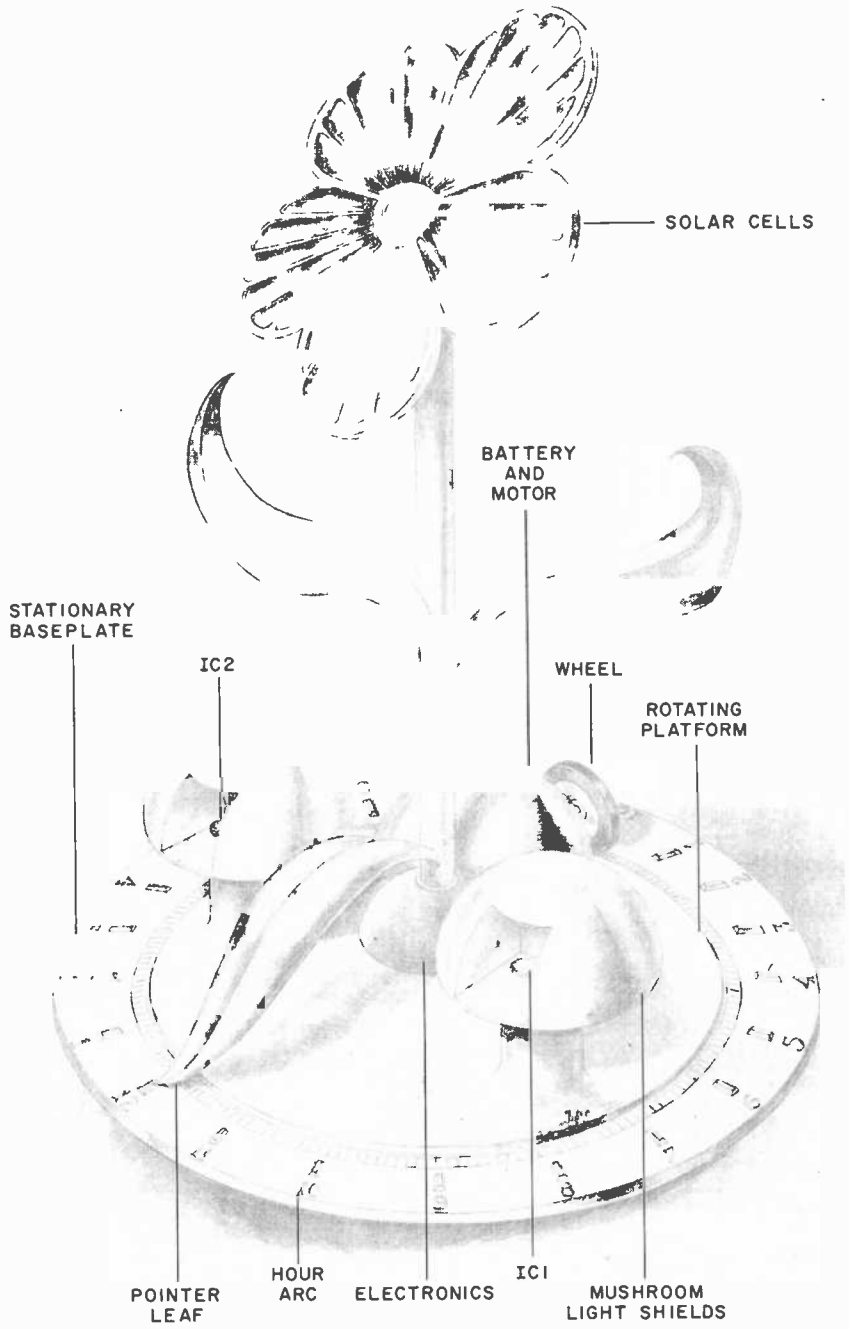
None of the remainder of the circuitry is critical, so conventional solderless breadboard wiring practice can be used. In the prototype, FETs *Q1* and *Q4* were located on one side of the breadboard and *Q2* and *Q3* on the other side.

Because room illumination is not as bright as sunshine, increase system sensitivity by changing the values of *R1* and *R2* to approximately 33,000 ohms. For outdoor use, re-install the 1000-ohm resistors specified in the Parts List.

After all wiring is complete, and the circuit checked, insert the fully charged battery in the holder. The mechanism should go into immediate operation if a bright light is played across the gnomon so that the latter's shadow falls on one or the other light sensors (*IC1* or *IC2*). The mechanism should try to align itself with the gnomon pointing at the light source. If the system tries to orient itself *away* from the light source, reverse the two leads to the dc motor.

If the platform bearing is too smooth, inertia may cause the platform to overshoot and cause mechanical oscillation as the system "hunts" for the center of the light source. In this case, cement a small pad of cotton to the underside of the platform to act as a gentle friction brake between the moving and stationary parts.

A dc voltmeter can be used to check operation of the solar-cell array as a bright light is played across the solar cells. Make sure that the voltage change occurs on the circuit side of *D1*. If not, then *D1* should be reversed. Keep in mind that the solar cell output will greatly increase when the array is exposed to bright sunlight.



In this design, a flower and mushrooms made of plastic hold the solar cells and light sensors with a leaf for a pointer.

Calibration. The sundial is calibrated by placing it outdoors on a flat surface so that it is exposed to the sun all day. Don't forget to use the proper values of *R1* and *R2*. If the batteries are charged, the platform should rotate to point the gnomon at the sun.

Using a watch as the time reference, at each hour, mark the point on the hour arc that the gnomon points to at that time. If you are north of the equator, at 12 noon, the gnomon should be pointing south. This is the "12" mark, and on the opposite side of the baseplate place an arrow to indicate north. This arrow can be used to orient the sundial if it is

SOLAR-POWERED SUNDIAL

CORRECTION FACTORS FOR SOLAR TO SIDEREAL TIME

Jan. 1 + 3.5	Feb. 1 +13.4	Mar. 1 +12.5	Apr. 1 + 4.0
6 + 5.8	6 +14.1	6 +11.4	6 + 2.6
11 + 7.9	11 +14.3	11 +10.2	11 + 1.2
16 + 9.8	16 +14.2	16 + 8.8	16 − 0.1
21 +11.3	21 +13.7	21 + 7.4	21 − 1.2
26 +12.6	26 +13.0	26 + 5.8	26 − 2.1
May 1 − 2.9	June 1 − 2.3	July 1 + 3.9	Aug. 1 + 6.3
6 − 3.4	6 − 1.5	6 + 4.6	6 + 5.8
11 − 3.6	11 − 0.6	11 + 5.3	11 + 5.2
16 − 3.7	16 + 0.4	16 + 5.9	16 + 4.3
21 − 3.5	21 + 1.6	21 + 6.2	21 + 3.2
26 − 3.1	26 + 2.6	26 + 6.4	26 + 1.9
Sept. 1 + 0.1	Oct. 1 −10.2	Nov. 1 −16.4	Dec. 1 −11.0
6 − 1.5	6 −11.7	6 −16.3	6 − 9.0
11 − 3.2	11 −13.1	11 −16.0	11 − 6.9
16 − 5.0	16 −14.3	16 −15.2	16 − 4.5
21 − 6.8	21 −15.2	21 −14.2	21 − 2.0
26 − 8.5	26 −15.9	26 −12.8	26 + 0.4

Source Sundials *by Roy K. Marshall, MacMillan Co., New York 1963*

moved to another location. Simply point the arrow north and the hour arc is correctly positioned.

A sundial keeps solar time, which may differ from "clock" time by as much as 16 minutes either way, depending on the date. The Table gives correction factors for sidereal time. For example, on March 1, the sundial will be 12.5 minutes "fast," while on April 16, the dial will be almost correct. On November 1, the sundial will be 16.4 minutes "slow."

The hour "tics" and numerals can be painted on the hour arc, or press-on type may be used. Weatherproof these indications for protection.

Once the hours have been marked, check that the dc voltage output of the solar-cell array is slightly higher than the battery voltage so that charging can take place.

A transparent bubble dome can be fitted over the moving platform, or the complete assembly, to provide weather protection and to create a greenhouse effect to maintain a reasonable internal temperature for the circuit. The bubble dome can be secured as desired. ◇

Uniform specifications and measurement procedures for car amplifiers, tuners and tape players

BY LEONARD FELDMAN

IN THE last few years, car stereo equipment has sold at so rapid a pace that some observers believe it has outdistanced hi-fi gear for use in the home. Somewhat surprisingly, this phenomenal growth has taken place despite a chaotic, "*caveat-emptor*" situation with respect to published specifications and measurement standards.

As matters have stood until now, a power designation of 20 watts might, if measured on the same basis as that used for home hi-fi components, mean as little as 2 watts. Similarly, the real meaning of a specified tuner sensitivity of, say, 2.0 microvolts, was often anyone's guess. The fact that the stringent rules adopted by the Federal Trade Commission in 1974 for disclosure of power-output capability applied exclusively to home hi-fi equipment provided a convenient loophole for many car stereo makers.

Recognizing that this state of affairs was unfair to the consumer and unhealthy for the industry, a group of dedicated car stereo equipment manufacturers formed the Ad Hoc Committee on Car Stereo Standards. In October of last year, the committee finished work on

Editor's Note: Readers wanting details of measurement procedures may obtain copies of the related standards from the Institute of High Fidelity, 489 Fifth Ave., New York, NY 10017. They are identified as IHF-T-200, 1975, for $6 and IHF-A-202-1978 for $7.

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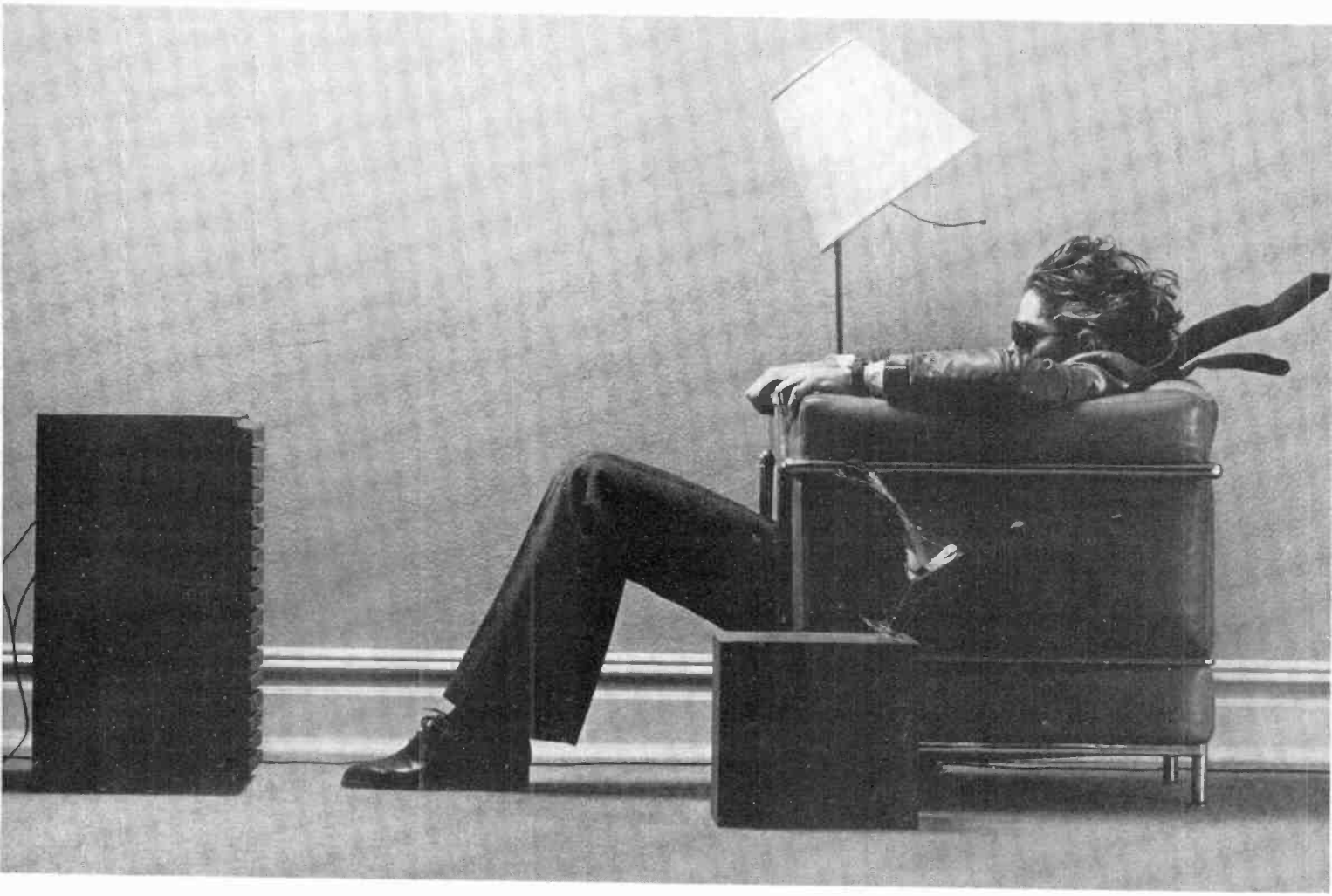

If your old favorites don't sound as good as they used to, the problem could be your recording tape.

Some tapes show their age more than others. And when a tape ages prematurely, the music on it does too.

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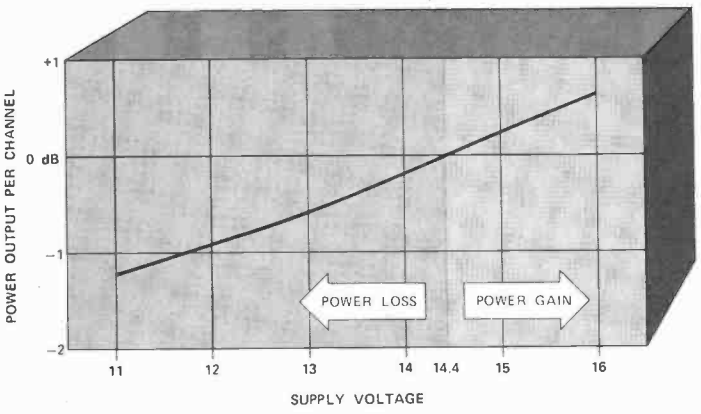


Fig. 1. Power output per channel of a car stereo amplifier varies with changes in supply voltage.

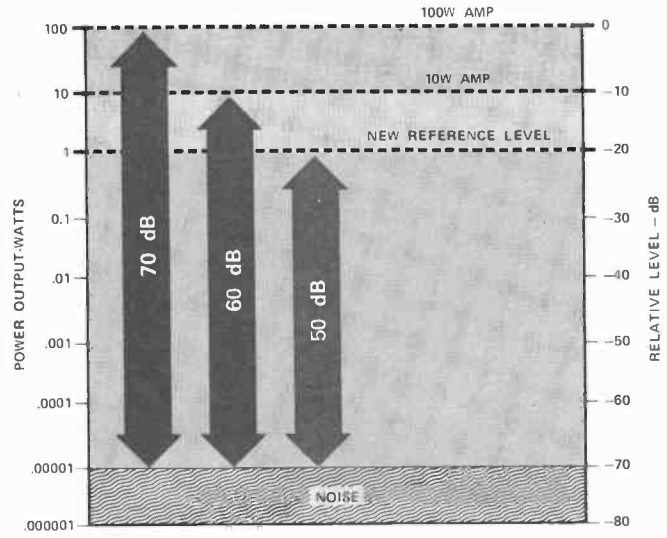


Fig. 2. Measured at standard reference level (1 watt), amplifiers with equal noise outputs have equal S/N specifications regardless of ratings.

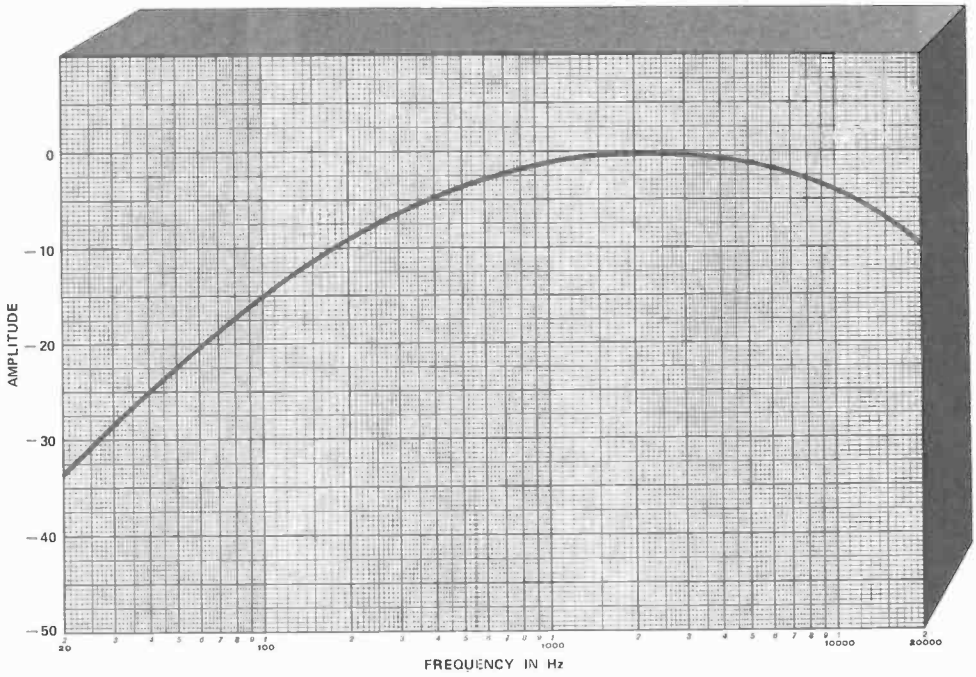


Fig. 3. A-weighting network yields S/N measurements that correspond more closely to human sensitivity to low-level noise.

Car Stereo Standards of Measurement relating to amplifiers, tuners, and tape players. (Receivers, of course, are covered by the amplifier and tuner standards in combination.) Further, the committee invited just about all car stereo manufacturers who market equipment in the U.S. to endorse the standards. By this action a manufacturer would agree that by June 1, 1980, all its printed catalogs, specification sheets, advertisements, and other literature will be in conformance with the standards. If, as seems likely, widespread industry endorsement occurs, consumers will, at long last, be able to assess and compare specifications for car stereo equipment in a meaningful way.

In writing the measurement standards for amplifiers and tuners, the Committee was able to borrow extensively from those previously formulated by the Institute of High Fidelity (IHF), and repeated references are made to various paragraphs in the corresponding IHF Standards. With tape-player measurements, however, the Committee was pretty much on its own, as the IHF is still working on its standards for this product category. In general, fewer disclosures are called for in the Car Stereo Standards than in the IHF Standards, but these should certainly help clarify product performance for prospective equipment purchasers.

Amplifier Measurements Standards. Six specifications concerning

amplifier performance are called for in the new standards: power output, frequency response, signal-to-noise ratio, sensitivity, minimum input impedance, and tone control action. To be in conformance, power output must be designated in watts per channel minimum average continuous power into a specified load (e.g. 8 ohms, 4 ohms, etc.) over a specified frequency range (e.g. 20 Hz to 20,000 Hz) with no more than a specified percentage of total harmonic distortion. An acceptable statement of power output might read: "Power Output: 10 W per channel into 4 ohms, 40 to 15,000 Hz, at 0.5% THD". This format pretty well follows that required by the FTC and by the new IHF-A-202 Amplifier Standards for home audio equipment, except that the abbreviations and slightly condensed verbiage shown in the example are allowable. The required test method is more fully described in paragraph 3.1 of the IHF Amplifier Measurement Standard.

While the procedure is essentially the same as for home equipment, the Committee had to consider one important additional matter. The supply voltage in most cars can vary between 11 and 16 volts under actual driving conditions. Figure 1 shows how this might affect the power output of a typical car stereo receiver. With 11 volts, rated distortion is reached at 8 watts per channel (−1.2 dB), while with a 16-volt supply, the same receiver would deliver more than 12 watts (+0.6 dB) for the same level of distortion. To keep things uniform, the new standard calls for a 14.4-volt dc supply which would give this receiver a 10.5-watt rating.

Frequency response for a car amplifier must be stated as follows: Frequency Response: __Hz to __ Hz, ± __ dB. Measurements must be made at a 1-watt output level, with the amplifier terminated in its rated load impedance. Where the amplifier is not separately accessible, as in a car stereo receiver, the input may be regarded as the input to the volume control.

Signal-to-noise ratios of audio products have often confused consumers. Given two amplifiers, one with a power output rating of 10 watts and the other 100 watts, both with identical residual output noise, the one with higher power will have a 10-dB higher signal-to-noise ratio if each is measured *relative to its own rated output*. Figure 2 shows this graphically. Yet, in listening, one would *hear* the same noise from both. The IHF Standard took care of this by specifying an output level of 1 watt as the reference, regardless of the rated power output. In addition, if a volume control is available, a standard *input* of 0.5 volts must also be used. Finally, because it was felt that weighted measurements more accurately reflect the perceptibility of low-level noise, the car standard follows the IHF practice of prescribing the use of an "A" weighting network. The "A" weighting characteristic curve is shown in Fig. 3.

Input sensitivity, the fourth required specification, is also referred to a 1-watt output level and is to be expressed in volts. In this case, an *additional* sensitivity rating may be given for the input voltage required to produce full rated output. The minimum input impedance called for in the new standard is aimed at separate amplifier components only and is intended to establish compatibility between models and brands. It is stated, simply, in ohms.

EQUIVALENT VOLTAGES FOR 75-OHM AND 300-OHM ANTENNA INPUTS

Input (dBf)	Across 75 ohms (μV)	Across 300 ohms (μV)
11.2*	1.0	2.0*
14.7	1.5	3.0
17.2*	2.0*	4.0
20.8	3.0	6.0
23.3	4.0	8.0
25.2	5.0	10.0
31.2	10.0	20.0

*A difference of 6 dBf represents a four-to-one power difference.

The last required disclosure for amplifiers is tone control (or equalizer) action, and the format is to be: Tone (Equalizer) Action: ± __ dB at __ Hz and __ Hz. In the case of bass and treble controls, the recommended frequencies for testing are 100 Hz and 10,000 Hz. For multiband equalizers, appropriate center frequencies are used.

Tuner Measurements Standards. The second section of the proposed Car Stereo Standards has to do with measurements made on tuners, or the tuner sections of complete receivers. Nine disclosures are called for. The first of these is usable sensitivity in mono. Like most of the other tuner measurements, it is derived from the IHF Tuner Measurement Standard, IHF-T-200 and is to be stated in dBf, rather than in microvolts, as has been the common practice up to now.

The change to dBf is especially important, because the antenna input impedance of most car stereo radios is 50 or 75 ohms, not 300 ohms as commonly found in home tuners or receivers. Sensitivity of a tuner is rightly measured in terms of *power*, not voltage, at the antenna terminals. But look what happens if *voltage* is used without taking impedance into account. The Table shows the equivalent microvolts across 75-ohm and 300-ohm antenna impedances to produce equal *power* levels in dBf. (0 dBf equals 10^{-15} watts, or 1.0 femtowatt). As you can see, 2.0 μV across a 75-ohm impedance is *four* times as much power as 2.0 μV across 300 ohms. This could easily confuse someone accustomed to sensitivity values in microvolts across 300 ohms, as was used for home equipment.

Another important indicator of tuner sensitivity which must be stated by manufacturers endorsing the new Car Standards is 50 dB quieting sensitivity in mono. This degree of quieting is considered to be the least acceptable for high-fidelity listening quality, whereas the 30-dB S/N figure, often used by car stereo manufacturers, really amounts to barely tolerable performance. The signal strength required to produce 50 dB of S/N must also be quoted in terms of power; that is, in dBf.

Frequency response of a tuner section is to be stated over the range from 30 to 15,000 Hz, with the usual "plus or minus" dB tolerance required in the reporting format. Stereo FM separation figures are required only for a 1000-Hz signal, though they may also be optionally stated for 100- and 10,000-Hz test frequencies, as required in the IHF Standard from which the measurement technique is derived.

Several less common tuner specifications are also called for in the new standard. Included are *capture ratio*, the ability of a tuner to suppress the weaker of two signals on the same frequency; *alternate channel selectivity*, the ability to separate signals that are two channel bandwidths or 400 kHz apart; *image rejection*, the ability of the tuner to reject frequencies that are 10.7 MHz above the local oscillator frequency; *i-f rejec-*

tion, the ability of the tuner to reject signals at its own i-f frequency (10.7 MHz). All of these specifications are to be stated in dB and measured in a manner consistent with the equivalent IHF standard.

An additional measurement called maximum output voltage is applicable to tuners, tape decks and integrated units that have line output terminals. It is intended primarily to establish interfacing compatibility between different models and brands. The minimum recommended load impedance for such separate units must also be stated.

Tape Player Measurements. The third section of the Car Stereo Standards deals with tape playback equipment—8-track cartridge or cassette. Six required measurements and reported specifications are called for. The first is playback response, which must be stated as follows: Frequency Response: ___ Hz to ___ Hz, ± ___ dB. The data must be referred to 1000 Hz as a 0-dB level. While a 3-dB tolerance is recommended, it is not mandatory; any tolerance may be used, as long as it is specified. Car stereo tape players equipped with tape selection switches should have frequency response specifications for each tape type (ferric, chrome, etc.).

Wow-and-flutter performance of tape players is to be measured using an rms-responding meter with weighted response. The meter is read for random 10-second periods at the beginning, middle and end of the tape cassette or cartridge and the average of the peak readings noted, excluding random peaks that do not occur more than twice in any 30-second period. Although the standard does not specifically say so, we presume that some pre-recorded standard test tape, having a continuous 3000 Hz or 3150-Hz signal is used in this test, since those are the test frequencies normally found on such test tapes and also the frequencies to which most wow-and-flutter meters are calibrated. Wow-and-flutter is reported as a percentage, followed by the notation WRMS (Weighted-root-mean-square).

This method of wow-and-flutter measurement represents current industry practice. It is expected that in the forthcoming IHF Tape Measurement Standards, WRMS wow-and-flutter measurements will be abandoned in favor of more meaningful DIN unweighted peak measurements. In that event, the Committee will appropriately revise the Car Stereo Standards.

In measuring stereo separation of tape players, a reference level of 250 nWb/m at 1 kHz is used, recorded on one channel. The opposite channel is played back through a narrow-band filter that includes 1 kHz, and the residual signal is measured. The filter is to minimize the masking effect of tape noise, since crosstalk may actually be lower in level than random noise and still audibly objectionable.

The "A"-weighted signal-to-noise ratio for car tape players must be specified and measured with respect to a 1-kHz recorded signal at a reference level of 250 nWb/m, using a 20-to-20,000-Hz bandpass filter. Required format is: Signal/Noise Ratio (A-Weighted) ___dB. Units having selectable equalization for various tape formulations, must have S/N ratio reported for all equalization settings. Finally, if the tape player is a separate component, maximum output voltage, with load impedance, must be specified to establish compatibility between models.

In Conclusion. Certainly, a great many more specifications might have been included in the new standard. For example, in the tuner-section, 50-dB quieting sensitivity measurements for stereo FM are notably absent. This seems a bit odd, considering that most listening these days is done in stereo. Possibly, concern for the feelings of manufacturers who fear that some of their competitors may *not* endorse the standards prompted the committee to settle for the less stringent mono spec. Strangely, too, the committee requires no distortion measurement in the tuner section even though one is included in the amplifier section.

However permissive these measurement standards may seem to those who are accustomed to the more comprehensive disclosures demanded of home hi-fi manufacturers, it is significant that a group of audio manufacturers was able to agree on them without government pressure. The result of their efforts will substantially benefit the audio consumer who wants to assess the suitability of equipment for use in his vehicle. He can now be confident that the specifications from competing manufacturers (who endorse the standard) are comparable and not designed to mislead. ◇

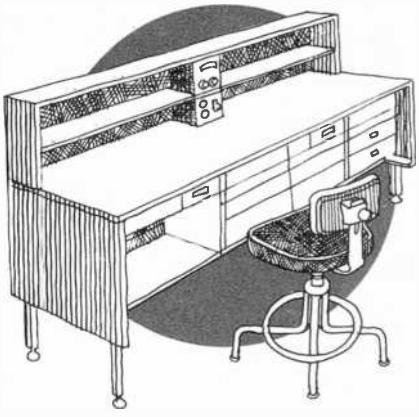
TOOLS & EQUIPMENT FOR ELECTRONICS WORKBENCHES

BY JOHN McVEIGH, Technical Editor

"A craftsman is only as good as the tools with which he works" is as true in the field of hobby electronics as any other. Tools are no substitute for knowledge, of course, but lacking key items or using improper ones can put severe limitations on an experimenter's activities.

The type and variety of tools and test equipment that an electronics hobbyist possesses have a direct bearing on which areas of personal electronics he will be able to explore.

In this editorial focus, we discuss how an electronics workbench should be set up and consider several factors that should be taken into account in deciding what items you need for *your* workbench as related to your electronics interest.



The Work Area

The workbench is the one place above all others where the electronics buff pursues his hobby. It is there that he takes a circuit idea or description and reduces it to a working model. Since a serious hobbyist spends a substantial amount of his special-interest time at his workbench, it should be designed for maximum user comfort and safety, and minimum fatigue. If space availability and resources permit, the electronics workbench should be just that and only that, because many projects require more than just a day's work. Thus, a partially assembled (or repaired) project can be left undisturbed until the next time it is to be worked on. In contrast, a work area that serves double duty, as, say, a kitchen table, would cause gross inefficiency and frustrations. In this case, everything would have to be periodically removed so that the "work area" could be used for its original purpose.

The fundamental requirement for an electronics workbench is that it provide a solid, flat, rugged, nonmetallic surface on which one can work. Of course, an actual workbench—a structure specifically designed and constructed for this purpose—can be used. However, if budgetary constraints rule this out, a sheet of ½- or ¾-inch plywood and a pair of wood saw horses can form the nucleus of a fine workbench.

In any event, the work area should be at least 24 inches (61 cm) deep and 48 inches (122 cm) wide. Having a work area of that size or larger will allow you to spread out components, a schematic drawing or assembly manual, a chassis, and tools, and still have some elbow room! A smaller work area will likely lead to crowding, fatigue, impatience and wiring errors.

A highly desirable feature is having one or more shelves above the main work area. Such shelves allow one to mount frequently used test equipment (a multimeter, oscilloscope, power supply, etc.) within easy reach without permanently tieing up substantial portions of limited work space.

The work area surface should be covered with a ribbed rubber runner. This runner will absorb punishment that would otherwise damage an unprotected work surface. Also, its ribbed surface will pre-

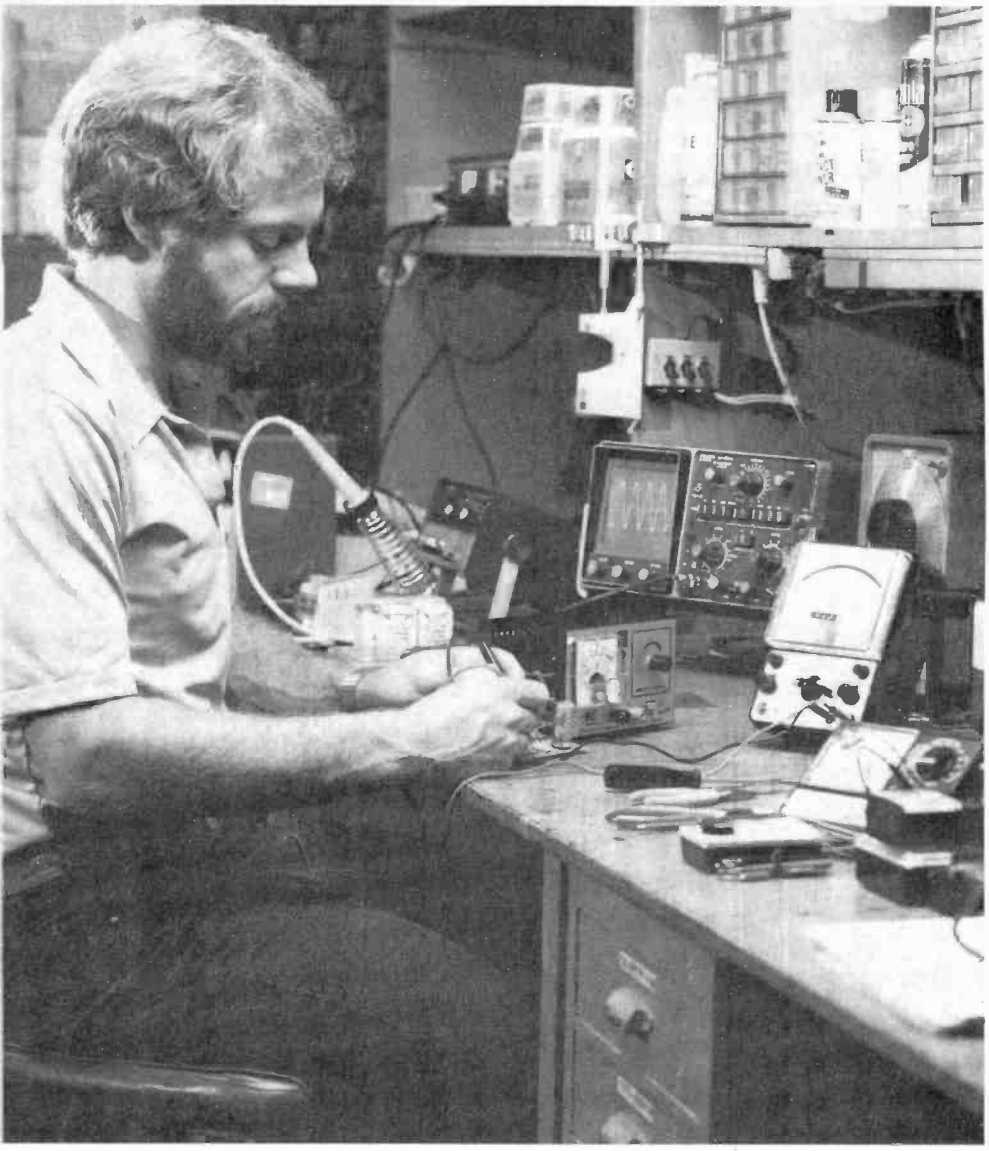


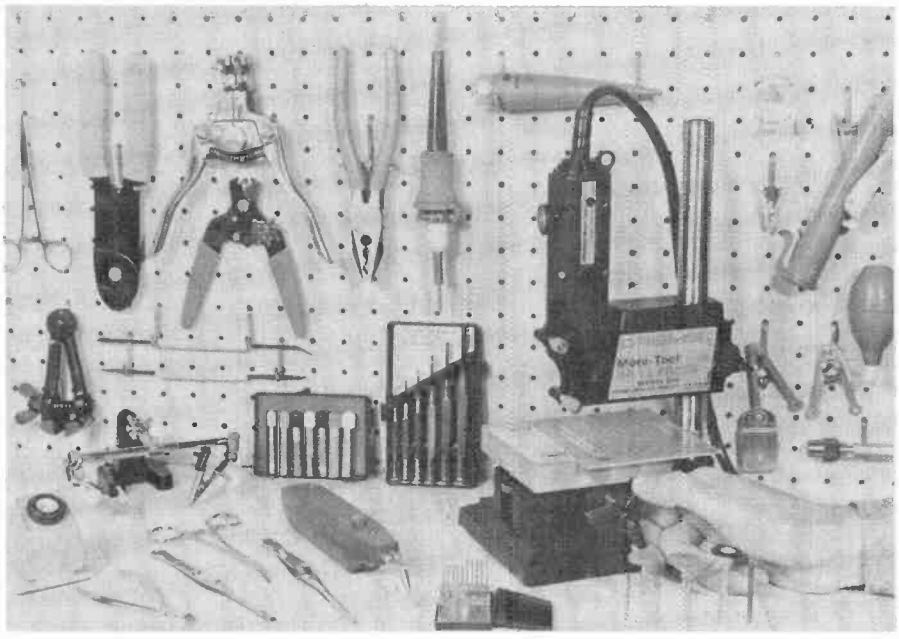
Photo courtesy GC Electronics.

A well-planned electronics work area includes room for the project, test equipment, and storage.

vent hand tools, hardware, and small components from rolling off the workbench and onto the floor.

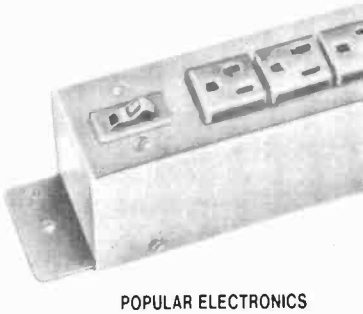
Selecting a chair will largely be influenced by the physical characteristics of the workbench. The chair should be high enough to put one's elbows at the same level as the work area. If the workbench is much higher than the average kitchen table, use of a common kitchen-type chair would be inadvisable. The ultimate in work chairs is a drafting chair with adjustable seat height and back support.

Lighting and Power. The area in which the workbench is installed should be well illuminated. If possible, the workbench should be directly below a ceiling light fixture. Light from this fixture can be supplemented with that from a lamp on the workbench. A compact high-intensity type will provide good spot illumination, but many experimenters prefer to use a drafting lamp with an articulated support arm, such as the Luxo Model LS-1/A. This lamp can accommodate a 100-watt incandescent bulb, has a 45-inch adjustable arm, and includes a clamp so that it can be mounted on the edge of the workbench. For work on densely packed circuit boards and compact projects, a similar lamp with an illuminated magnifier is an invaluable aid. If the need for an illuminated magnifier arises only occasionally, a less costly, hand-held unit such as the GC Electronics Model 22-282 is a good choice.



Use of pegboard and hooks permits convenient storage of tools.

Heath Model HD1274 power distribution strip.



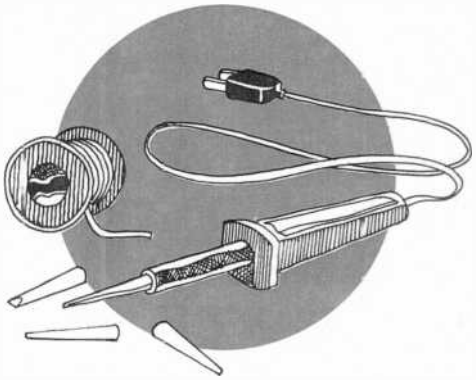
There should be a source of ac electrical power near the workbench. The bench should therefore be positioned near at least two electrical wall outlets, and a bench-mounted power distribution strip with a *minimum* of six sockets should be plugged into one of them. The strip will be used to channel power to test equipment, lamps, soldering tool, etc. Choose a strip with a minimum current rating of 15 or 20 amperes and three-conductor sockets. One with a master on/off switch or individual switches for each outlet is convenient to use. Some include a master fuse or circuit breaker, or even individual ones for each outlet to back up the line's master fuse or circuit breaker.

Storage. A key to high workbench utility is organization. Tools, hardware, electrical components and similar items should be stored in a logical manner that ensures quick accessibility. Certain tools, for example, can either be kept in nearby drawers or hung on a piece of pegboard mounted on a nearby wall.

The best way to store hardware and small electrical components is in suitably sized storage bins. There are modular ones with drawers that are made of transparent styrene to allow quick visual inspection of their contents.

Hobbyists with many items to store can buy several such small storage cabinets. Some manufacturers models with different characteristic drawer sizes to hold certain items. Modular storage cabinets can be stacked either vertically or horizontally on shelving above the main work area.

After a few years, most electronics hobbyists build up a respectable "junk box" of discarded chassis, old projects, etc., which are kept around for parts scavenging purposes. Such items are usually much too large to fit in modular storage cabinets. A nearby closet that is not being put to another use is ideal for junk-box storage. If one is not available, a wooden toy chest or a free-standing metal cabinet will probably do.



Tools for Electrical Work

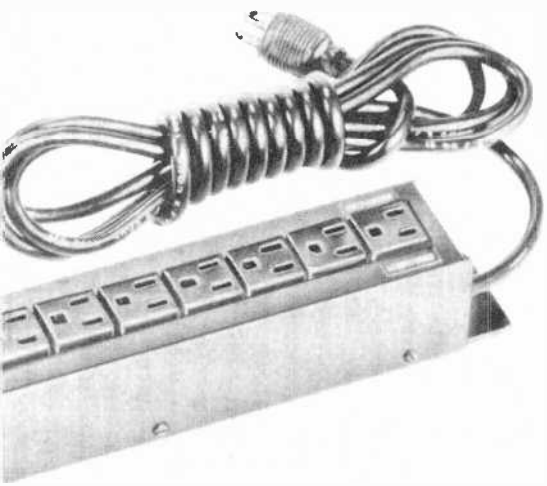
Much electronic-building and service work is centered around the process of making secure connections between conductors by soldering. That is the process by which two or more pieces of metal are bound together by a metal alloy that's applied to the connection in a molten state. This section will deal with implements needed to do this work, as well as other facets that relate to electrical assembly.

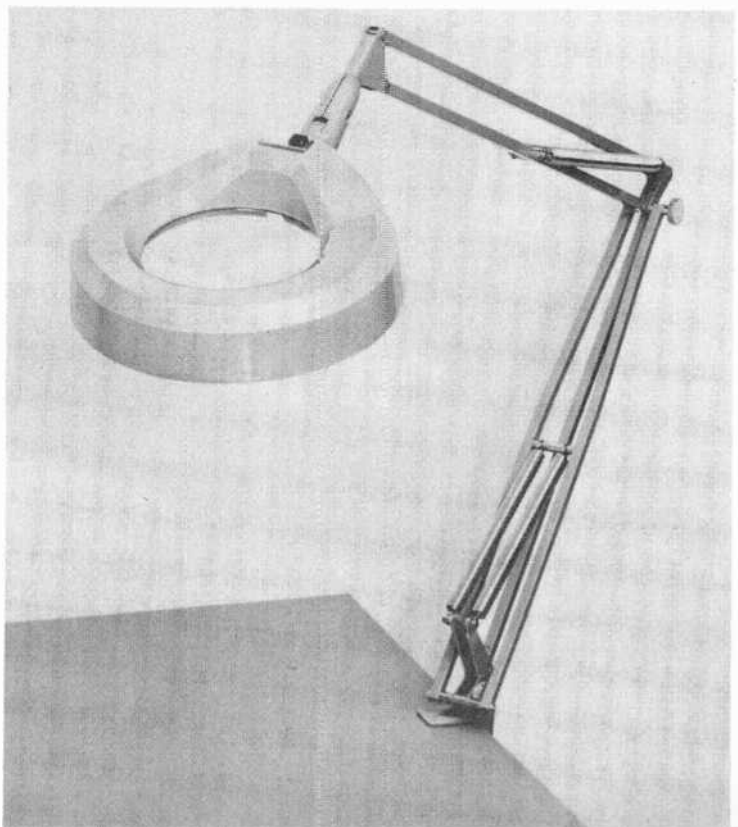
Soldering Irons. A soldering tool should supply sufficient heat to melt solder by heat transfer when the iron tip is applied to a connection to be soldered. There are two general classes of soldering irons—*guns* and *pencils*.

A typical soldering gun is larger, heavier and generates more heat than the average pencil. Soldering of heavy-duty conductors or connectors calls for use of a gun because it can generate enough heat to quickly bring a heavy metal joint up to the proper soldering temperature.

Soldering irons in this category are called guns simply because they resemble pistols, as shown in an accompanying photo. The gun's "trigger" is actually a switch that controls application of ac power to a built-in transformer and thence to the heating element. The working temperature is reached almost immediately. Some models feature multi-position trigger switches to provide

(Continued on page 56)





Luxo Model LFM-1/A illuminated magnifier.

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(Continued from page 51)

different heat levels. For example, a two-detent switch might give the user a choice of generating 100 watts or 150 watts, depending on whether the trigger is fully or partially depressed.

At the other end of the spectrum are small, lightweight soldering pencils. They can generate as little as 12 watts of heat, or as much as 50 watts, depending on the particular model. A relatively low-power pencil such as a 25-watt unit is well suited for light-duty work such as soldering on printed-circuit boards. Some medium-duty applications like chassis wiring require a higher-wattage heating element. Many pencils, called modular soldering irons, use interchangeable heating elements and tips which mate to a main pencil body. Such elements screw into a threaded receptacle at the end of the pencil.

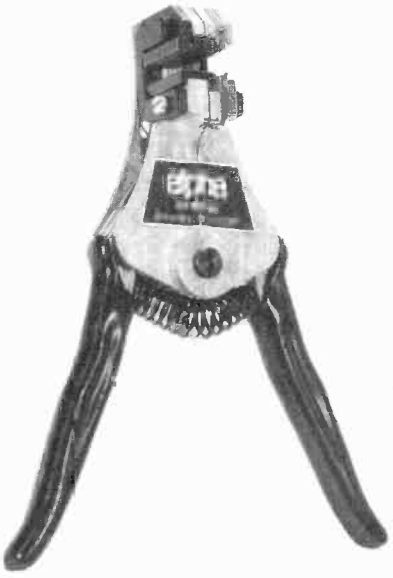
Some heating elements have ceramic bodies with tips of various shapes permanently bonded to them. Others are ceramic or stainless steel units that are terminated with threaded studs on which any one of several different-shaped tips can be mounted. The advantage of such a modular soldering pencil is that it can be assembled in any of several permutations that is optimized for a specific soldering job.

There are tips available for modular soldering pencils to handle most soldering tasks. Very fine, almost needle-like tips are used on printed-circuit boards with IC and component foil pads that are very closely spaced. Larger, blunt chisel and pyramid tips can store and transfer greater amounts of heat for more massive, widely spaced connections. Bent-chisel types can get into difficult-to-reach areas. Whatever size and shape tips are chosen, it's best to buy plated (as opposed to raw copper) tips. Plated tips cost more, but they last up to ten times longer than raw copper tips. The principal advantages of raw copper tips are low cost and more efficient heat transfer. Plated tips, however, transfer heat with enough efficiency for almost any soldering job. Note that before any tip is mounted, its threads and those of the heating element stud should be treated with an antiseize compound to facilitate tip removal.

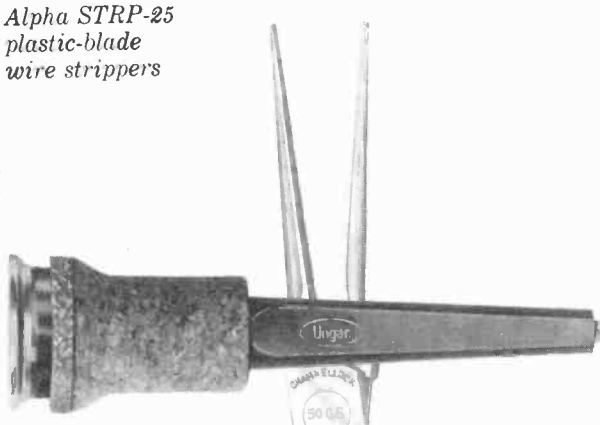
Power is usually applied to a soldering gun on an intermittent basis. The tip

Wahl Model 7295 safety stand holds iron and cleans tip.

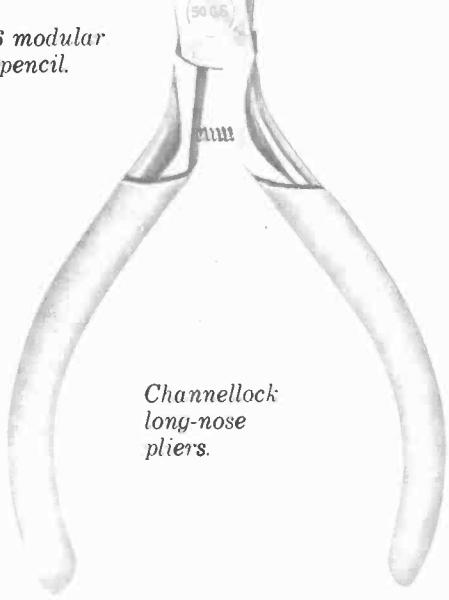
Ungar Solder-Off desoldering bulb.



Alpha STRP-25 plastic-blade wire strippers



Ungar 776 modular soldering pencil.



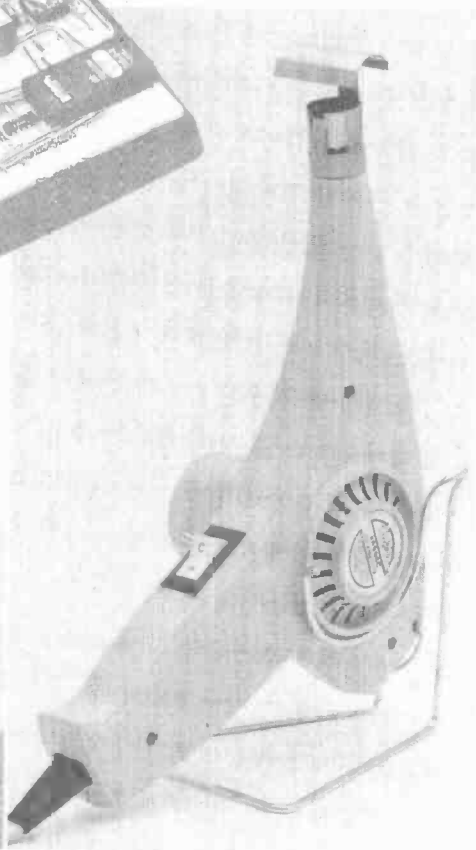
Channellock long-nose pliers.

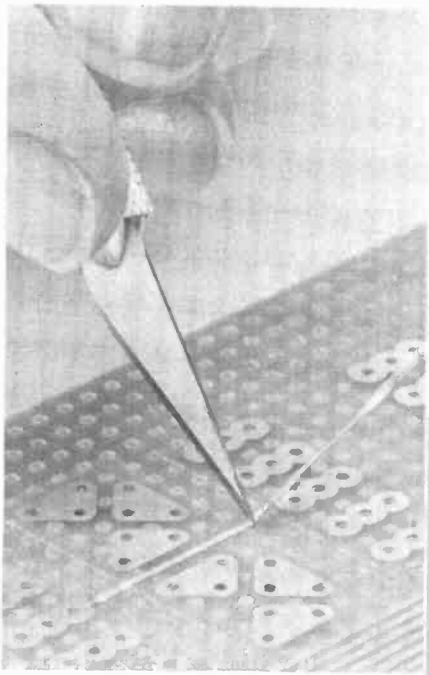
Wahl Model 7500 Isotip cordless iron and recharging stand.

Weller Model 8200 soldering kit.

AP Products POWERACE 103 solderless breadboard

Ungar Model 6966 heat gun for heat-shrink tubing





Making a pc board using Bishop Graphics E-Z CIRCUIT aids and an X-acto knife.

AP Products Logical Connections for interconnecting breadboards

of the gun will heat up to working temperature very quickly, and it will cool off soon after power is removed. Therefore, the gun can be left lying on its side on the workbench, picked up and powered to make the required connection, and then laid on its side again. A typical pencil, however, takes a few minutes to attain working temperature. This means that during a typical work session the pencil will be continuously powered and its tip will remain hot for the entire interval. Therefore, some method must be employed to keep the iron secured in a safe place at working temperature.

One solution to this problem is a special soldering iron holder. This may be a coiled steel form into which the hot soldering iron can be inserted. Most stands of this type also include a sponge which can be kept moistened and used periodically to clean the soldering tip. A more deluxe solution incorporates the foregoing with an iron and a control console that offers switch-selectable temperatures, usually low, medium, and high. This system is called a soldering station. Obviously, this is more convenient than waiting for a modular pencil's heating element to cool, unscrewing it from the holder, and then replacing it with another heater/tip combination. Predictably, however, soldering stations are expensive compared to basic soldering pencils. Among the manufacturers that produce soldering stations are Weller, Ungar, and Heath.

Special Considerations. The proliferation of metal-oxide semiconductor devices has focussed the attention of some manufacturers upon characteristics of certain soldering irons that were largely ignored until recently. As you may know, MOS devices have gate structures that are extremely susceptible to damage by electric potential gradients such as those which can be generated by friction (i.e., static electricity). A source of such electric fields can be the soldering equipment itself.

There are two sources of troublesome potential differences associated with soldering irons. The first is common to most soldering irons—electrostatic tip potential. Static electricity can be set up in an ordinary soldering tip and can be transferred to the component to be soldered when the tip is placed next to one of its leads. If the electrostatic potential is high enough and the MOS device is unprotected, its delicate gate structure will be de-

stroyed. The solution to this problem is to place the tip at ground potential so that static charges do not have a chance to accumulate. Several manufacturers now produce special soldering irons whose heater/tip assemblies are grounded. These units are readily identifiable by their three-conductor NEMA plugs for insertion into three-conductor power sockets.

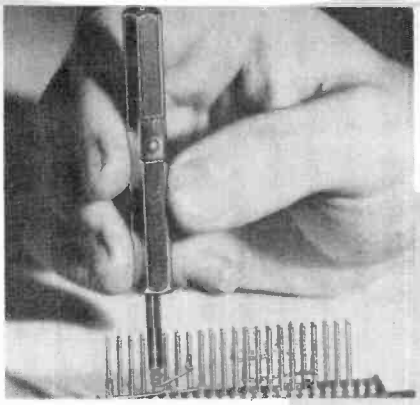
Another source of potential trouble is peculiar to a certain type of soldering iron. Some of the more sophisticated soldering implements (most of them soldering stations) feature automatically controlled tip temperature. These implements employ some type of heat sensing and closed-loop feedback control to gate power to the heating element. This allows the control circuit to compensate for variations in the amount of heat being drawn from the soldering tip and keep the tip at a constant temperature. The switching action of some controlled-output soldering implements can generate voltage spikes which can be transmitted to and adversely affect a MOS device. Some manufacturers, such as Ungar, have designed their controlled-temperature soldering stations and irons in such a way that voltage spikes are kept to a low value.

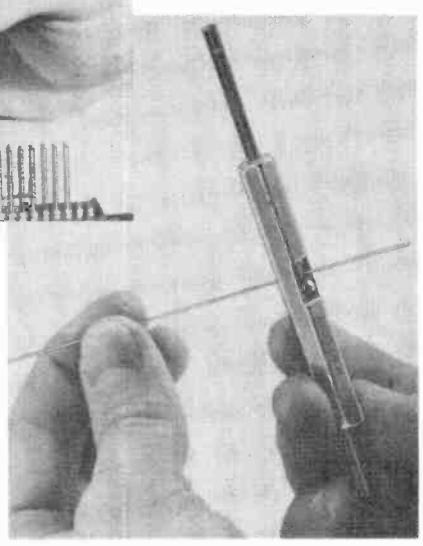
Cordless Irons. All of the soldering irons discussed so far rely on ac power cords. However, there are times when it is inconvenient to be tied to a 117-volt line. Here, a cordless, battery-operated soldering iron serves well. These compact, hand-held tools employ rechargeable NiCd batteries as a power source. Recharging is done automatically when the iron is placed in its recharger/stand (assuming the charger is plugged into an ac outlet, of course).

In operation, the tips come up to working temperature in five to eight seconds and cool off to ambient temperature in one minute or so. They can be used to make the same kinds of solder connections that pencils do.

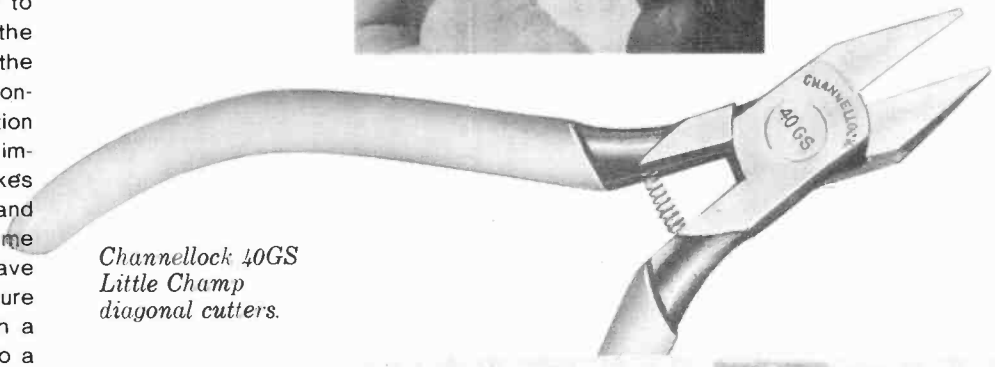
The number of solder connections able to be made before recharging is required varies according to a particular model. Typically, about 125 or so soldering connections can be made on one charge. For a standard iron, a typical charging interval of approximately 14 hours is needed to return the cells to full strength. There are quick-charge irons, however, that require only one hour. Others take three or four hours.

Many optional tips for battery-pow-

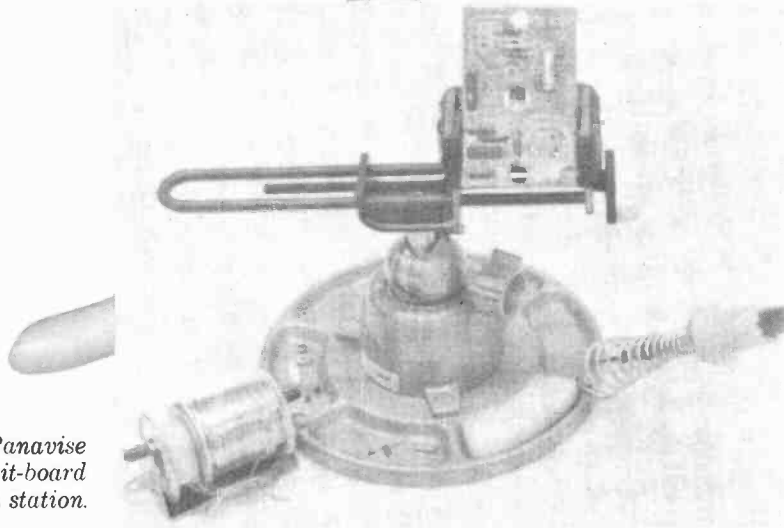




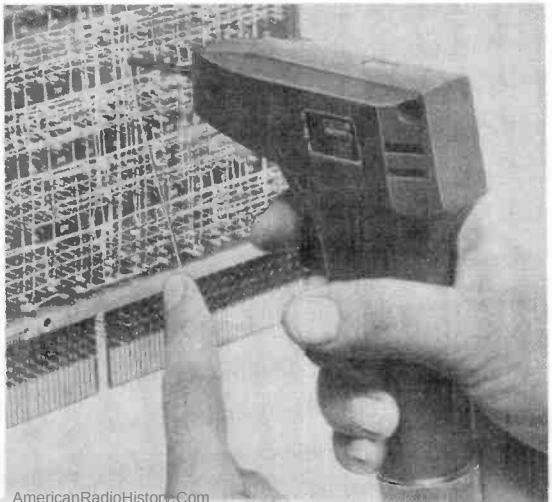
OK Machine & Tool HSU-30 Hobby-Wrap tool strips (right) wraps, and unwraps (above) wire.



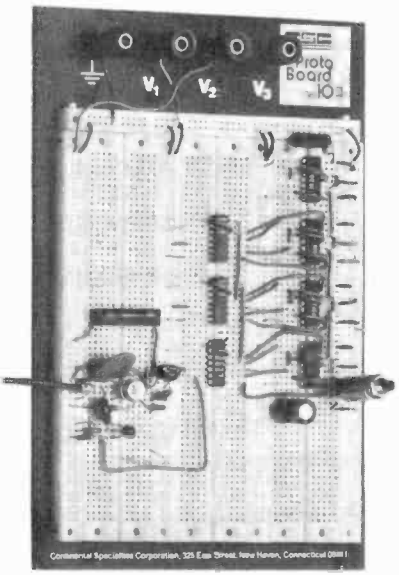
Channellock 40GS Little Champ diagonal cutters.



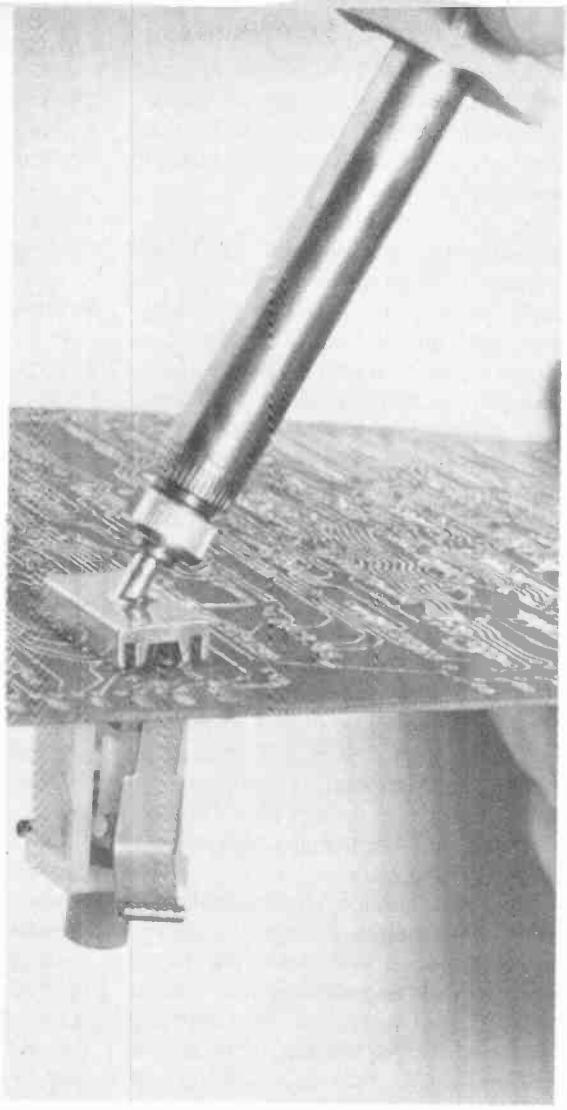
Panavise circuit-board work station.



OK Machine & Tool BW-2630 motorized wrapping tool.



Continental Specialties Proto Board 103.



Ungar 50 DK desoldering implements.

Heathkit Model GH-17 soldering station.

GC Electronics Model 22-306 Deluxe Soldavac desoldering tool.

ered irons, all differing in shape and size, can be snapped into the bodies. A light is often built into the case of the iron to illuminate the work area whenever battery power is applied to the heating element.

It is obvious that there are many different types of soldering irons available. Some are better suited for a particular kind of soldering job than are others. An experimenter who works only with printed circuit boards will find that a soldering pencil (especially a modular one) will be adequate for most (if not all) of the soldering connections he has to make. Someone who builds projects employing coaxial connectors and heavy-gauge wiring will need a higher-power soldering gun. Another person will find a cordless soldering iron an invaluable implement for work far from ac outlets.The choice is often easy for hobbyists with broad electronics interests. They own one of each. In fact, many hobbyists have more than one modular pencil body so that much tip switching is avoided.

Solder. No solder connection can be made without solder. The most common type of solder used in electronic work is an alloy consisting of 60% tin and 40% lead. This alloy is drawn into a hollow wire whose center is filled with an organic paste-like material called rosin. The resulting product is known as "60/40 rosin-core solder." It is completely molten when heated to approximately 375°F (190°C) and solidifies as it cools. If conditions are right, it will form a rigid, conductive bond with the metals to which it has been applied.

There are other solder alloys containing different proportions of tin and lead that are sometimes used in electronics work. The eutectic alloy of tin and lead, that mixture having the lowest melting point, is 63/37. It melts at 361° F (183° C) and is used in applications where applied heat must be kept to as low a level as possible. An equal mixture of tin and lead, called 50/50 solder, is completely molten at 415°F (213° C), while a 40/60 tin/lead alloy has melted completely by the time it attains a temperature of 455° F (235° C). The latter two alloys are not used very often in electronics work today because their higher melting temperatures require more heating of the solder joint, which might damage heat-sensitive semiconductors.

For almost all electronics work, 60/40 rosin-core solder should be used.

This alloy is available in wire form in several gauges. Thinner gauges are to be preferred over thicker ones. For general-purpose soldering, 18-gauge wire solder is a good choice. Close printed-circuit work calls for the use of No. 20 or 22 solder. Finely drawn solder is not only easier to position above a connection on a densely packed board, but also requires less heat for the formation of a given joint. This is true because fine solder sinks away less heat into the roll of solder than do thicker gauges.

To allow solder to form a good joint, rosin *flux* must be applied to the connection. The flux is available separately, as well as imbedded in wire solder. Even with the latter, it's a good idea to have extra flux on hand so that some can be added to a stubborn joint that won't readily accept solder. Flux is needed to scrub away the microscopic film of oxides on the surfaces of metals to be soldered, and it forms a protective film that prevents reoxidation while the connection is heated to the point at which the solder melts.

For applications *other than* electrical wiring, solders with acid fluxes are available. However, the acid is highly corrosive and will damage both electrical components and wiring. Accordingly, it should *never* be used in electronics applications.

Other Soldering Tools. Very useful in soldering work is a small hand tool called the soldering aid. It consists of a plastic or wood wand with a pointed metal tip at one end and a notched metal tip at the other. The blunt end of the aid is used to clear solder from holes in pc boards and from solder lugs. The notched end can be used to make right-angle bends in component leads, to hold leads and wires while the solder joint is made, and to pry leads away from pc boards and lugs during desoldering operations. There are several other soldering aids available, each with different types of tips (metal brushes, reamers, scrapers, etc.) suited for a specific task.

To protect heat-sensitive components during soldering, heat sinks are required to divert potentially damaging heat from delicate components. A set of alligator clips or commercial clip-on heat sinks made for this purpose can be used. They are clipped onto component leads while the soldering job is accomplished.

Those who work with printed circuit or perforated boards will find a so-called "third hand" circuit-board holder a valuable aid. This type of device usually includes a pivoting head that can rotate to just about any desired angle to facilitate soldering.

Desoldering Equipment. On those occasions when a component must be replaced or a circuit rewired, *desoldering* must be performed. There is a whole series of desoldering implements and aids available to today's electronics hobbyist. Most rely on either vacuum or capillary action to remove the solder after it has completely melted.

A common desoldering tool that employs the vacuum principle is a rubber suction bulb with a Teflon tip. The bulb is employed in the following manner: A soldering iron is applied to the connection to be undone until the solder has melted completely. Then the bulb is squeezed and its tip butted up against the solder joint. The bulb is allowed to expand quickly, creating a mild vacuum which draws the molten solder up into the bulb. Another vacuum type uses a spring-loaded plunger.

The other method of removing solder is to employ capillary action. If a copper braid is placed over the solder to be removed and a soldering iron placed over it, the solder will melt and be drawn up by the wicking action of the copper braid. Specially constructed braids are available for this purpose.

Removing multi-lead components such as ICs presents a special problem. If the component to be removed is still functional, it must be unsoldered quickly lest it be damaged by heat. Alternatively, if the device is defective, it must be removed fairly quickly or else printed-circuit foil conductors might be lifted from the board by excessive heat. The solution to this problem is to employ specialized devices. These might be a special DIP-shaped soldering iron tip and a spring-loaded IC extractor tool. The tool is placed above the IC to be removed and locked into position. The special tip is then mounted on the heating element of a modular iron. When the tip is hot, it's applied to all the dual-inline IC's pins on the foil side of the board. The extractor tool lifts the IC off the board as soon as the solder holding it melts. There are desoldering tools available for use with other IC and transistor cases.

The final item we will mention with respect to solder is flux remover. Although rosin flux is not very corrosive and can usually be left on a circuit board with no ill effects, there are some purists who insist on removing all of it. The circuit board can be scrubbed with a toothbrush and an organic solvent like Toluene to remove flux, or it can be sprayed with a product such as GC Electronics No. 22-270 Flux Remover & Cleaner Spray.

Printed-Circuit Aids. For those who intend to make their own printed-circuit boards, special items are needed for layout and fabrication. If pc foil patterns are to be taken from the page of a magazine, a kit like GC Electronics' Lift It (No. 22-326 or 22-318) is ideal. Those who are designing complex boards from scratch might choose to employ Bishop Graphics or similar pc materials and photosensitizing compounds to produce sharp, detailed foil patterns. A glass or plastic pan, etchant solution, rubber gloves, blank boards, a heat lamp, a thermometer, and a small drill will also be needed.

Complex circuit boards are best produced by means of photographic techniques employing master artwork or the copying of etching and drilling guides published in magazines. Simple boards, however, can be fabricated by the direct application of etchant-resist ink by means of a felt-tip pen made especially for this purpose. Whichever means is employed to produce a printed-circuit board, it should be prepared to accept solder well. One item that's well suited for this application is a nonmetallic scrubbing pad such as the Scotchbrite pad. It can be used to remove etchant resist from the board prior to drilling as well as to remove oxidation from foil.

Wrapping Wire Equipment. A fairly new method of making connections between points in a circuit is the wrapped-wire technique. This involves tightly wrapping the stripped ends of a wire around square (usually 0.025-by-0.025-inch or 0.6-by-0.6-mm) terminal posts. Wrapped-wire connections are quickly and inexpensively made, and are used most often in digital circuits assembled on perforated board.

There are many tools available to those who want to assemble projects using the wrapped-wire construction method. These include a manual, multifunction tool that strips insulation from No. 30 wrapping wire, makes a modified wrapped-wire connection (which adds about 1½ turns of insulated wire to enhance mechanical stability), and unwraps the wire when a connection is to be changed or removed.

(Continued on page 62)

ITEM NO.
WK-7

CMOS SAFE

IC INSERTION/EXTRACTION KIT

KIT INCLUDES

- MOS-1416 14-16 CMOS SAFE INSERTER
- MOS-2428 24-28 CMOS SAFE INSERTER
- MOS-40 36-40 CMOS SAFE INSERTER
- EX-1 14-16 EXTRACTOR
- EX-2 24-40 CMOS SAFE EXTRACTOR

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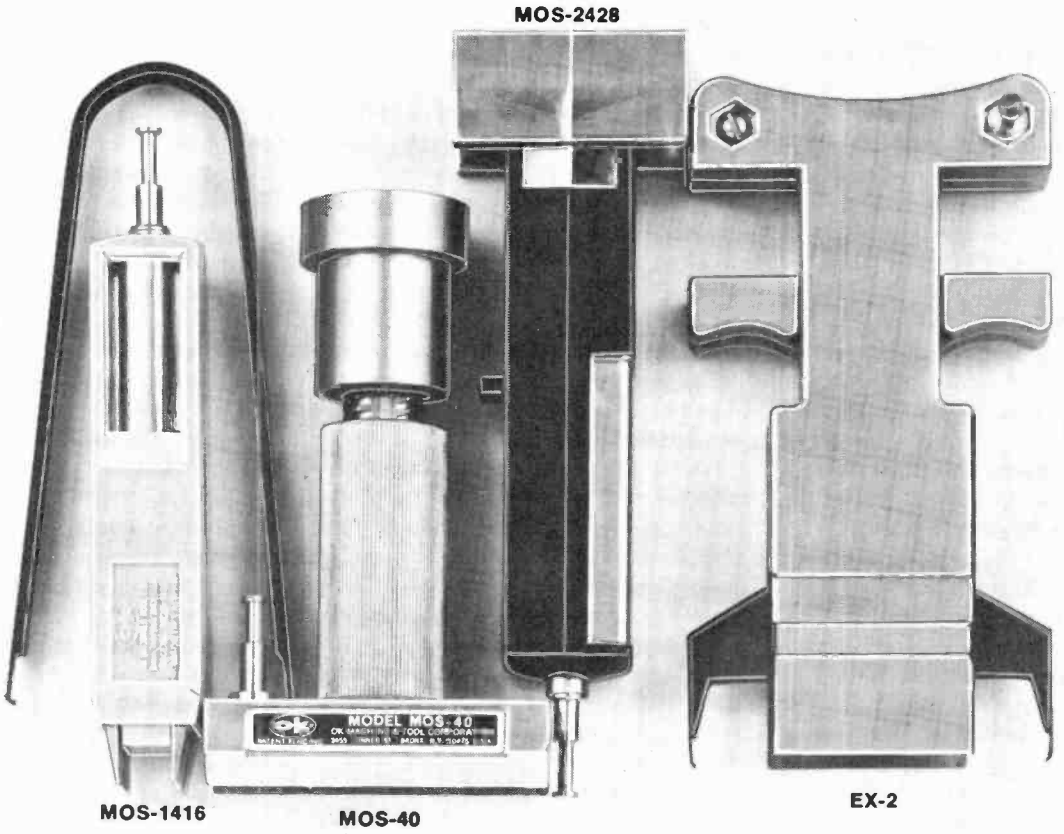

WK-7	COMPLETE IC INSERTER/EXTRACTOR KIT	$29.95

INDIVIDUAL COMPONENTS

MOS-1416	14-16 PIN MOS CMOS SAFE INSERTER	$ 7.95
MOS-2428	24-28 PIN MOS CMOS SAFE INSERTER	$ 7.95
MOS-40	36-40 PIN MOS CMOS SAFE INSERTER	$ 7.95
EX-1	14-16 PIN EXTRACTOR TOOL	$ 1.49
EX-2	24-40 PIN CMOS SAFE EXTRACTOR TOOL	$ 7.95

MINIMUM BILLING $25.00. ADD SHIPPING CHARGE $2.00. NEW YORK RESIDENTS ADD APPLICABLE TAX.

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(Continued from page 60)

Besides the manual wrapping-wire tools manufactured by OK Machine and Tool Corp., Vector Electronics Corp., and other companies, there are motorized tools available for wrapping-wire applications. One such motorized tool is the Model BW-2630 by OK Machine and Tool Corp. It's powered by two NiCd C cells (not included) and accepts one of two bits—one for No. 30 wire, the other for No. 28 or 26 wire.

Besides a wrapping tool, there are several other items the hobbyist interested in utilizing this construction technique must have. The most obvious additional one is wrapping wire. This special wire is available in a variety of colors and comes in spools or in packs of precut lengths with stripped ends. Also necessary are IC sockets designed for wrapped-wire applications and perforated circuit boards with holes of the proper spacing.

Solderless Breadboards. Ideal for designing or experimenting with circuits is a solderless breadboard. This is a plastic block with arrays of holes spaced 0.1 inch (2.5 mm). The block is mounted on a supporting structure and has embedded in it a series of electrical conductors which interconnect adjacent rows or columns of holes. These boards readily accept IC pins and the leads of other electronic components, allowing the hobbyist to build up a circuit with secure, reliable connections without having to resort to soldering or wrapping wire.

A typical solderless breadboard is Continental Specialties' Proto Board No. 103. This board has binding posts for ground and three supply or signal voltages and offers enough tie points for a fairly complex circuit. AP Products, in turn, offers three sophisticated breadboards. These POWERACE models include power supplies and, depending on model, logic indicators, one-shots, pulse detection, two-phase clock, and data switches. Among other companies offering breadboard products are the OK Machine and Tool Corp. and the Heath Company. There are a large variety of finished breadboards available, ranging from simple units with perhaps two binding posts to complex models with built-in fixed or variable regulated supplies, signal generators, potentiometers, etc.

Solderless breadboards are valuable design and experimenting aids that greatly facilitate circuit prototyping. No well-appointed electronics workbench is complete without one!

Wire Cutters and Strippers. We now move into the area of hand tools designed for the manipulation of electrical wires. Before a wire can be soldered, wrapped, or a connector crimped onto it, it must be cut to length and its insulation removed.

The most popular implement used to cut electrical wires and the leads of electronic components is the diagonal-cutting pliers, usually called diagonals or dykes. The diagonal cutters intended for electronics applications should be used only to cut soft metal conductors—*never* to cut iron or steel wire.

The size of the diagonals to be used is determined by the diameter of the wires to be cut. Cutters up to 5 inches long are often employed in electronics applications. Any cutters chosen should be made of high-quality tool steel so that they will make a sharp, clean cut. The tips of the cutters should be tapered to allow the user to reach a particular wire in a crowded area. Cutter jaws should be very well aligned so that cutting edges meet squarely and allow little or no light to pass through when held together. Cutter action should be smooth and clean.

There are, too, a wide variety of specialized cutters—tip cutters, end nippers, etc.—that are handy to have if the budget allows. Diagonal cutters can, if used with care, be employed to strip insulation from wires. Also suited for this purpose is the familiar, inexpensive, yellow-plastic-handled wire cutters/strippers. The object of wire stripping is to remove insulation from the wire without nicking or cutting the conductor.

Far more convenient than traditional wire cutters/strippers are precision, automatic strippers. Although such tools are expensive, they can be real timesavers when there's a lot of point-to-point wiring to be done.

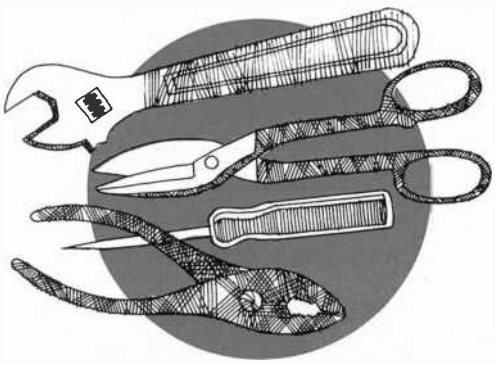
Sometimes a situation arises where insulation is to be *added* to a wire or wire splice. Although PVC (*not* cloth!) electrical tape can be used for this purpose, *heat-shrink* tubing is far more convenient. It is composed of a special plastic material which contracts when heated to a relatively high temperature. Heat-shrink tubing comes in a variety of lengths and diameters to suit any number of applications. There is even heat-shrink electrical tape available for a really *tight* fit.

Pliers. One of the most commonly used class of tools is pliers. In electrical work, needle- and long-nose pliers are necessities. Mechanical work, on the other hand, often involves the use of slip-joint or gas pliers.

Frequent tasks for long-nose pliers include holding wires in place during soldering, acting as a heat sink to protect a delicate component, bending component leads to fit mounting holes on a circuit board, and pulling wires through a panel or chassis hole.

Such pliers are available in a wide range of sizes and configurations. A small size (about 4.5 inches) with a long, thin nose is best for electronics applications. A single pair of longnose pliers is adequate for most jobs, but having several on hand can simplify a task.

Alignment Tools. If a hobbyist intends to work on communications projects, he should have a set of alignment tools on hand. Among the items in this category are a neutralization tool (a plastic or wooden tubular holder with a small metal blade inserted in one end), a nonmetallic screwdriver, and a plastic hexagonal slug-alignment tool. Most alignment tools are nonmetallic and fairly long in size. Using a nonmetallic tool enhances safety because of the tool's insulating property. It also prevents disturbance to sensitive r-f circuits that can be detuned merely by bringing a metal tool near frequency-determining devices. Similarly, the use of a long alignment tool minimizes the effects of hand capacitance.



Tools For Mechanical Work

Drivers. This category includes screwdrivers and nut drivers. Both are extremely important to the mechanical

Breakthrough

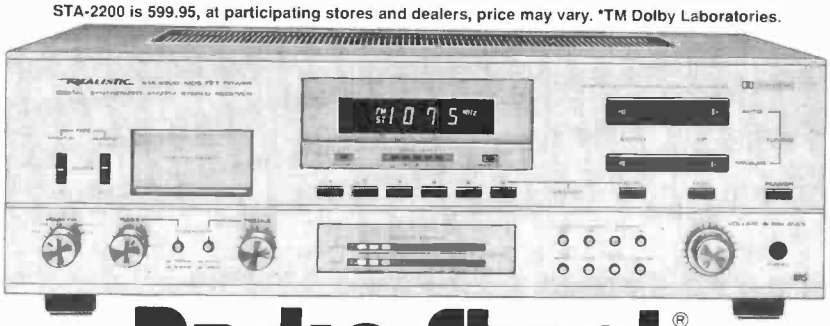
is a word that Realistic® uses very very very rarely. But nothing else describes our new STA-2200 all-digital receiver.

Could Radio Shack have scooped its peers (like Pioneer, Technics and Kenwood) in technology as well as features? Before you buy a conventional receiver that may be old-fashioned before 1980 is over, you can see what's really new at any of our stores. And decide for yourself!

The Computerized Tuner. Quartz-locked, microprocessor-controlled digital synthesis circuitry ends mechanical tuning errors and problems. No dial, no knob, no tuning meters. Instead, bright fluorescent digits display each station's frequency with absolute accuracy. Computer-type "feather-touch" tuning automatically scans up or down the FM and AM bands. Or you can select manual tuning. Store any six FM and any six AM stations in the microprocessor memory for instant recall. Even command the receiver to sample the stations in the memory, then touch-select the program of your choice. There's also battery back-up memory protection, Dolby* FM noise reduction, LED signal level indicators, and dual-sensitivity muting. And the display "off" is a quartz clock.

The High-Technology Amplifier. The Realistic STA-2200 uses a new generation of power transistors called MOSFETs. Their ultrahigh-speed operation brings you stunningly accurate sound reproduction through superior linearity, superior slew rate and inaudible TIM. They are more reliable than ordinary transistors and generate less heat. The amplifier features go on and on. 11-step bass and treble controls with turnovers for controlling ranges below 150 Hz and above 6 kHz. Tone control defeat. Hi-MPX filter. Monitoring and dubbing controls. And more. Power is 60 watts per channel into 8 ohms, 20-20,000 Hz, with no more than 0.02% THD. And one more thing: it's made by the same company that makes the breakthrough TRS-80™ microcomputer.

STA-2200 is 599.95, at participating stores and dealers, price may vary. *TM Dolby Laboratories.



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work ancillary to personal electronics hobby activities.

There are two basic types of screwdrivers—blade and Phillips. A typical electronics project will employ a dozen or more screws to fasten circuit boards, terminal strips, etc., to the chassis or enclosure. Therefore, a complement of screwdrivers must be kept on hand.

Blade screwdrivers come in a great number of sizes. A minimum of three should be at hand for electronics work, with the following blade sizes: 1/8 inch; 3/16 to 1/4 inch; and 5/16 inch or larger. If possible, a larger selection of blade screwdrivers should be maintained.

There are several "specialty" screwdrivers which are not necessary, but are on occasion very handy. One is a "stubby" screwdriver with a short shaft. It's very useful in tight quarters. In really tight situations, an *offset* screwdriver can be especially helpful. Another useful "specialty" screwdriver is one that holds a screw against the blade of the driver. The Stanley Works makes such a device, called the "Screwstart", which can be added to an existing driver.

Phillips screws, those with star-shaped holes in their heads as opposed to straight slots, are often found in electronic equipment. Phillips screwdrivers, like many other hand tools, come in a variety of sizes. There are four standard points, No. 1 through 4. The star-shaped hole in a Phillips screw and the tip of a Phillips driver must fit together properly so that the walls of the screw head or the tip of the driver or both will not be damaged. In electronics work, No. 1 and No. 2 Phillips drivers are those usually employed.

One way to satisfy screwdriver requirements is to buy a driver set containing a handle into which any of several driver shafts can be inserted, such as Xcelite's Model CK-5 driver set. Each of the shafts is doubled-ended, yielding two different tips on each shaft.

Nutdrivers are like screwdrivers except that they fit nuts instead of screwheads.They are very useful in mounting a nut on a captive threaded stud and in holding a nut while its screw is being tightened. (A pair of pliers should *not* be used to hold hex- or square-head screws.) Nutdrivers are available as individual drivers with separate handles, as individual driver shafts that plug into a common handle, or as individual sockets that plug into a universal handle/shaft combination. There are master driver sets available that include nutdriver shafts, slotted screwdriver shafts, and Phillips screwdriver shafts.

Nutdrivers are available with either solid or hollow shafts. The major advantage to hollow-shaft drivers is that they allow the user to keep a grip on the nut even though the screw on which the nut is mounted is protruding. Stubby nutdrivers are handy when work is to be done in tight places. These can be bought in sets that include a large slip-on handle that multiplies torque. Extra-large nut drivers permit the installation of potentiometers and rotary switches without risking damage to the control panel.

Selecting Drivers. As in the case of pliers, cutters, and other hand tools, there are many, many companies manufacturing drivers. It is better and more economical in the long run to buy high-quality tools than so-called "bargains." How can the electronics hobbyist tell that the tools he is thinking of buying are of high quality? Here are a few things to look for.

The handles should be sturdy, made of heavy-duty plastic, and preferably have rubber grips for comfort. Tool shafts should be deeply and firmly embedded into handles in the case of individual drivers (as opposed to plug-in sets). The shafts of plug-ins should lock firmly into place when inserted in the master handle. Tools should have shafts of tempered, plated steel and have ground tips. They should be well-balanced and comfortable in the hand. Perhaps the easiest way to choose high-quality tools is to stick with established names such as Xcelite, Stanley, Vaco, Channellock and Sears Craftsman.

Allen Wrenches and Miniature Drivers. Many control knobs have small Allen or slotted setscrews. To install or remove such knobs, a set of Allen wrenches and miniature screwdrivers should be kept on hand. There are other uses for miniature tools, especially in such fields as remote control modeling, model railroading and slot-car racing, and the fabrication of miniaturized electronic projects. Performing such work when equipped with a precision miniature tool set is so much easier that the purchase of such a set is well justified.

One of the big names in miniature precision tools is Moody Tools, Inc. (42-60 Crompton Avenue, East Greenwich, RI 02818). Jensen Tools & Alloys is another, with a host of precision tools, including many tool kits (1230 So. Priest Dr., Tempe, AZ 85281).

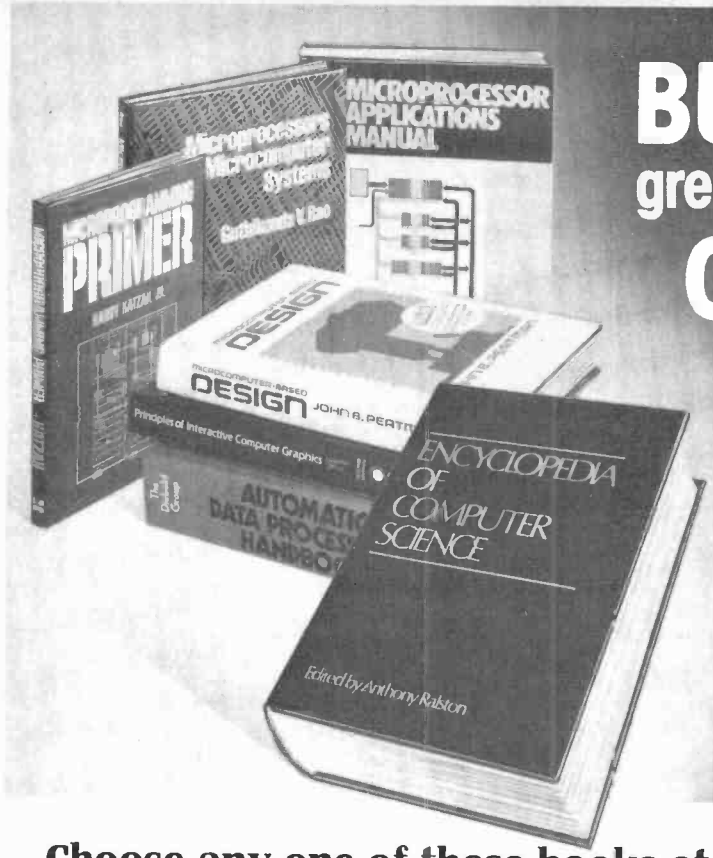
Wrenches. There are several types of wrenches that the electronics hobbyist will need from time to time. Among them are the open-end wrench, the box wrench, and the plier wrench or "vise-grips" tool.

Open-end wrenches are used primarily on the large hexagonal nuts that secure switches and controls to project panels (actually, a large nut driver is better suited for this application) and to operate chassis punches. The box wrench has similar applications but has the advantage of completely enclosing the nut, thus eliminating the danger of slippage that can mar a finished front panel. Box wrenches are not essential, but are handy to have around if the workbench budget permits.

The plier wrench or "vise-grips" is a tool that is not found on every electronics workbench, but it should be. Not only is this an excellent tool for applying brute torque to the task of turning bolts, nuts and shafts, it can also serve as a restraining tool and as a "third hand" for holding small parts, circuit board assemblies, etc. A pair of vise-grips can be adjusted for a given jaw opening and has a locking lever and in some cases a separate unlocking lever for quick-action clamping and release. Vise-grips come in several sizes, but a 10-inch model is sufficient for most workbench applications.

Metal-Working Tools. Experimenters who mount their projects in metallic enclosures will need an assortment of metal-working and metal-finishing implements. A hacksaw is used to cut large and irregular-shaped chassis holes, to trim control shafts, to cut off brackets, etc. Most hacksaws are adjustable so that they can accept blades of several different lengths. More important than blade length, however, is coarseness. The number of teeth per unit length determines blade coarseness. For general-purpose work, a hacksaw blade should have between 14 and 18 teeth per inch. A relative of the hacksaw, the "coping saw," has a thin blade and is very handy when cutting curved and irregular-shaped holes.

Metal shears allow the hobbyist to cut sheet metal for chassis, brackets, shields and other items. Chassis punches take much of the drudgery out of cutting large holes in chassis and panels for meters, connectors, sockets, etc. Chassis punches, which are manufactured by such companies as Greenlee Tool and GC Electronics (both in Rockford, IL), come in a variety of



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shapes and sizes, and should be selected for the types of holes that might have to be made.

A metal nibbling tool can be used to make just about any needed chassis or panel opening. This tool starts at a predrilled hole and is guided along the area to be cut out, taking bite-size chunks out of the metal as it is moved along. Cutting a large hole in a piece of sheet metal can be a tedious procedure with a nibbling tool, but the nibbler will provide good results if care is taken in using it.

Drills. Perhaps the most commonly used metal-working tool from the electronics hobbyist's point of view is the electric drill. A drill for the electronics workbench should have a chuck capacity of 1/4 or 3/8 inch (6.4 or 9.5 mm) and should have variable-speed control. (Slow speeds are ideal for starting holes and for drilling through soft materials.)

The drill should also have either a three-conductor power cord and a metal body or a two-conductor cord and a double-insulated plastic body. Its motor should be rated at a minimum of 1/4 horsepower. For maximum user comfort, the drill should fit comfortably in the hand and should be well balanced.

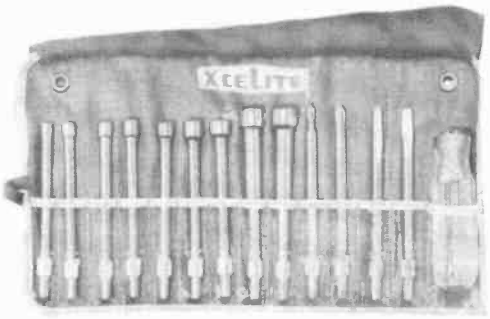
The piece of metal that does the actual cutting of the material being drilled is called a drill bit. There are two general classes of drill bits—those composed of carbon steel and those composed of tungsten-molybdenum steel. The latter is called "high-speed steel" and is used in the manufacture of high-speed drill bits. Because of their superior cutting and wearing characteristics, high-speed bits are the clear choice for the electronics hobbyist. The most economical way to purchase an array of high-speed drill bits is in a set that includes units with diameters ranging from approximately 3/32 inch (2.4 mm) to 1/4 or 3/8 inch (6.4 or 9.5 mm).

Ancillary items for drilling and other metal work are a center punch, a ball-peen hammer, a reamer, a heavy-duty bench vise and a set of files.

At least one centerpunch is needed to make indentations in the material to be drilled at the exact centers of the holes to be made. These indentations will prevent the bit from wandering around the surface when first brought up to speed.

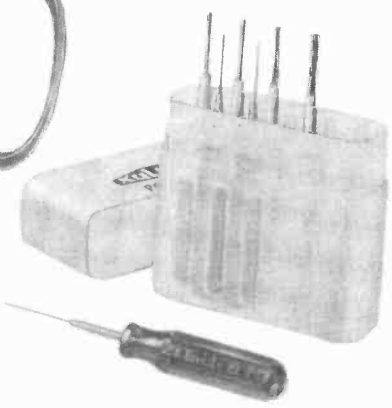
A reamer is used to enlarge holes in sheet metal, and can also be used to remove burrs around the perimeter of a freshly drilled hole. General-duty work calls for a 1/2-inch (1.3-cm) tapered reamer. A heavy-duty bench vise will be

Moody Tools miniature precision tools.

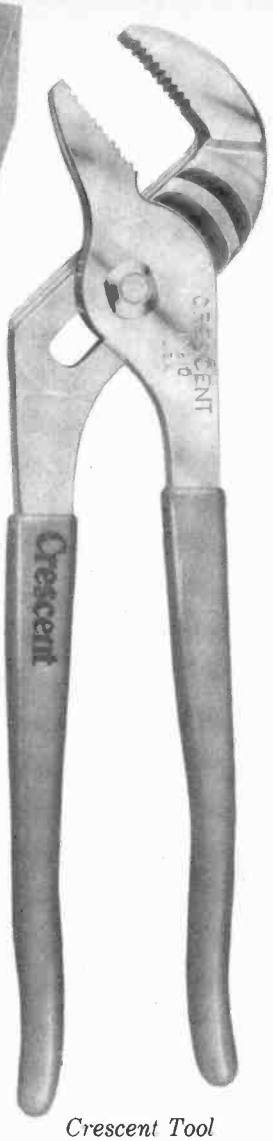


Xcelite Model 99-PR driver set.

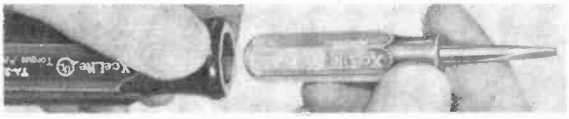
Wiss metal shears.



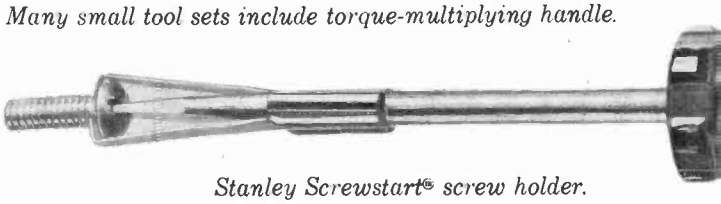
Xcelite Model PS-89 Allen drivers.



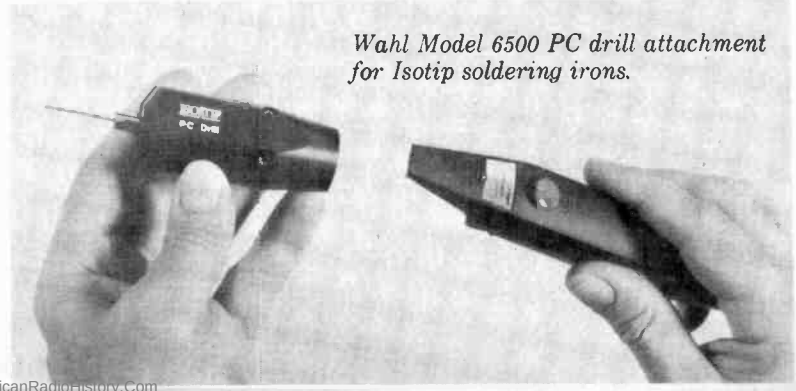
Crescent Tool adjustable offset wrench



Many small tool sets include torque-multiplying handle.



Stanley Screwstart® screw holder.



Wahl Model 6500 PC drill attachment for Isotip soldering irons.

needed if a lot of metal working will be done. It is very useful in holding chassis and other items as they are drilled or sawed. The jaws of the vise should be at least 2 inches long, and the vise should be a swivel unit which rotates in the horizontal plane. This will allow its jaws to form any desired angle with respect to the edge of the workbench.

At least four files should be kept on hand for metal work. Round, half-round, and "rat-tail" files are especially useful in opening up a hole or deburring. Most electronics metal work involves aluminum chassis. Because aluminum is relatively soft, coarse files are the best.

Miniature Power Tools. Hobbyists who do a lot of printed-circuit work will find most power tools to be too big and unwieldy. The answer to their problem is a miniature electric hand drill designed especially for pc applications. Among the companies that make such tools are Micro Electronics Systems, Weller, Dremel, and the Wahl Clipper Corporation.

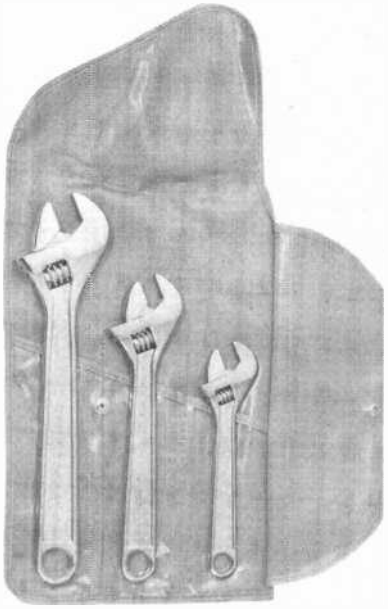
Those printed-circuit enthusiasts who already have a Wahl "Isotip" cordless soldering iron will no doubt be interested in Wahl's Model 6500 PC Drill attachment. This unit plugs into the body of the soldering iron and converts it into a battery-powered electric drill with a No. 56 bit and an operating speed of 10,000 to 12,000 rpm. Wahl also makes specialized Electronics Technician Drills with collet chucks designed specifically for pc applications.

A good tool to use for circuit-board work is the Dremel Moto Tool high-speed drill and grinder, which comes in models ranging from the general-purpose Model 260 to the heavy-duty, variable Model 380. Light in weight, the tool is easy to handle and accepts drill bits ranging from No. 80 to No. 30, depending on which of three chuck collets is to be used.

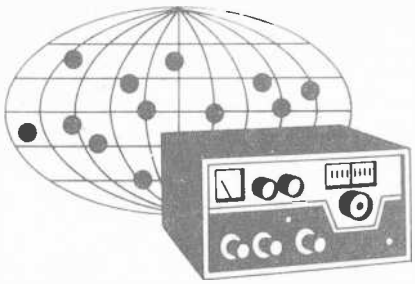
Another flexible hand-held power tool is the Weller Model 651K variable-speed Mini-Shop Kit. This kit includes a handheld power tool and a whole complement of drilling, grinding, polishing, sanding and cutting attachments. Such mini-tools are not for everyone, but those who do a considerable amount of close circuit-board work wouldn't be without one.

In Conclusion. Hands-on personal electronics calls for a work area stocked with a considerable assortment of tools, test equipment, hardware, etc. Some items are absolutely necessary; others are convenient and enhance work efficiency. Many implements can be found in any well-stocked hardware store. Others are specialty items that must be obtained from more exotic sources. Look into your needs now so that your future electronics work will be more enjoyable to pursue. ◇

Stanley Model 61-130 nut driver set.



Crescent Tool adjustable wrench set.



DX Listening

By Glenn Hauser

CANADIAN CAPERS

WHEN THEY have a choice, avid shortwave listeners usually prefer tuning in a country's domestic service (especially if it's in English), rather than the international service. Domestic relays on shortwave last for many hours, allowing foreigners to get essentially the same radio programming heard within the country.

International services tailor their programs for a foreign audience, in repetitive blocks that are typically only 30 to 60 minutes long. International broadcasters believe it is part of their job to explain basic facts about their country; they assume their audience is basically ignorant. So for example, the Voice of America usually tacks on a geographical locator when mentioning a certain state—"the midwestern state of Ohio" and so on.

Despite the great overlap in culture between the USA and Canada, Radio Canada International does the same thing: Nova Scotia has to be identified as an "Atlantic province." But such talking-down to an audience goes much deeper. Humor, for instance, is seldom broadcast; when carried, it is carefully screened or explained. CBC domestic radio generally has one or two Canadian comedy shows running, but to hear them one must tune in something besides Radio Canada International.

For many years now, RCI has been the victim of its own misconceptions about how best to fulfill its mission with the limited resources available. A study showed that, to be effective, a high degree of redundancy must be introduced. (This may be true for distant target areas, but not for the country next door!) As a result, the same half-hour program (except for news updates and the Sunday DX-Digest) is broadcast to the USA four times each evening (five times in the summer), in the hope that at least one of the airings will reach all listeners.

A secondary reason is the time-zone difference. While this does introduce a convenience factor, it is absurd to assume that everyone listens to the radio only at 8 pm local time. The fact is that everyone in North America can hear all of the broadcasts without difficulty.

Of course, it requires much more than half a man-hour to produce a half-hour program. But RCI could better serve its American audience by continuing to produce its special 'for external use only' program and broadcast it twice, liberating another hour (which ought to be in a one-hour block instead of two half-hour blocks) for re-broadcasting some of the best Canadian domestic radio programs. This would simply be a matter of juggling tapes and should involve very little additional production costs.

RCI is constantly faced with budget problems. An obvious solution would seem to be to relay more domestic programming and produce less original programming. The RCI staff would probably consider this a step backwards, an admission of defeat, while RCI listeners would welcome access to more Canadian domestic radio via powerful shortwave transmitters.

What about the CBC Northern Shortwave Service? For many years, Americans have had an alternative to RCI. But the mission of the CBC NS is not to allow Americans to listen to CBC domestic radio. On the contrary, its mission is to serve the few remaining isolated areas in the Canadian North where there is still no local radio and no satellite receiving terminals.

The director of CBC NS revealed in an interview on RCI that the Northern Service is mainly concerned with reaching only 13,000 people in northern Quebec, the native language of the great majority of whom is either Inuktituk or Cree. The fact that many CBC NS programs are still in English is considered a necessary evil, resulting from a limitation of resources necessary to produce programming mainly in Inuktituk and Cree.

But CBC NS has been making progress. Little by little they have been systematically dropping English-language programs. Last year, among those to be dropped were: the last hour of "Morningside" on weekdays; the first third of "As It Happens", and then all of it; "Booktime", "Eclectic Circus", and the weeknight entertainment strip at 8:04 pm local, which includes comedy, drama, nostalgia and quiz shows.

Americanization of Programs. Ironically, much of the time gained in this way has been given over to playing American-style country and western music, with native lyrics, which is undeniably popular among the Indians and Inuit, but is no more native to their cultures than Beethoven or Barbara Frum. Perhaps we should charitably consider this a remarkable effort by English Canada to cease imposing its cultural values on native peoples. In reality, it seems to be a case of "give 'em what they want," rather than "give 'em what they need."

I maintain that this trend is *not* progress, but serves to further isolate native peoples from some of the best aspects of western culture. An RCI spokesman maintains that it

is progress; and we are frequently reminded that the American audience is of no concern to the CBC NS.

Fortunately, there is some hope that RCI will adopt some of the programs dropped by CBC NS. The RCI broadcast of "As It Happens" (the weeknightly newsmagazine which inspired NPR's "All Things Considered" in the USA) has become one of its most popular items. For the past several months, RCI's new director, Betty Zimmerman, has been reevaluating how RCI can best fulfill its mission with an inadequate budget, and carrying more domestic programs on shortwave is one of the options.

RCI's own programs throughout the evening are carried on from three to five frequencies at once. By breaking away just one of these, an alternative programme of CBC domestic radio could be made available to U.S. listeners, while traditional RCI programs to be broadcast on the remaining channels.

There is still another alternative for U.S. listeners: Tune in to CBC Radio on AM (in some cases, FM). Americans close enough to the border can get CBC Radio via a "clear" channel at night, and even closer to the border, they can be heard also in the daytime. These are the main ones: Halifax 360, Moncton 1070, Montreal 940, Toronto 740, Windsor 1550, Thunder Bay 800, Winnipeg 990, Regina 540, Calgary 1010, Edmonton 740, Vancouver 690.

Unfortunately, CBC domestic radio itself is embarking on a trend in the wrong direction. Big changes are in store during the prime-time hours of 8-10 pm as of March 31. Currently, after the 4-minute 8:00 o'clock news, there is a different 25-minute entertainment program each night, followed by an hour and a half of a different musical style (quebecois, folk, country, rock, jazz). CBC programmers have now seen the (American) light and decided to take all this material and mix it up together into a two-hour magazine each weeknight, without any specific identity. In a way, that'll be a help to listeners like me, giving me two hours during which I can safely not listen to CBC. Little gems from "Dr. Bundolo's Pandemonium Medicine Show" may be in there somewhere, but damned if I'm going to sit though 10 hours to find it.

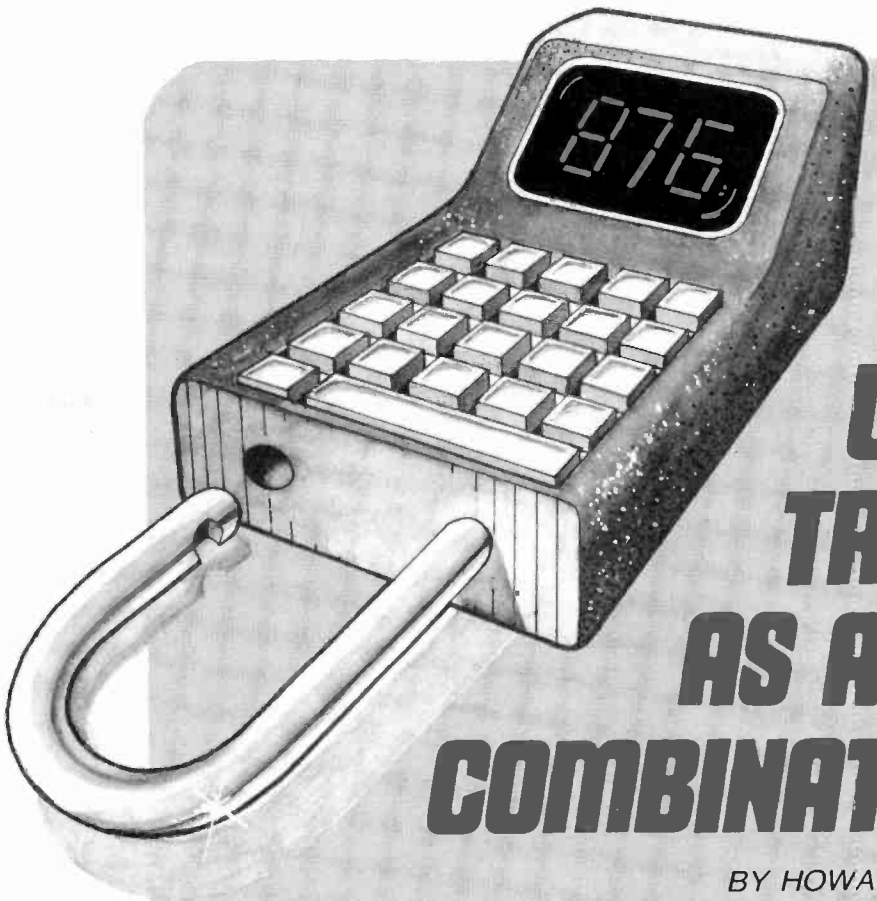
Canada is inundated by American culture, including American radio and TV. It's a constant topic of concern, and moves frequently surface to Canadianize their own broadcasting services. This is certainly all to the good. Not only Canadians, but Americans are bombarded with too much American-style programming in too little variety.

But why doesn't CBC retaliate, by making an effort to get Canadian programming into the U.S.A.? An old-fashioned inferiority complex may be at work here: Canadians like to run down the efforts of CBC as second-rate, while tuning in to American (or American-style) commercial stations and networks in large numbers.

The Grass Is Always Greener. Americans who have had a taste of noncommercial CBC Radio, a national network with block programming of classical concerts, book readings, science programs, children's programs, a weekly nationwide call-in, drama, documentary, comedy and satire—in other words, a well-rounded, intelligent radio service—are eager to hear more CBC Radio.

Reception of CBC NS on shortwave is not reliable, nor is it intended to be in the U.S.A. Two 250-kilowatt transmitters in New Brunswick operate at half-power on a beam heading of 348° (almost due north), so we are lucky to hear anything at all, more or less off the side of the beam. The problem is compounded by the extremely conservative frequency policy of CBC NS. All their frequencies suffer various degrees of interference, ranging from light to extreme, but no changes are ever made to improve the situation as far as reception is concerned.

There is a final ray of hope for would-be American listeners to CBC Radio. Though certainly there are small numbers of hunters, hermits and nomads throughout the vast Canadian North not within range of a community radio station and without a dish to receive satellite service, it's questionable whether these people actually depend on shortwave while it is still available. Once that pocket of 13,000 shortwave-dependent people in northern Quebec is served by satellite and local radio, CBC NS may consider its shortwave mission accomplished, and close down that portion of its effort. This would liberate two powerful transmitters for other uses. We can hope that at least one of them would be dedicated to dawn-to-midnight broadcasts of CBC Radio toward the USA. It would serve us right. ◇



USE YOUR TRS-80 AS A COMBINATION LOCK

BY HOWARD BERENBON

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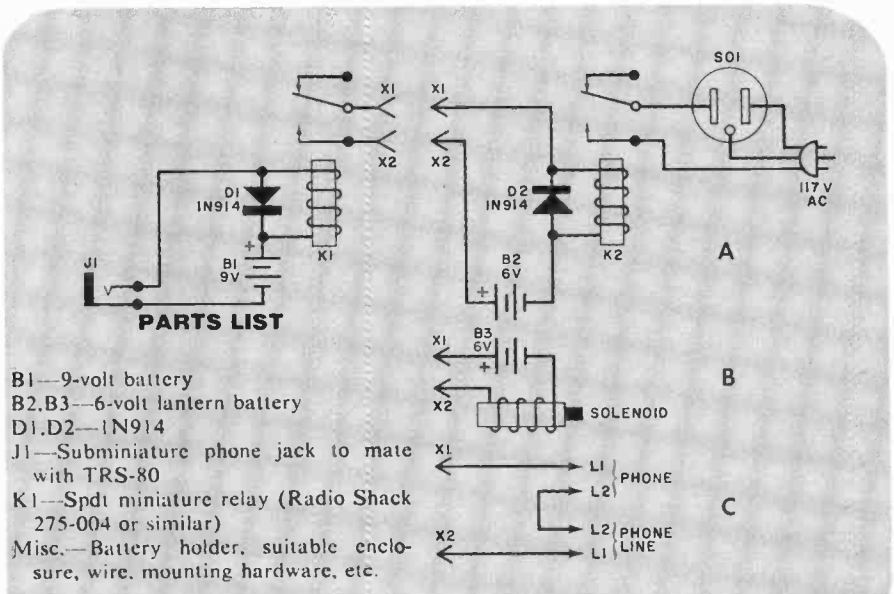

Fig. 1. When computer gets correct combination, it sends a signal to energize K1, which can control other circuits as in A, B, and C.

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PC Board: glass epoxy, plated through holes with solder mask • **I/O:** provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader ...provision for 24-pin DIP socket for hex keyboard/display...cassette tape recorder input...cassette tape recorder output...cassette tape control output...speaker output... LED output indicator on SOD (serial output) line...printer interface (less drivers)...total of four 8-bit plus one 6-bit I/O ports • **Crystal Frequency:** 6.144 MHz • **Control Switches:** reset and user (RST 7.5) interrupt...additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • **Counter/Timer:** programmable, 14-bit binary • **System RAM:** 256 bytes located at F8ØØ, ideal for smaller systems and for use as an isolated stack area in expanded systems...RAM expandable to 64k via S-100 bus or 4K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at FØØØ leaving ØØØØ free for user RAM/ROM. Features include tape load with labeling ...tape dump with labeling...examine/change contents of memory ...insert data...warm start...examine and change all registers...single step with register display at each break point, a debugging/training feature...go to execution address... move blocks of memory from one location to another...fill blocks of memory with a constant...display blocks of memory ...automatic baud rate selection...variable display line length control (1-255 characters/line)...channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling... tape dump with labeling...examine/change contents of memory...insert data...warm start...examine and change all registers...single step with register display at each break point ...go to execution address. Level "A" in the *Hex Version* makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.

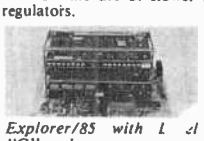
Hex Keypad/Display.

Hex Keypad/Display Specifications

Calculator type keypad with 24 system defined and 16 user defined keys. 6 digit calculator type display which displays full address plus data as well as register and status information.

Level "B" Specifications

Level "B", provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks...address decoding for onboard 8k EPROM expansion selectable in 8k blocks...address and data bus drivers for onboard expansion...wait state generator (jumper selectable), to allow the use of slower memories...two separate 5 volt regulators.



Explorer/85 with Level "C" card cage.

Level "C" Specifications

Level "C" expands Explorer's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and cards are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the motherboard. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from ØØØØ to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

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Computer Terminal

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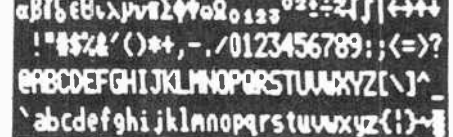
When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: *1.5 P/P into 75 ohm (EIA RS-170)* • **Baud Rate:** *110 and 300 ASCII* • **Outputs:** *RS232-C or 20 ma. current loop* • **ASCII Character Set:** *128 printable characters—*



BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : • 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8* • **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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TABLE I—LEVEL-I BASIC PROGRAM

```
0100 PRINT "TRS-80 COMBINATION LOCK"
0110 PRINT "FOR LEVEL I BASIC"
0120 PRINT
0130 PRINT "COPYRIGHT (C) 1979 BY HOWARD BERENBON"
0140 PRINT
0150 PRINT "ENTER MODE (1) LOAD NEW COMBINATION"
0160 PRINT TAB(11);"(2) ACCESS COMBINATION LOCK"
0170 INPUT A
0180 IF A=1 THEN 210
0190 IF A=2 THEN 270
0200 GOTO 150
0210 PRINT "LOAD NEW COMBINATION"
0220 PRINT "ENTER UP TO 6 DIGITS PER VARIABLE"
0230 PRINT "IN THE FORM: X,Y,Z"
0240 INPUT X,Y,Z
0250 PRINT "COMBINATION LOADED"
0260 GOTO 150
0270  CLS
0280 PRINT "ACCESS MODE"
0290 PRINT
0300 PRINT "ENTER COMBINATION"
0310  N=5
0320 INPUT U,V,W
0330  N=N-1
0350 IF (X=U) * (Y=V) * (Z=W) THEN 380
0360 GOTO 550
0380 GOSUB 600
0390 INPUT #A
0500 PRINT "NO ENTRY"
0510 GOTO 510
0550 IF N=0 THEN 500
0560 PRINT "RE-ENTER"
0570 GOTO 320
0600 PRINT "OPEN"
0610 RETURN
```

TABLE II—LEVEL-II BASIC PROGRAM

```
0100 PRINT "TRS-80 COMBINATION LOCK"
0110 PRINT "FOR LEVEL II BASIC"
0120 PRINT
0130 PRINT "COPYRIGHT (C) 1979 BY HOWARD BERENBON"
0140 PRINT
0150 PRINT "ENTER MODE (1) LOAD NEW COMBINATION"
0160 PRINT TAB(11)"(2) ACCESS COMBINATION LOCK"
0170 INPUT A
0180 IF A=1 THEN 210
0190 IF A=2 THEN 270
0200 GOTO 150
0210 PRINT "LOAD NEW COMBINATION"
0220 PRINT "ENTER UP TO 25 CHARACTERS"
0230 PRINT "LETTERS AND/OR NUMBERS"
0240 INPUT A$
0250 PRINT "COMBINATION LOADED"
0260 GOTO 150
0270  CLS
0280 PRINT "ACCESS MODE"
0290 PRINT
0300 PRINT "ENTER COMBINATION"
0310  N=5
0320  N=N-1
0330 INPUT B$
0340 IF A$<>B$ THEN 550
0360 GOSUB 600
0370 INPUT #-1,A
0500 PRINT "NO ENTRY"
0510 GOTO 510
0550 IF N=0 THEN 500
0560 PRINT "RE-ENTER"
0570 GOTO 320
0600 PRINT "OPEN"
0610 RETURN
```

activated until the TRS-80 RESET pushbutton is depressed.

Software. Programs for the lock combination are illustrated for Level-I and Level-II BASIC. The Level-I program (Table I) permits up to 18 digits to be used for the combination. After running the program, the computer will request a mode entry. Entering a "1" allows the loading of a new combination. The entry is in the form: x, y, z, with entry limited to 6 digits per variable. Entering a "2" will allow access to the entry mode for operating the control circuit. As an example, assume that, for x,y,z, we use 19034,001,1705 the two commas being required to separate the variables. If the size of the combination is limited to 12 digits and variables x and y are filled with 6 digits each, a 0 must be entered for variable z. Thus, a correct entry might be 190340,170501,0.

After the access mode is entered, the program is locked into that mode. Now the correct combination will activate the control circuit, and OPEN will be displayed on the monitor screen. If there is an error in entry, the program will print RE-ENTER, calling for re-entry of the combination. After five unsuccessful attempts to match the stored combination, the program will print NO ENTRY and loop at line #510. Depress the BREAK key to return to READY.

The Level-II version allows entry of numbers and letters for the combination and is limited to 25 characters. After the program is loaded, you are requested to select the mode (1 or 2). To enter a new combination, type a "1." Entering a "2" will allow access to the entry mode for operating the control circuit. The combination of 25 characters (using no commas) or less can be entered. An example of a suitable combination is: 19034ABCDEFXYZ.

As before, the program locks into the access mode once it is entered. Entering the correct combination will activate the control circuit, and OPEN will be displayed on the monitor screen. If there are errors in entry, the Level-II program behaves exactly as does the Level-I version.

Hardware. The remote control plug from the TRS-80 cassette interface is inserted into jack *J1* shown in Fig. 1. When the correct combination is entered, relay *K1* will be activated. The contacts of *K1* can be used to control a wide variety of other circuits as the examples in Fig. 1 show.

In example A, relay *K1* is used to activate a relay with a higher power rating (*K2*) to control lighting or appliances connected to *SO1*. In example B, a solenoid (*K3*) is used to create a computer-activated door lock. The plunger of the solenoid then operates the latch on the door of a room or safe.

For a phone lock, example C, the normally open contacts of *K1* are connected in series with *L1* of the phone. (Note: Any connection made to the phone line must be approved by your local telephone company.) The phone will be totally inactive when this circuit is connected. When the correct combination is entered and the signal is received from the computer, the phone will be connected to the line as in normal use. This arrangement is most useful if one phone is left active for receiving incoming calls, and extension phones are controlled by the computer lock.

The examples given serve only to demonstrate how the TRS-80 combination lock program might be applied. Any device or system that can be relay-controlled can be kept under security by the program. If means can be developed for attaching a remote keypad (with secure leads) to the TRS-80 to allow entry of the combination, the computer could be kept in the secured area. The program would then represent a sophisticated electronic locking system. ◇

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Power-Supply Overload Protection

BY PETER STYS

IF you use a variable-output power supply, there is always a possibility of accidentally increasing its output beyond a load's capacity. In some instances, it will not matter. In others—say, with TTL ICs in the load—changing the output delivered from 5 to 10 volts would quickly "fry" the devices.

To ensure that the foregoing will not happen, add the overload protection circuit shown here to the supply's regulator. The circuit senses any sudden increase (or decrease) in output voltage, whereupon power to the regulator automatically shuts off. And it does this at any voltage within the supply's range! Moreover, the circuit also provides short-circuit protection by detecting the sudden drop in voltage.

How It Works. Normally, comparator *IC1B*'s noninverting (+) input is referenced below its inverting (−) input. Hence, the comparator sinks all of *SCR1*'s gate drive through *R2*. Now, when the voltage increases rapidly, the level at the noninverting input rises above that at the inverting input (which is delayed by *R7* and *C1*) and the comparator ceases sinking. At this point, *SCR1* fires and removes base drive from transistor *Q1*. In turn, this shuts off the regulator.

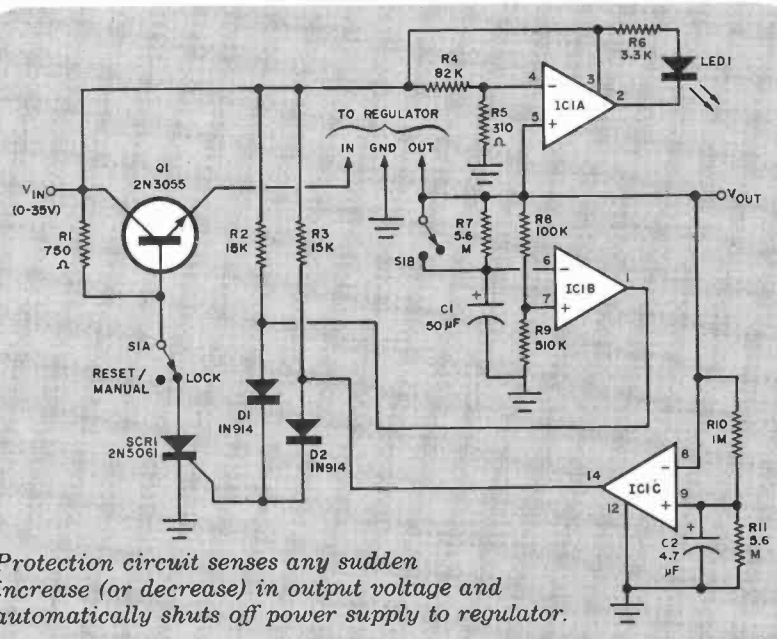
The same sequence of events applies to comparator *IC1C*, except that here the sensitivity is toward sudden decreases in voltage. If only overvoltage protection is desired, the *IC1C* circuit can be omitted.

Resistor networks *R8*/*R9* and *R10*/*R11* set tolerance margins for increases and decreases, respectively, in voltage within which any changes in voltage, no matter how rapid, will not trigger the circuit. The values of the resistors can be selected to suit the particular regulator being used to prevent false triggering. All resistance values depend on how steadily the output voltage is maintained under changes in load, how good the regulator's transient response is, etc.

Networks *R7*/*C1* and *R10*/*C2* determine what will be the allowable rates of increase and decrease, respectively, of regulator voltage without triggering. If an external pass transistor already exists in the power supply's regulator circuit, its base can be shunted and *Q1* can be eliminated.

Light-emitting diode *LED1*, which can be any discrete red LED, simply indicates when an error has occurred in the preset output voltage and that power to the regulator has been shut down.

Switch *S1* is used for resetting the circuit if the protect system is tripped or for restoring variable output control capability when in the RESET/MANUAL position. This position interrupts current flow through *SCR1*. Setting *S1* to LOCK arms the automatic protect circuit. Manually adjusting the output potentiometer on the power supply will, therefore, trigger the circuit.



Protection circuit senses any sudden increase (or decrease) in output voltage and automatically shuts off power supply to regulator.

Construction. The simplest way to assemble and install the protective circuit is to use a piece of perforated board and solder clips. Alternatively, you can design a printed circuit board to accommodate all components except *Q1*, *LED1*, and *S1*. In either case, there is nothing critical about component placement and wire lengths. Also, it is a good idea to use a socket for *IC1*.

Mount *Q1* on the rear apron of the power supply, if possible, with an insulating socket and mica spacer. Use thermal-transfer paste between spacer and transistor and spacer and chassis. Then use an ohmmeter to make absolutely sure that *Q1*'s collector (case) is isolated from the chassis. If you cannot mount *Q1* on the rear apron, fabricate an aluminum L bracket large enough to hold the transistor, mount *Q1* on it as above, and bolt the assembly to the chassis. Mount *S1* and *LED1* on the front panel of the power supply. Use a small rubber grommet to hold the LED in place. Finally, interconnect all components and integrate them into the power supply's circuit, carefully following the schematic diagram. ◇

PARTS LIST

C1—50-μF, 35-volt electrolytic
C2—4.7-μF, 35-volt electrolytic
D1,D2—1N914 diode
IC1—LM339 quad comparator
LED1—Any discrete red light-emitting diode
Q1—2N3055 or similar transistor
R1—750-ohm 2-watt resistor
The following resistors are ½-watt, 5%:
R2,R3—15,000 ohms
R4—82,000 ohms
R5—310 ohms
R6—3300 ohms
R7,R11—5.6 megohms
R8—100,000 ohms
R9—510,000 ohms
R10—1 megohm
S1—Dpdt switch
SCR1—2N5061 or similar silicon controlled rectifier
Misc.—Printed-circuit board or perforated board and solder clips; socket for IC1; machine hardware; socket and mounting hardware for Q1; etc.

WHAT'S ON THE AIR BELOW 500 kHz

PART 2: Longwave receiving equipment, antennas, and the 1750-meter experimenter's band

BY KARL THURBER, JR.
W8FX/4

LAST MONTH, we examined that portion of the radio spectrum below 500 kHz. Now we shall turn our attention to longwave receiving equipment, antennas, and the license-free, 1750-meter experimenters' band.

Communications gear capable of tuning below 500 kHz is a prerequisite to any exploration of the long waves. Receivers can be purchased as military surplus or as commercial products in new or used condition. It is also possible to buy or construct a receiving converter that will extend the frequency range of a multiband, shortwave set.

Surplus Receivers. A fairly large number of surplus receivers can be tuned down to 150 kHz or so, but few reach into the tens of kilohertz. Many surplus receivers require restoration if they are to be put back in working order. Most need some modification to be compatible with a source of 120-volt, 60-cycle alternating current.

Among the more suitable and commonly available surplus receivers are the BC-453, BC-1206-A, BC-348, ARB, and RAK-7. If you want to tune down to 10 or 20 kHz, some of the surplus receivers you should consider are the R-439, URM-41, RBA, RBL, and R-389/URR. The last-mentioned receiver, made for the government by Collins Radio in the fifties, is an excellent all-round communications unit whose coverage extends to very low frequencies. Try to obtain the instruction manual and schematic of *any* surplus equipment you buy, of course.

Commercial Receivers. The long waves are covered by a few older commercial communications receivers that you might find on used-equipment racks. In the low-to-medium price range are such units as the Heathkit DF-2, Hammarlund RDF-10, and the National NC-66. These are not too common, but you might find them at one of the major used equipment dealers. Make sure, however, that any receiver you are thinking of using for longwave listening has a bfo (beat-frequency oscillator) because many of the signals will be CW.

If you can afford an expensive receiver, there are many excellent used ones that cover the range from the long waves up to about 30 MHz or so. The famous National HRO-60 is an excellent general-coverage and ham receiver. With its accessory *G, H,* and *J* plug-in coil sets, the receiver will tune down to 50 kHz. The Hammarlund VLF Super-Pro, also known as the SP-600-VLF, will tune as low as 10 kHz, about as low as you can expect to hear anything.

There are some nice new units on the market, too. The National HRO-600 is the latest in a long line of receivers that stretches back through the HRO-500 to the HRO-60 and beyond. It employs digital frequency synthesis and display, and offers fine performance from the long waves continuously up to 30 MHz. The Drake DSR-2, another contemporary receiver, features continuous coverage from 10 kHz to 30 MHz with 100-Hz digital frequency readout.

All of these receivers are excellent—though extremely expensive. For example, the HRO-600 costs $4995; the HRO-500, $3000; and the DSR-2, $3200! If you're interested in the very latest equipment, McKay-Dymek (P.O. Box 2100, Pomona, CA 91766) markets a new communications receiver known as the DR22 that tunes from below 50 kHz to 30 MHz. Even newer on the market is the R. L. Drake Model R-7. This receiver, whose design is based on the company's Model TR-7 transceiver, tunes from dc to 30 MHz and also employs digital frequency synthesis.

If you want to explore the long waves more cheaply, there are several general-coverage receivers that you should consider. One is the noteworthy Drake SPR-4 that covers 150 kHz to 30 MHz. It sells for about $700, but it can double as a main amateur station receiver. The Kenwood R-300, at $300, is within the reach of most amateurs and SWLs who would like to DX the long waves. It tunes down to 170 kHz, and is ideally suited for portable use because it can operate on direct current. Another moderately priced communications receiver that offers long-wave coverage as well as digital readout and ac or dc operation is Radio Shack's Realistic DX-300.

Converters. Another way to get started listening to longwave signals is to buy a frequency converter and hook it up to an existing communications receiver. There are at least two reasonably priced converters available at the present time.

One is made by Palomar Engineers, and another by Jim Hagan. Each is a high-performance, crystal-controlled unit capable of outstanding results, assuming it is used with a good shortwave communications receiver.

The Palomar converter sells for approximately $55. It uses a crystal-controlled local oscillator and a mixer to heterodyne or translate the 10-to-500-kHz range to the 80-meter amateur band, from 3510 to 4000 kHz. The converter is inserted between a receiving antenna and the antenna input of any amateur band or general-coverage receiver that covers the 80-meter band. A 10-kHz longwave signal will appear on your receiver at 3510 kHz; a 200-kHz signal will appear at 3700 kHz; etc.

The converter, powered by a standard 9-volt battery, is available from Palomar Engineers, P.O. Box 455, Escondido, CA 92025.

The Hagan unit is similar to the Palomar, but it requires a source of 12-volt dc. This voltage can be derived from most receivers or transceivers of recent vintage. Unlike the Palomar, the Hagan converter allows you to buy your own mixer crystal to convert the output to whatever frequency range is convenient for your receiver. Jim Hagan, WA4GHK, builds these units in batches on a sort of custom basis. If you're interested in one, contact Jim at 896 Port Malabar Blvd., Palm Bay, FL 32905, to check on availability and price.

Radio West (3417 Purer Rd., Escondido, CA 92025) also markets a longwave converter which it can custom-install in your existing receiver. It is quite popular with Yaesu FRG-7 and Drake SSR-1 users. The same company also specializes in custom performance modifications for these and several other receivers, such as the Drake SPR-4 and the Barlow-Wadley unit that is popular among SWLs. (One particularly interesting modification Radio West does is the addition of a digital frequency readout to the Yaesu FRG-7.)

If you want to build your own converter, an extremely simple, one-transistor converter was described by W3NNL in the February, 1965 "Hints and Kinks" column of the magazine, *QST*. It is little more than an untuned mixer circuit, but it should let you get your feet wet on the long waves at an absolute minimum of expense. Comprising only nine components (including a transistor and 3-MHz crystal), it can be built for about $10.

If you plan to use a converter with a transceiver, be careful to disconnect it when you go back to regular hf operation, as any transmitter r-f applied to the converter will quickly damage it. When you are listening through the converter, it is best to disconnect the microphone or key and disable the VOX circuit, just to be sure.

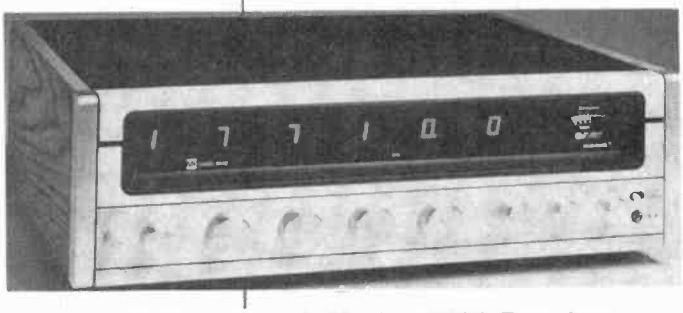
Antennas for the Long Waves. Many of the antennas at the high-power, longwave transmitting installations are truly awesome. For example, the Navy station at Cutler, Maine, boasts a two-square-mile (5.3 km²) antenna system, supported by more than two dozen towers each more than 800 feet (248 m) high. Its four-square-mile (10.5 km²) ground system is made up of about 11,000,000 feet (3,300,000 m) of buried, heavy-gauge copper wire. In fact, the whole antenna system actually operates something like the plates of a giant capacitor—the antenna acting as one plate, the ground system as the other!

For home receiving purposes, a no-frills half-wave dipole would seem to be more appropriate. However, a dipole cut for 20 kHz would be 7.5 kilometers or more than 4 miles long! Even a modest quarter-wave vertical antenna for the 1750-meter experimenters bands would be 438 meters, or 0.3 mile high.

Realistically, to start listening to longwave signals, you can run 50 to 150 feet (15.2 to 45.6 m) of wire to the antenna terminal of your receiver or converter,

Kenwood Model R-300 Receiver

Yaesu Model PRO-7000 Receiver



McKay Dymek Model DR33 Receiver

and connect a good ground to the receiver's ground terminal. The exact length of the wire you use isn't important, since any practical antenna you can construct will be very short compared to wavelength. A resonant antenna just isn't needed for adequate reception of most signals. You can even tie the ends of your shortwave antenna feeders together and use them.

Antennas for the long waves are somewhat similar to those used for 160-meter work. Variations on the single or long wire, end-feds, Marconis, and combination vertical and horizontal elements (L's) are commonly used for longwave reception. As a general rule, you should get as much wire as possible in the air, and run it clear of surrounding objects.

As the operating frequency increases, more familiar types of antennas are found. One antenna that has been popular for many years on both long- and mediumwave frequencies is the *wave* or Beverage antenna. For longwave reception, it consists of a horizontal wire a wavelength or more long and oriented in the direction from which the desired signals arrive. It is usually suspended 10 to 25 feet (3 to 8 m) above the ground and supported at intervals to relieve strain. The simplest Beverage is a single wire terminated in its characteristic impedance on the far end. Most longwave listeners can't accommodate a full wavelength, although commercial stations often lengthen the antenna to several wavelengths to increase directivity and gain.

There are many types of horizontal and dual-polarized antennas you can adapt for longwave applications, although very little has been written about them in recent years. The *ARRL Antenna Book* will give you some ideas and basic principles. An article by Doug DeMaw, W1FB, in the October 1977 issue of *QST* entitled "The Gentleman's Band—160 Meters" will give you some practical antenna ideas that you should be able to adapt for use below 500 kHz. In many ways, receiving antennas for 600 meters and down are like those you might construct for 160 meters or for serious mediumwave broadcast DXing, only on a larger scale.

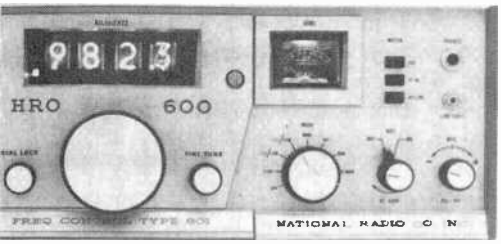
Small Loops and Whips. There are some disadvantages to random-length, single-wire antennas. For example, even if the antenna could be made long enough for efficient signal pickup and good directivity, it would be difficult to take full advantage of the directional characteristic because it's impractical to reorient the antenna. Also, the long wire is likely to be severely affected from the high noise levels that prevail in most urban and suburban locations.

Loop antennas, on the other hand, are effective at longwave frequencies, and can be used to null out interference. Most receiving loops give a figure-eight pattern similar to that of a half-wave dipole. Loops are most commonly used in RDF (radio direction-finding) applications, and amateurs have been using them on all bands, especially on 160, 10, and 2 meters, for hidden-transmitter "fox hunts." The basic loop is simply a single-turn coil whose diameter is small in comparison to the operating wavelength. The physical configuration of the loops can be in the form of a circle, a square, a triangle, diamond, octagon, or whatever else is convenient.

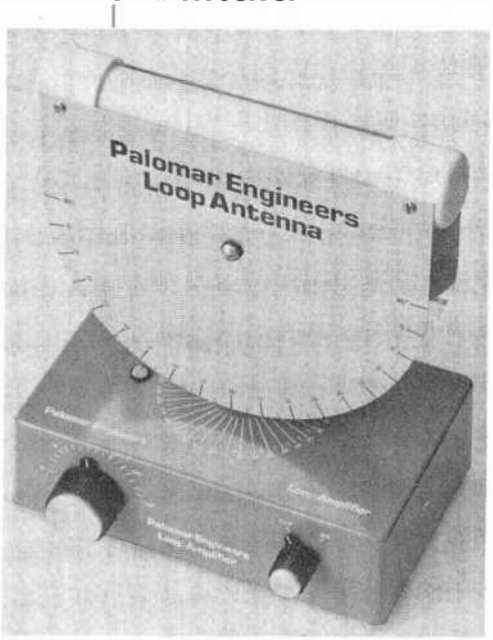
Certainly not new (having been in use from the earliest days of radio), loops are enjoying a new lease on life at the lower frequencies. This is because they can be physically small yet still work well, can be resonated or tuned to a particular frequency, and can be rotated to take advantage of their directivity. They are also a lot quieter than single-wire outdoor antennas, and are less

Drake Model DSR-2 Receiver

Realistic Model DX-300 Receiver



National Model HRO-600 Receiver



Palomar Engineers Loop Antenna with Amplifier

prone to swamping by strong local broadcast stations. Some loop designs allow for even greater noise reduction by enclosing the loop wires in a special, nonmagnetic shield. This can markedly improve the overall signal-to-noise ratio of the received signal.

A few commercial loops designed for longwave applications are available. Palomar Engineers offers a preamp/loop (adjustable in both azimuth and elevation) for use in conjunction with its longwave converter, or with any longwave receiver. And Radio West has recently introduced a line of preamp loops that cover long- as well as medium- and shortwave bands.

A very interesting receiving antenna system which covers the radio spectrum from below 50 kHz to 30 MHz is the DA100 by McKay Dymek, P.O. Box 2100, Pomona, CA 91766. The same company also makes a special ferrite rod antenna, known as the DA7, which covers both the longwave and mediumwave bands. The DA100 consists of a short vertical whip and a preamplifier that drives the receiver. This antenna system is capable of delivering far better results than the short length of its whip might suggest.

Grounds. Grounds are important both from the standpoint of good signal reception and freedom from noise. However, it's hard to get a really good ground in the traditional sense, for two reasons. First, the long waves penetrate the earth to a greater extent. Second, the wavelengths involved make it impractical to install radials that are sufficiently long to be truly efficient as a ground plane. Much of the radiated signal returns to the earth beyond the limits of the ground system, so that most ground losses can't be controlled.

For casual listening, don't worry too much about your ground system. The serious LWL or 1750-meter enthusiast will want to thoroughly investigate ways to minimize ground losses. Star grounds, buried-radial systems and counterpoises are some of the methods most commonly employed.

1750 Meters. For years, a small but enthusiastic group of experimenters have been communicating on an almost totally unknown, license-free "amateur radio" band. This is the so-called "1750-meter band," whose wavelengths range from 1874 to 1578 meters (160 to 190 kHz). It really isn't a ham band at all. Rather, this 30-kHz chunk of the longwave spectrum was allocated by the FCC in 1950 for limited-radiation device use. No operator or station license is required.

The FCC rules governing this type of operation set forth three main requirements. They are found in FCC Rules and Regulations, Part 15.203. First, the power input to the final amplifier must not exceed *one watt*. Second, all emissions below 160 kHz or above 190 kHz (in other words, out of the 1750-meter band) must be suppressed by at least 20 dB. Third, the length of the antenna and transmission line combined cannot exceed 50 feet (15.2 m).

Although no transcontinental DX contacts have yet been made on 1750 meters, the LOWFERS ("Low Frequency Experimental Radio Stations") have a great time trying to work other enthusiasts operating under the same severe power and antenna restrictions. Signals from aeronautical beacons, which run several hundred watts, have been received as far away as 1000 miles (1600 km) or so, but DX contacts on 1750 of 150 miles (240 km) are unusual.

No one really knows how many LOWFERS there are, but their numbers are quite small. The restrictions imposed by the FCC make operating very challenging, which increases the fun. There are no restrictions as to the type of emission that can be used: SSB, AM, FM, RTTY, or CW are all acceptable, so long as the modulation sidebands outside the band are down at least 20 dB.

Most activity on the 1750-meter band has been centered near the very top, near 189.5 kHz, due to a "hole" in beacon (interference) there. Most work to date has been done on CW. As was mentioned earlier, long-haul DX is unusual, though in at least one case, a beacon transmitter in New Mexico has been heard in California. A 160-meter-to-1750-meter cross-band contact on the West Coast set the current 800-mile (1280-km) DX record.

One key to effective 1750-meter work, of course, is good receiving equipment that will tune the band. High i-f selectivity is important. A sharp active audio filter or a "Q-multiplier" will also help to pull in weak signals. Most transmitters employed on 1750 meters are simple CW units made from receiving-type components because power levels are low.

The transmitting antenna is a bit critical. When all you've got is one watt, your signal needs all the help it can get! Although the FCC doesn't limit communications range by specifying a field-strength limitation on your signal, it effectively crimps your style by limiting the antenna length to 50 feet (15.2 m). A length of wire tossed out the window won't work well for transmitting on 1750 meters. A base-loaded vertical is almost always employed, and ground losses must be kept as low as possible. For receiving, a separate antenna is often used. Typically, a tuned, rotatable loop is employed for 1750-meter reception, and a 40- or 50-foot (12.3- or 15.2-m) TV mast guyed with nylon rope and insulated at the bottom for transmitting.

Despite all the problems associated with operation on 1750 meters, if you listen in on the long waves long enough, you're likely to want to try communicating on these frequencies. For the experimentally inclined radio buff, working on 1750 is said to be much like communicating in the early days of "spark." Many LOWFERS transmit beacon signals (using automatic CW keyers) for one another to log. Because the FCC frowns on the use of ham calls on non-amateur frequencies, many use either their initials, or old-style telegraphers' "sines." Some even use their nicknames as homemade IDs! Working 1750 can indeed be a refreshing change from the types of communications you are used to. But be prepared to do some experimenting. Try to locate another local communications buff who'd like to try 1750 meters. It will be much easier and more enjoyable getting started if you have a buddy to help you set up, test, and tune up your gear.

Finally, keep in mind that license-free operation on 1750 meters exists by grace of the FCC. At any time, these operating privileges could be withdrawn. In fact, there have recently been some strict FCC interpretations about 1750-meter operation in general and antennas in particular. They indicate there may be some problems encountered with future use of 1750 meters.

In Conclusion. We think you'll find the long waves an interesting complement to the more conventional aspects of radio communications. Being an LWL takes some technical skill in building special antennas, adapting commercial gear, and restoring surplus equipment. The microwaves may be more exotic, but there's a lot to learn about the old "kilohertz bands." Twist your dial below 600 meters, and enjoy a challenging new type of radio you may not have known even existed. ◇

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ABOUT THE AUTHOR

Robert C. Genn is the Director of Engineering at Columbia College in Los Angeles, and President of the Genn Technical Institute. He has been involved in the electronics field for more than 20 years as a Field Engineer, Director of Engineering and Electronics technician and instructor. Mr. Genn is certified by the California Institute of Technology to teach technicians to troubleshoot, service and repair microwave systems.

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Experimenter's Corner

By Forrest M. Mims

EXPERIMENTING WITH NOISE

THOSE of us who appreciate good-quality sound reproduction might disagree about the definition of good music, but it is safe to say that all audio enthusiasts share a common opinion of noise—the less the better! Noise is equally unpopular among radio astronomers, biomedical engineers, radio communications users, and others who work with low-level electrical and electromagnetic signals.

So much engineering effort is devoted to the suppression of noise (it can *never* be entirely eliminated) that it might come as something of a surprise that there are many useful applications for noise. These include acoustics measurements, instrument calibration, antenna tuning, signal jamming, data encryption, electronic music and even applied psychology! This month, we'll examine several methods of generating noise and explore a few of its uses. First, let's define a few basic terms.

Noise can loosely be called an electronic or electromagnetic weed. More precisely, noise is an undesired electronic or electromagnetic signal having frequency components within the frequency range of interest which tends to interfere with the reception or detection of desired signals. By definition it excludes crosstalk and interference from other information-carrying signals within the frequency range of interest.

There are many kinds of noise. We are primarily interested in *white noise* and *pink noise*. White noise is a complex waveform with a Gaussian amplitude probability characteristic. It is formed by contributions from all frequencies over a theoretically infinite but, in practice, broad and specified bandwidth. White noise has a flat (constant) spectral power density. Thus, it contains equal energy per unit of frequency (Hertz). Transduced, audible white noise contains equal contributions from all audio frequencies perceptible to the human ear. It is thus analogous to white light, which comprises all wavelengths (colors) perceptible to the human eye.

Pink noise is also a complex waveform with a Gaussian amplitude probability characteristic and is also formed by contributions from all frequencies over a theoretically infinite but, in practice, broad and specified bandwidth. Pink noise contains equal energy levels in each octave of its spectrum. Because each next-higher octave possesses twice the number of discrete frequencies (in hertz) as compared to the octave immediately below it, the low-frequency components of pink noise have higher amplitudes than the high-frequency components. This is necessary if pink noise is to contain equal amounts of energy in each octave of its spectrum. Audible pink noise, therefore, has more bass content than white noise and sounds "warmer."

Plots of amplitude versus frequency for white noise (dashed line) and pink noise (solid line) appear in Fig. 1. Note that pink noise displays a −3/dB octave slope. If white noise is routed through a low-pass filter having a −3-dB/octave response, the filtered signal will be pink noise. Pink noise is commonly used as a test signal in audio work because many audio spectrum analyzers are "constant percentage bandwidth" instruments. That is, the passband of each bandpass filter in these analyzers is an unchanging percentage of its center frequency. Therefore, the higher the center frequency of the filter, the broader its bandpass. If white noise is applied to such an analyzer, a rising 3-dB/octave characteristic will be displayed. If pink noise is applied to the analyzer input, a flat amplitude-versus-frequency characteristic will be indicated. The most common audio applications for a pink noise source and such a spectrum analyzer is in frequency-response testing of audio preamplifiers and amplifiers and in the equalization of an audio system in a listening room.

Now that we have examined some basic ideas about noise, let's see some circuits that generate and employ it.

Diode Noise Generators. The simplest noise generator is a forward-biased diode. Figure 2 shows a basic diode noise generator that you can quickly assemble. Connect the circuit to an audio amplifier (capacitive coupling might be necessary) and the speaker will produce a continuous rushing or hissing sound.

A circuit like this can be used to adjust a radio receiver for optimum noise figure. With a suitable diode such as the 1N21 or 1N23 and short, point-to-point wiring, the generator will produce wideband noise with components extending as high as 148 MHz. The ARRL *Radio Amateur's Handbook*, which describes how to make receiver noise adjustments, suggests adding a 500-pF capacitor between the anode of *D1* and ground. It also suggests inserting a 50,000-ohm potentiometer, preferrably one with a logarithmic taper, in series with the anode of *D1* and the positive power supply terminal to permit adjustment of the noise amplitude.

If you like to experiment, try various kinds of diodes for *D1*. A red LED, for example, produces both light *and* noise. Of course, you must increase the value of *R1* to protect the LED from excessive current levels. Use 470 ohms when the voltage of *B1* is +6 volts and 820 ohms when *B1* is a 9-volt battery.

Transistor Noise Generators. When reverse-biased beyond the avalanche point, the emitter-base junction of a bipolar junction tran-

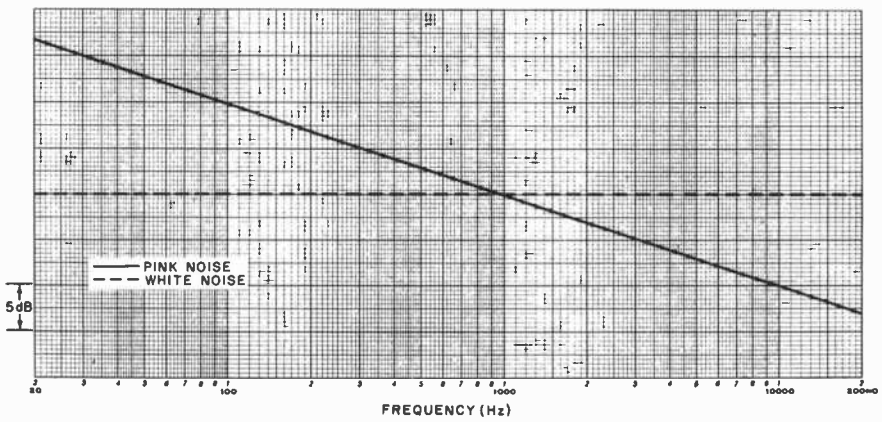

Fig. 1. Plots of amplitude versus frequency for white noise and pink noise.

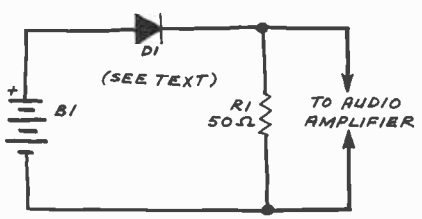

Fig. 2. Simple schematic of basic diode noise generator.

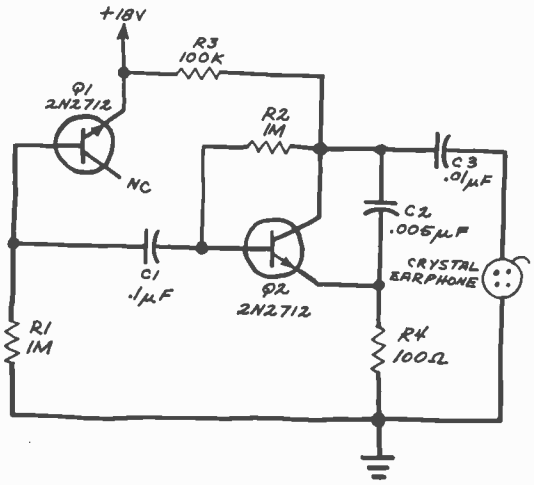

Fig. 3. Noise generator designed by John Simonton.

sistor generates noise. In the winter edition of the 1975 *Electronic Experimenter's Handbook*, John S. Simonton, Jr. described how to assemble a pocket-size sonic noise generator based upon this effect. John noted in his article that pink noise is an excellent mechanism for masking and thereby concealing low-level sound such as a confidential conversation. John also noted that audible pink noise can help produce a feeling of relaxation and can in some cases block pain stimuli.

Figure 3 is the schematic diagram of John's circuit. In operation, *R1* limits the current through the reverse-biased emitter-base junction of *Q1* to a safe value. The noise signal is coupled to amplifier *Q2* via *D1*. After the noise has been amplified, *C2* shunts some of the high-frequency components to ground. The resulting output signal, which is transduced by a high-impedance earphone, is a reasonable approximation of pink noise.

John points out that most 2N2712s will produce noise, but some will not. Should you want to try other transistor types, make sure they have an emitter-base breakdown voltages of less than 18 volts.

Shift Register Digital Noise Generators. Figure 4 shows a simple 7-stage shift-register pseudorandom bit generator which produces a sequence of 127 bits before recycling. Other shift-register/exclusive-OR gate arrangements can be used to produce shorter or longer sequences.

White noise is synthesized when a pseudorandom bit generator such as the one in Fig. 4 is clocked at a sufficiently fast rate. Shift-register generated noise is not necessarily as random as that produced by a diode, especially if a relatively small number of stages is involved. But the noise level is more uniform and of a much higher amplitude than that from a diode.

If you would like to experiment with digital noise generators of this type, see pages 277 to 283 of *TTL Cookbook*, by Don Lancaster (published by Howard W. Sams). Don describes several interesting applications, including a scrambler for encoding computer data, and he also gives schematics of several shift-register pseudorandom sequencers.

S2688/MM5837 Digital Noise Generator. The S2688/MM5837 (National Semiconductor) is a complete PMOS digital noise generator in an 8-pin mini-DIP. The internal circuit, shown in Figure 5, consists of a 17-stage shift register, some gates and a clock. Pseudorandom bit patterns are produced by connecting the outputs of the 14th and 17th stages of the shift register to an exclusive-OR gate whose output is applied to the input of the first stage in the shift register.

A 17-input NOR gate monitors the output of each stage of the shift register. Should the outputs of all 17 stages simultaneously go low, the NOR gate prevents a lockup condition (a continuous output of all 0's) by automatically applying a logic 1 to the third input of the exclusive-OR gate. This, in turn, applies a logic 1 to the first stage of the shift register.

The S2688/MM5837 is exceptionally easy to use. If the output is connected to an op amp or other high-impedance circuit, the chip can be powered by a single supply (V_{SS} = 0 V and V_{DD} = −14 V ±1 V). If the chip must drive a low impedance, V_{GG} should be connected to −27 V ± 2 V.

Though it is recommended that V_{DD} be within a volt of −14 V, I've found that the internal clock speed can be altered by varying V_{DD}. Here's what I measured:

V_{DD}	Approximate Clock Frequency (Hz)
−5	0
−6	0.7
−7	2267
−8	8731
−9	16,382
−10	23,531
−11	32,564
−12	38,347
−13	40,010
−14	37,800
−15	33,173

Because broadband noise is best suited for most audio applications, it's evident that a supply voltage of −12 to −14 volts gives the best noise quality. However, the lower frequency noise generated when lower supply voltages are used has several possible applications. For example, when V_{DD} is between −6 and −7 volts and the noise generator is coupled to an audio amplifier, the random clicks of a radiation counter can be simulated.

(Continued on page 82)

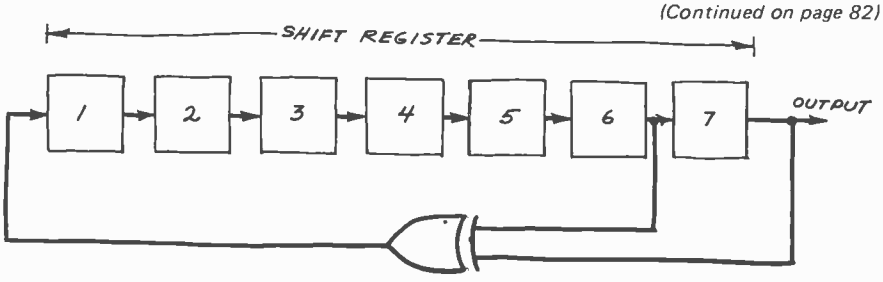

Fig. 4. Basic pseudorandom bit generator.

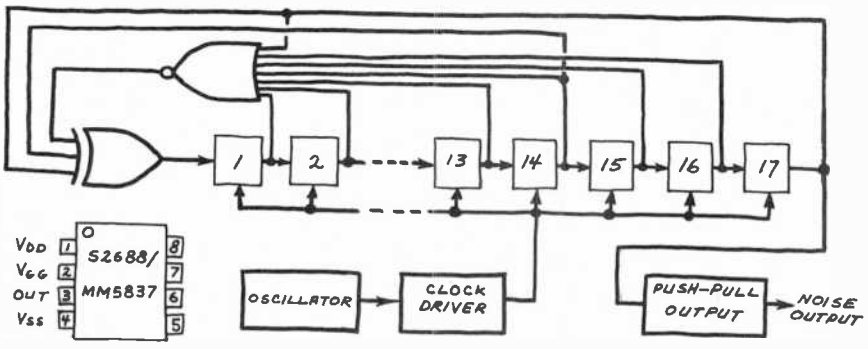

Fig. 5. Block diagram of S2688/MM5837 digital noise generator.

EXPERIMENTER'S CORNER *continued*

S2688/MM5837 Pink Noise Generator. Pink noise, which is required for room equalizing and other acoustical applications, can be produced by following an S2688/MM5837 with a −3 dB/octave low-pass filter. One such filter appears in National Semiconductor's *Audio Handbook* (Fig. 2.17.6, p. 2-56) and is shown connected to an S2688/MM5837 in Fig. 6. The pink noise produced by this generator contains equal amounts of energy in each octave of the audio spectrum from 20 Hz to 20 kHz. The output is about 1 volt of pink noise superimposed on an 8.5-volt dc level.

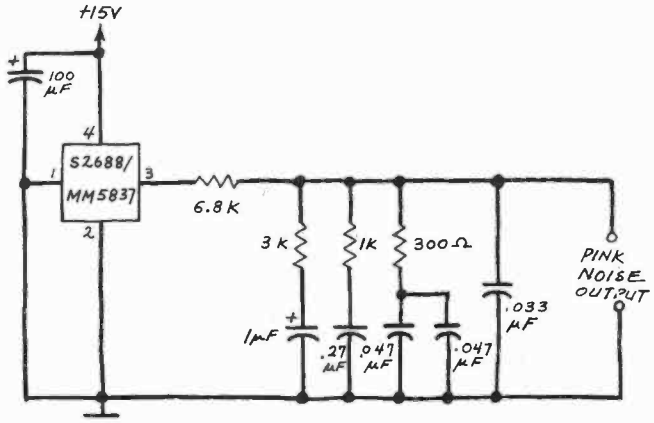

Fig. 6. Pink noise generator using S2688/MM5837.

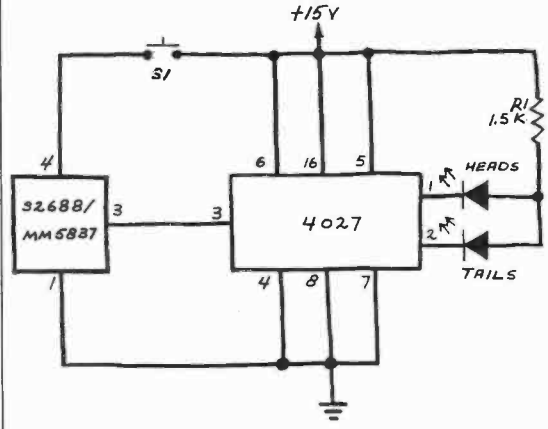

Fig. 7. Noise generator coin tosser.

Coin Tosser. Circuits that produce a completely random binary output are much in demand. Figure 7 shows a simple random-output circuit made from a noise generator and a 4027 flip-flop operated in its toggle mode.

Pressing *S1* applies power to the noise-generator chip and causes noise pulses to be applied to the flip-flop. The output LEDs appear to glow continuously even though they are rapidly being switched on and off by the noise pulses. Releasing *S1* turns off the noise chip. The logic states at the outputs of the 4027 then reflect the input status at the time that the noise is cutoff. Therefore, only one of the two LEDs glows.

Ideally, the output of the tosser should be completely random. With my circuit, however, in 100 tosses, green came up 56 times and red 44 times. I tried another 100 tosses and this time green came up only 43 times while red came up 57 times. These results seemed contradictory and not very random until I added them together. The result: In 200 tosses green glowed 99 times and red glowed 101 times.

SN76477N/SN76488N Complex Sound Generator. This versatile chip is literally a complete sound-effects machine in a 28-pin DIP. It includes a noise generator which can be modulated by a low-frequency oscillator to produce propeller-aircraft, steam-engine, snare, and other sounds.

There are so many uses for the SN76477N/SN76488N that we can't do this chip justice here. If you want to find out more about its operation, see the Texas Instruments data sheet and pages 42 and 43 of the *Engineer's Notebook* (Radio Shack). ◇

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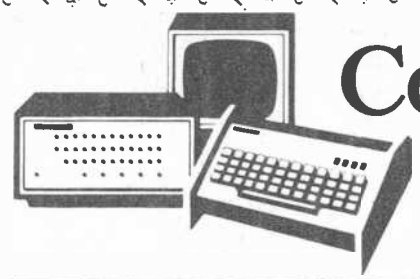

Computer Bits

By Hal Chamberlin

KEYBOARDS

WHAT IS the most important part of a microcomputer system? Is it the microprocessor chip, memory boards, mass storage system, or display interface? If it is the part that is most used by the owner, then the answer is probably the keyboard. As necessary as these other parts are to the functioning of the system, most users spend far more time with the keyboard than any other peripheral. While many informed sources foresee the day when the primary man-machine interface link will be through speech, keyboards will be with us for quite a while. It is amazing how many manufacturers overlook the importance of the keyboard to a successful product and how many prospective users fail to intelligently evaluate a system's keyboard.

Human Factors. When speaking of keyboards in conjunction with microcomputers, we mean so-called *alphanumeric* keyboards; that is, those that have 10 digits, 26 English letters, and an adequate complement of punctuation marks. Today, the feature that most distinguishes a microcomputer from the multitude of less expensive programmable calculators is the ability to handle *textual* information as easily as numerical information. Any system that offers only a numeric keypad is definitely limited in its potential beyond learning machine language and experimenting with short programs.

Assuming an alphanumeric keyboard is needed, how many and what kind of characters should it have? Since all personal computers use the ASCII character code which in its smallest form defines 10 digits, 26 letters, and 27 symbols, it follows that a minimum keyboard should have all of these. A more comprehensive keyboard would have an additional 26 lower-case letters and 5 symbols and thus could be called a *full ASCII* keyboard. While many of the earlier packaged computers had just a minimum keyboard, the availability of lower-case letters is required for the computer to realize its text editing and processing potential—a major application area. In fact, many people have either sold their older systems or modified them to handle lower-case letters. Fortunately, manufacturers are starting to get the message so most personal computer keyboards and displays in the future will be capable of handling the full 94-character ASCII set.

Another keyboard variable is the arrangement of the character keys. There is little question that the 26 letters should be arranged in the traditional typewriter style. While exhaustive human-factor tests have shown this layout to be less than optimum with respect to typing speed and accuracy (the relatively obscure "Dvorak" layout, which is also scrambled, holds that distinction), it is practically universal on today's typewriters and is taught in typing classes. Any system with a sequential "ABCDEFG" keyboard is severely limited in utility when the user passes the "get acquainted" stage. Even if the user cannot touch-type, it is valuable to have a keyboard that uses a standard layout because then it will be easier to adapt if he or she should ever "trade up" to a more powerful system. There are actually touch-typing training programs on the market in which the computer itself generates the drill text (on the screen) and measures typing speed and accuracy automatically.

There is very little agreement however on where the digits and symbols should be placed on the keyboard. Digits are usually placed in a horizontal row above the letter keys (as on a conventional typewriter) but this is not very efficient if a lot of numerical data is to be typed in. A method used by many data processing machines is to put the digits in a 3-by-3 matrix as the *shifted* version of the characters U I O J K L M · · (with zero in its normal location), which can then be typed by skilled adding machine operators. Fortunately no personal computer uses this approach, but many have a "numeric keypad" with the 3-by-3 digit arrangement to the right and separate from the main keyboard. The ideal keyboard would probably have both with provisions for the program to determine which group of digits were to be used. This would allow nonbusiness programs to use the extra keys for functions such as cursor movement or text editing commands.

Symbol placement generally conforms either to the IBM or ASCII arrangement. While the latter is preferred because of its association with the standard character set used by computers, many systems aimed primarily at text-editing applications use the IBM arrangement because of its greater similarity to typewriter keyboards. The two arrangements are easily distinguished. IBM has the parentheses on the 9 and 0 keys while ASCII has them on the 8 and 9 keys.

Mechanics. Just having an acceptable arrangement of keys doesn't necessarily make an acceptable keyboard; mechanics are important too. Probably the most important mechanical factor is the size and spacing of the keys. In this respect, the standards are quite clear: the keys are to be placed on 3/4-inch centers both horizontally and vertically and are to be staggered by 3/8 inch for the top two and bottom two rows and 3/16 inch for the middle two rows. Some manufacturers have attempted to ignore this standard and provide a keyboard with smaller-than-normal

keys packed together with as little as ½-inch spacing. The results have been tens of thousands of lost sales and, for at least one vendor, a new line of machines with standard-size keyboards.

Another area of considerable variation among available systems is keybutton travel. On standard typewriters, this varies from nearly an inch on manual to about ⅛-inch on electric machines. The electronic keyboard industry, however, is in general agreement the optimum travel should be about 0.15 inch for the feel of good positive action. Recently, there have been some systems with keys that travel little if any. In this case there are really no keys at all; the letters and symbols are merely printed on a plastic sheet stretched over a supporting frame with pressure-sensitive contacts molded in. When typing, the effect is like drumming your fingers on a tabletop. While this makes little difference for the occasional hunt-and-peck typing needed for preprogrammed game machines, it would probably drive a touch-typist crazy. Although such keyboards are very inexpensive and somewhat more immune to coffee spills, a standard travel keyboard is certainly worth the difference when many hours are to be spent using the system.

An additional mechanical consideration is the degree of feedback the keyboard gives the operator when a key is struck. As previously mentioned, full-travel keys give some feedback merely by their substantial displacement when pressed. There have been numerous attempts on professional keyboards to provide tactile feel with the key itself making a click and then suddenly releasing backpressure at the instant the computer gets the character code. While the basic idea is sound, very few keyboard manufacturers have implemented it correctly (there is a confusing secondary click and pressure increase when the key is released). As a result, acceptance has been minimal. On personal computers it would be a simple matter to provide an audible click or short beep from a built-in speaker when a keystroke is entered—but very few systems actually do. Audible feedback not only gives confidence that the system is responding (or an instant indication that it is not), it also improves typing rhythm and thus speed and accuracy. If audible feedback is provided, however, there should be a way to turn it off when silent operation is desired.

One final human-factor feature that is nice to have on a keyboard is automatic repeat. It is often necessary to enter the same character continuously—as when moving the cursor for editing. Pounding the same key repeatedly not only shortens its life, but is annoying and slow. With automatic repeat, a key continuously held down repeats its code in rapid succession until the key is released. There is usually a time delay of about ½ second before repetition starts to avoid unintended repeats, and the repeat rate is about 15 per second. Although this feature is very easy to implement (and nearly free) when the keyboard is scanned by software, few if any packaged systems offer it at present.

Interfaces. Several general methods of keyboard interfacing are in common use, even on packaged systems in which the keyboard is integral to the system. Modular computers, such as S-100 machines, often use the key-

board of an external display terminal. From the computer's point of view, characters come in at random times on a serial interface encoded and ready to go. A large number of modular machines use a video display interface plugged directly into the bus and a separate keyboard interfaced to a parallel port. This approach saves the expense of a separate terminal and gives added flexibility.

In either case, the computer program must be "looking" at the keyboard when the keys are struck, otherwise the input characters may be lost. A system with this difficulty can be greatly helped by having audible feedback to tell the operator instantly when a keystroke is or is not accepted. A better way to solve the problem is to use interrupts with the keyboard. With interrupts, every keystroke interrupts the running program and informs it that a key has been struck. If the program is not yet ready for an input, the character is read and placed in a memory buffer. When the program is ready, the buffer is examined first and characters are taken from it until the buffer is empty. Then the program waits for a keyboard input. This is a very valuable feature for interactive programs written in BASIC, in which it is easy for the operator to get ahead of the program.

While the keyboard logic does most of the work associated with scanning the keys and forming the character code on modular systems, many packaged systems use the microprocessor itself to do this task at much lower cost. In these systems, the individual keyswitches are wired into a matrix, usually with 8 rows and 8 columns and a switch at each crosspoint. The 8 column wires are then connected to an internal 8-bit output port and the 8 row wires to an 8-bit input port. Whenever a key is depressed, an output is connected to an input with the combination different for each key. With proper construction, it is possible for the program to identify which keyswitch is closed and then look up its code in a memory table for use by the rest of the software.

Typically the keyboard-read program, which is usually part of ROM software, scans the keyboard, which means it "looks" at each key in sequence and registers a character when it locates a depressed key. Additional software tests are required to prevent the same character from being generated each time the software scans and to negate the effects of keyswitch contact bounce.

There are two common ways of solving the former problem, each giving a different typing characteristic to the keyboard. One of these is to stop scanning the keyboard when a depressed key is found, output the code, and then wait until the key is released. At that point, scanning is resumed. This system is called "two-key rollover" because it produces the proper sequence of characters (that is, the same sequence that was typed) for a maximum of two keys being pressed simultaneously. The second method uses continuous scanning and keeps a copy of the state of each key in memory. A keystroke is registered only when a key that was not previously down (as determined by looking at the copy in memory) is seen down for the first time. Thus, the keyboard responds only to up-to-down movement of a key and then completely ignores it. This is called "N-key rollover" because it produces the proper character sequence regardless of the number of

keys already down. Having more than one key down simultaneously is a common occurrence, particularly with fast typing, so it is important that the keyboard, whether it be hardware or software scanned, handle the situation in a reasonable manner.

Keyswitch contact bounce is a serious problem. All mechanical contacts fail to make and break instantaneously and may vibrate (produce multi-contacting) for a few milliseconds before a solid contact is assured. With the speed of modern microprocessors, a keyboard scanning program could interpret this bouncing as several keystrokes and produce multiple repetitions of the same character. From a software viewpoint, the problem can be solved by having the scanning software verify the making or breaking of a contact by testing it for about 10 milliseconds and requiring that every test produce the same results before concluding that a make or break actually took place. Fortunately, systems with bounce problems can be cured by using a "keyboard fix" program available from the manufacturer or on the open market.

Interrupt operation of a keyboard that is software-scanned is more difficult than if it is hardware-scanned, but one hardware manufacturer has figured out a way to do it with its line of computers. The trick is to have a 60-Hz line-frequency interrupt cause periodic entry into the keyboard scan routine regardless of program activity. The scan routine in turn, does one scan of the keyswitch array and stores any key that is newly pressed into a character buffer for later use. Thus, it is possible to be several keystrokes ahead of program execution. Since the operating system takes care of all of the details automatically, the programmer doesn't even have to know about it. This same 60-Hz interrupt also updates an elapsed time "clock" in memory, which can be quite useful. ◇

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Software Sources

By Leslie Solomon
Technical Director

TRS-80 Math Library. Requiring 16K of RAM, and written for Level-II BASIC, this package contains 22 programs for solving various scientific problems including equation roots, differentiation and integration, simultaneous equations including sparse and tridiagonal systems, matrix operations (inversion, determinant, etc.), interpolation (one and two dimensional), regression analysis (linear, polynomial, multiple), ordinary differential equations (single and simultaneous), partial differential equations, statistics and plotting (any function, any range). The package comes with a user manual, example runs, program descriptions, brief theories and sources to refer to. Disk version is $35, Level-II cassette is $32. Dr. Lee Scientific Software, 5819 Thomas Ave., Philadelphia, PA 19143 (Tel: 215-748-4558).

8080 APL. Running under CP/M for the 8080/8085/Z80 processors, Softronics APL has most of the functions and operators of full APL including n-dimensional inner and outer product, reduction, compression, general transpose, reversal, take, drop; execute and format; system functions and variables; and system commands. It resides in 30K, and is ready to go in ASCII. It also comes with an optional driver program for video display with programmable character generator. $350. Softronics, 36 Homestead Lane, Roosevelt, NJ 08555.

Three For the PET. The Checkbook program selects and displays checks by person, purpose or data and sums checks by category or person. Accounts program allows creation of a data base for company names, addresses, invoices and purchase order numbers, and the amounts of purchase. It locates information on specific companies, determines amounts owed and displays past-due accounts. Calender program enables the user to keep track of appointments, schedules, etc. $9.90 for PET/CBM cassette, $12.95 for diskette. TIS, Box 921, Los Alamos, NM 87544 (Tel: 505-455-7049).

1802 Programs. Space Battle is a two-dimensional game for two players while Breakout is similar to the arcade version. Both require 2K of RAM, the 1861 video chip and hex pad entry. For 1802 systems with Tiny BASIC there is Bugger, a one-dimensional game, and Carrier, an aircraft landing program. For 1802 systems having Tiny BASIC and Netronics Display, there is Lander (lunar), Klaybor Shuttle (a space flight game), and Battleship (a computer version of the old game). Programs are available on cassette or as listings. Send SASE to Donald R. Shroyer, 209 Brinker St., Latrobe, PA 15650.

Parle Vous Computer? The Language Translator Program can accept a word, phrase or complete sentence and translate it from English to a foreign language, from a foreign language to English, or from one foreign language to another. It is not a simple word-for-word translator. When a sentence is entered, the proper verb conjugation is checked as well as word contractions. New words may be added. A special mode allows the translator to input one language and output a translation on a printer. A Teach Mode allows working at a slower pace. Display formatting shows vocabulary words in logical categories, or alphabetically. CP/M or North Star Disk. Spanish or French presently available with 500 words per disk, at $30. Additional initial languages (French, Spanish, German, Italian, Hungarian, Polish and Slovak) on starter disk only for $10. Practical Programming Corp. Box 3069, North Brunswick, NJ 08902.

Statistical Package. MICROSTAT is designed for scientific research and business applications. It uses special algorithms to minimize errors and a Data Management Subsystem to control, edit and modify all files employed as data input. It permits up to 11 data transformations on any data file, including reciprocals, exponential and linear transformations, plus the ability to augment, rank order, sort and log variables in the data file. It features 8 probability distributions, 11 nonparametric tests, Chi-square, one and two way ANOVA, hypothesis tests (mean and proportions), simple and multiple regression, and data plots. Used with North Star and BASIC. $200. ECOSOFT, P.O. Box 68602, Indianapolis IN 46260 (Tel: 317-253-6828).

North Star Assembler. The ASMB-48 assembler/editor can be used with 8021/8022/8039/8049 microcomputers. Programs developed on the Z80/8080 host must be off-loaded to the target processor for test. The INTEL MCS-48 assembly language is supported as well as psuedo-operations for conditional assembly, data and string definition, and multiple location counter program development. On diskette, $75. Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107 (Tel: 213-793-5748).

TRS-80 FORTH. TinyFORTH 2.1 is a unique version of FORTH tailored to the TRS-80. Programs run faster since this language includes a compiler as well as an interpreter. TinyFORTH is based on a memory-resident dictionary of words with each word a program. The user can define new words, with the size limited by available memory. The 300 words in tF 2.1 occupy 8K of memory. It also includes a Z80 assembler, and graphics package. The text editor can be used to edit TinyFORTH or other text. TinyFORTH for 16K (or larger) Level-II machines is $29.95 with $1.50 shipping/handling. The Software Farm, P.O. Box 2304, Reston, VA 22090 (Tel: 703-437-9218). ◇

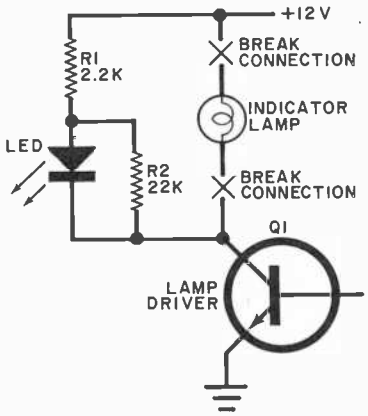
Tips & Techniques

INHIBITING PC BOARD OXIDATION

If you've ever made your own pc board, you know that the foil on a freshly etched board quickly takes on an oxide layer when exposed to the air. This oxide makes soldering difficult because more heat than normal is required for a good solder connection. This excess heat can damage delicate semiconductors and even the board itself. The problem can be avoided by applying a thin film of high-viscosity lubricating oil on the foil with a wad of cotton or a cotton swab. The oil will not interfere with soldering but will prevent oxidation of the copper foil. —*Harry J. Miller, Sarasota, FL.*

LED REPLACES "ODDBALL" INCANDESCENT

The situation occasionally arises in which a replacement for an uncommon incandescent lamp is hard to find. In such a case, minor circuit changes and the addition of a readily available LED can solve the problem. The circuit shown here was employed when the stereo indicator



lamp in an FM receiver burned out and no suitable replacement could be found in Tehran, Iran. This circuit can be adapted for use in a great many similar situations.

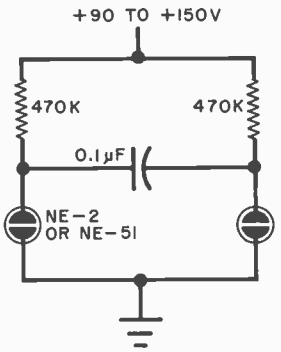
Shunt resistor *R2* was required to prevent collector leakage current through *Q1* from illuminating the LED in the absence of base drive. This resistor might not be needed in other applications. The value of *R1* can be changed to permit substitution of the LED for an incandescent lamp requiring some other supply voltage. —*J. Smolski, S. Plainfield, N.J.*

SPAGHETTI FROM BALLPOINT PENS

When your ballpoint pen runs out of ink, disassemble it and snip off the plastic tube which formerly held the ink. Thread a string through the tube and then pull the string back and forth through it to remove any residual ink. You now have a length of "spaghetti" wire insulation for your latest electronic project. —*Frank Shore, New York, N.Y.*

NEON BLINKER

The circuit shown here is an astable multivibrator employing two neon bulbs that alternately blink on and off. It will delight children when used as the blinking eyes of a Santa Claus, jack-o-lantern or similar toy and can be used to create eye-catching window displays. Type NE-2 or NE-51 neon bulbs can be employed, and the operating voltage (190 to 1150 volts) can be derived from a high voltage photographic battery, a line powered



supply, or a small dc-to-dc converter and a low-voltage battery. Current drain is very low, so long battery life can be expected. The flash rate can be changed by varying the values of resistance (don't reduce below 100,000 ohms) and or capacitance. Use a non-polarized capacitor with an adequate voltage rating. —*H. Muller, Danboro, PA.*

Electronics Library

VIDEOCASSETTE RECORDERS

by Gerald P. McGinty

This book provides the service technician with an introduction to the popular Beta- and VHS-format videocassette recorder. Early chapters concentrate on the theory and design of the videocassette recorder. From here, the book goes into failure modes of the electronic and electromechanical systems and relates them to specific groups of components. Adjustment and repair procedures are then described in detail and related to basic theory so that the reason for each step is understood by the reader. Use of mathematics is minimized, and the text is liberally illustrated.

Published by Gregg Div., McGraw-Hill Book Co., 1221 Ave. of Americas, New York, NY 10020. Soft cover. 256 pages. $9.95.

HOW TO SELECT AND INSTALL YOUR OWN SPEAKERS

by Norman Crowhurst

A beginner's overview of loudspeaker design and application, this book covers the field in broad strokes ranging from horns, infinite baffles, and bass reflexes for the home listening room to columnar systems for PA use. The concepts and philosophy are there along with some interesting hints about doing the job. If you're serious about designing, though, the higher simplified math is disappointing. You'll have to solve the equations eventually, and the author gives very few of them. Examples are given, but without general expressions. Also, there's no mention of Thiele-Small parameters, nor any data to help you figure power-handling or crossover frequencies. As a consequence, the value of this book depends on how seriously you are or plan to be involved. If you're just getting your feet wet, this book is certainly a good place to start.

Published by Tab Books, Blue Ridge Summit PA. 17214 Soft cover. 234 pages. $5.95

ELEMENTS OF ELECTRONIC INSTRUMENTATION AND MEASUREMENT

by Joseph J. Carr

Written with both student and engineer in mind, this book presents both traditional instrumentation techniques and the latest developments from research labs and manufacturers. Coverage runs the full range of instrumentation and measurement, from traditional analog and digital equipment to microprocessors. The book introduces specific instruments and provides guidelines for using them. A list of objectives begins and ends each section and questions and problems end each chapter to provide self-evaluation.

Published by Reston Publishing Co., Inc., Reston, VA 22090. Hard cover. 508 pages. $17.95.

MOST OFTEN ASKED QUESTIONS AND ANSWERS ABOUT AMATEUR RADIO

by Leo G. Sands & Joseph L. Lynch

Written in a conversational question-and-answer format, this new book should appeal to the prospective Amateur Radio operator. It is broken down into 10 sections, each of which focuses on a different aspect of ham radio. The first part is devoted to amateur licenses. Subsequent parts deal with communication operations, frequency bands, and the build-or-buy decision. The remainder of the book covers the technical aspects of the hobby—diagrams, transmitters, receivers, antenna systems, microphones, and projects for experimenters.

Published by Hayden Book Co., 50 Essex St., Rochelle Park, NJ 07662. Soft cover. 120 pages. $4.95.

HANDBOOK OF ELECTRONICS CALCULATIONS FOR ENGINEERS AND TECHNICIANS

Prepared by experts in each area, this large book gives detailed solutions to problems in just about every area of electronics. Pertinent background information and related theory are given for each calculation. Focusing on work-related problems, the book covers: basic technical mathematics, dc and ac circuit analysis, audio and tuned amplifiers, feedback, oscillators, power supplies, digital logic, computer-aided circuit design, transmission lines, filters, antennas, communication systems, and microwaves.

Published by McGraw-Hill Book Co., 1221 Ave. of Americas, New York, NY 10020. Hard cover. 600 pages. $24.50.

PROJECT OF THE MONTH

Pocket Color Organ

BY FORREST M. MIMS

THIS LITTLE color organ has only a thousandth of the light power of its conventional counterparts, but it's ideal for solo viewing. I've also found it to be an effective attention-getting device at small gatherings.

As shown in Fig. 1, the circuit consists of three active filters which separate the audio input signal into low, medium and high frequencies. Each filter drives three series-connected LEDs. I chose red for the low frequencies, yellow for the middle range and green for the high frequencies.

The red and yellow LEDs are driven by bandpass filters. With the component values I chose, the red filter peaks at 20 Hz and has a total passband of 1 to 70 Hz. The yellow filter peaks at 80 Hz and has a total passband of 25 to 85 Hz. The green LED is driven by a high-pass filter with a response which extends from about 75 Hz to beyond the limits of audibility.

Figure 2 shows the frequency response of the three filters superimposed on the same graph. The overlap of filter responses can be eliminated by altering the frequency responses of the filters. I intentionally included the overlap, however, to prevent the possibility of all the LEDs going dark simultaneously.

As clearly indicated in Fig. 2, the circuit favors the low end of the audio spectrum. While I've found this gives an excellent visual representation of most music, you might want to alter the frequency response of one or more filters for other effects.

For best results, assemble the circuit in a light-tight enclosure. Make a window for the LEDs from a thin sheet of translucent plastic or ground glass, materials sold at many camera stores.

Figure 3 shows the enclosure I selected, a French bicycle light sold under the trade name "Wonder." It or a similar bike light of domestic manufacture can be purchased from most bicycle stores.

I removed the light's reflector and switch assembly and installed a circuit board cut with a nibbling tool to fit the interior of the case. The LEDs were grouped in three red-yellow-green triangles as shown in Fig. 4. You can, of course, select your own color and pattern arrangements. The visual impact of the LEDs is much greater if they are viewed through a translucent screen. You can transform the plastic flashlight lens from transparent to translucent by lightly buffing it with fine emery paper.

I used point-to-point wiring to interconnect the various components. The flashlight case didn't have sufficient space for batteries, so I taped two 9-volt batteries to the back of the case and connected them to the circuit via a short cable and a couple of battery clips. The circuit will work when powered by a 9-volt supply, but 18 volts gives more light and provides better response at low volume settings.

A two-conductor cable with two miniature phone plugs soldered in parallel at one end and connected to the input transformer's 8-ohm primary is used to route audio signals to the color organ. Insert one plug in the phone jack of a transistor radio. The other plug should go to a jack connected to a small monitor speaker box so you can hear the music while you're viewing it. Alternatively, you can defeat the radio's speaker cutoff by rewiring its earphone jack.

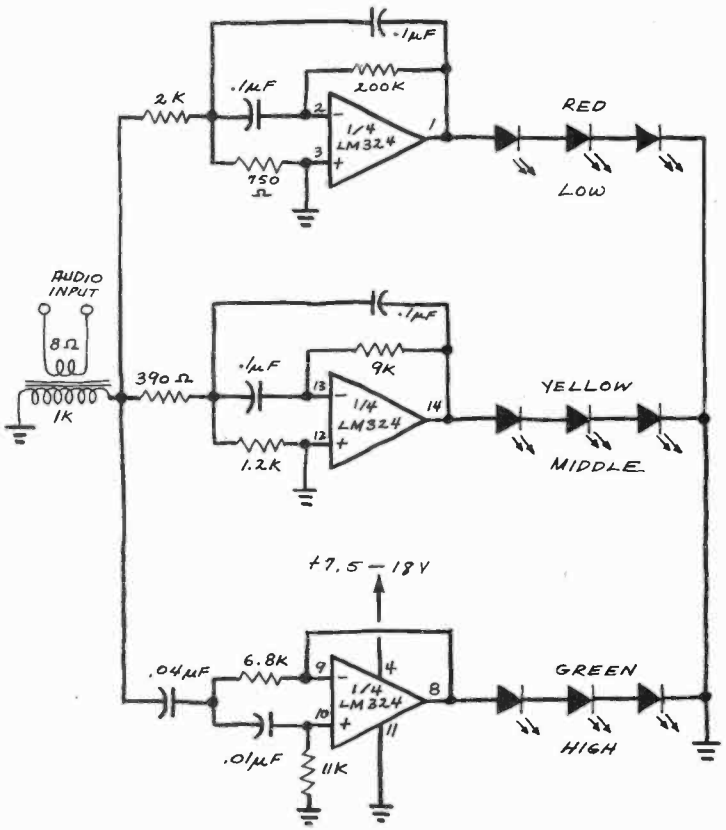


Fig. 1. Schematic diagram for a miniature color organ.

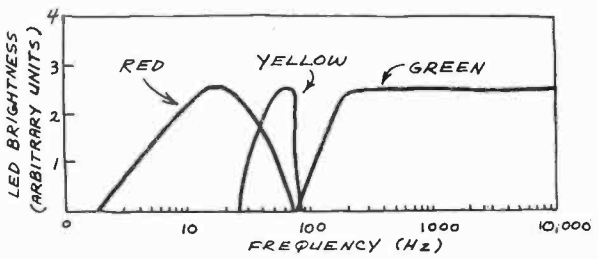


Fig. 2. Frequency response of LED color organ.

Next, dim the room lights, tune in some good music and enjoy the show. You can adjust the radio's volume and tone controls to alter the visual effects. And don't worry about power consumption. The circuit draws only 3 to 5 mA from a single 9-volt battery or 5 to 12 mA from two series-connected 9-volt batteries. ◇

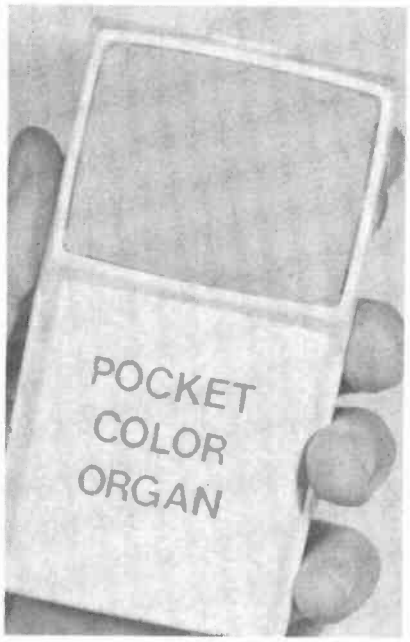


Fig. 3. Prototype assembled in a bicycle light.

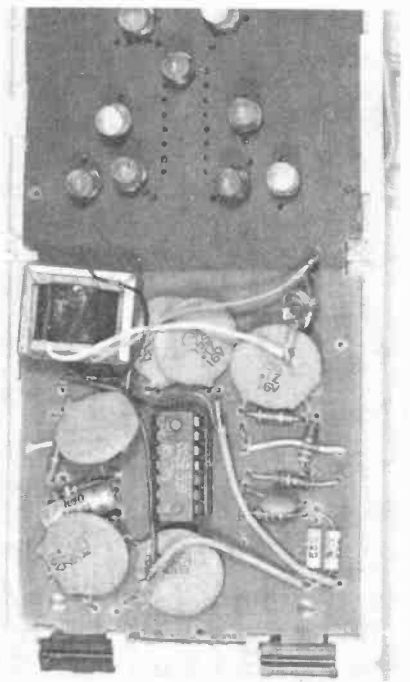


Fig. 4. Prototype internal assembly. Transformer is cemented to circuit board.

Correction: *Byte* magazine's advertisement in January 1980 POPULAR ELECTRONICS featured incorrect prices. Subscription rates are: for one year, $18; two years, $32; and three years, $46.

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74LS27	276-1913	.69
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74LS32	276-1915	.69
74LS47	276-1916	1.29
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4028	276-2428	1.29
4046	276-2446	1.89
4511	276-2447	1.69
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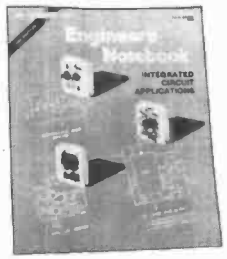

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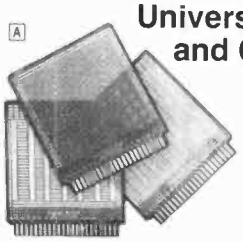

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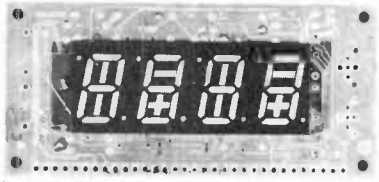

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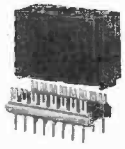

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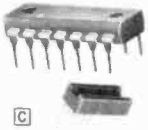

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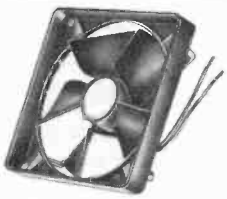

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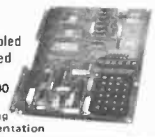

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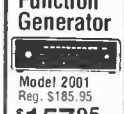

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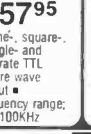

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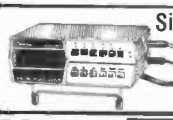

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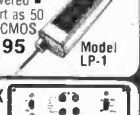

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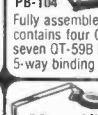

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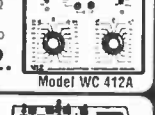

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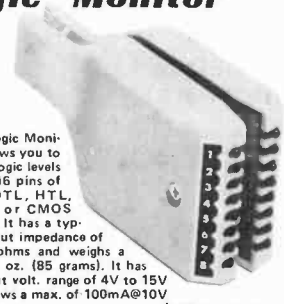

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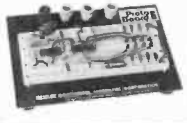

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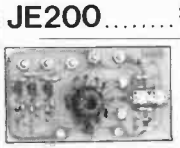

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MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49

UART'S

A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS

M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

ROM'S

2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S

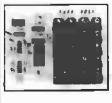
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	7.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 300ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S

1702A	2048	FAMOS	$5.95
2716INTEL (2716)	16K*	EPROM	59.95
TMS2516	16K*	EPROM	49.95
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

*Requires single +5V power supply
**Requires 3 voltages, —5V, +5V, +12V

JE600 HEXADECIMAL ENCODER KIT



FEATURES:
- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bistable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 ..... **$59.95**

Hexadecimal Keypad only **$14.95**

DIGITAL THERMOMETER KIT

- Dual sensors—switchlug control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Slim, walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 ..... **$39.95**

62-Key ASCII Encoded Keyboard Kit

The JE610 62-Key ASCII Encoded Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and —12V @ 10mA for operation.

FEATURES:
- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user-define keys provided for custom applications
- Caps lock for upper case only alpha characters
- Utilizes a 2376 (40 pin) encoder read only memory chip
- Outputs directly compatible with TTL/DTL or MOS logic arrays
- Easy interfacing with a 16-pin dip or 18-pin edge connector

JE610 ..... **$79.95**

62-Key Keyboard only . . $34.95

HICKOK

LX303 Portable LCD Digital Multimeter

- Big ½ inch high, 3½ Digit Liquid Crystal Display
- Over 200 Hours of operation with a 9V battery
- Automatic zero, polarity and overrange indication
- 100mV DC F.S. sensitivity
- 1% basic accuracy
- 19 ranges and functions
- Rugged Cycolac® case and removable cover, stores test lead set.
- Full one year warranty.

SPECIFICATIONS: DC volts (5 ranges): 0.1mV to 1000V. Accuracy ±0.5% rdg ±0.5% f.s., input imped. 10MΩ. Max. input 1kV except 500V on 200mV range.
AC Volts (40Hz to 5kHz): 0.1V to 600V. Accuracy: ±1.0% rdg ±0.5% f.s. (1-2kB max. at 5kHz). Max. input: 600V.
Resistance (6 Low Power Ranges): 0.1 to 20MΩ. Accuracy: ±0.5% rdg ±0.5% f.s. (±1.5% rdg on 20MΩ range). Input protected to 120V AC all ranges.
DC Current (6 ranges): 01mA to 100mA. Accuracy: ±1.0% rdg ±0.5% f.s.
Dimensions and Weight: 5-7/8" x 3-3/8" x 1-3/4", 8oz. POWER: 9V battery (not included) or Hickok AC adapter.
READ RATE: 3/sec.

LX303 Digital Multimeter **$74.95**

PART NO.	DESCRIPTION	PRICE
RC-3	115V AC ADAPTER	7.50
CC-3	PADDED CARRYING CASE	7.50
VP-10	X10 DC PROBE ADAPTER (Up to 10kV)	14.95
VP-40	40kV DC PROBE	35.00
CS-1	10 Amp DC Current Shunt	14.95

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage—Add 5% plus $1 Insurance (if desired)

Spec Sheets — 25¢
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The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modern and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.
Receive Sensitivity	-46 dbm accoustically coupled.
Transmit Level	-15 dbm nominal. Adjustable from -6 dbm to -20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K, Kit comes complete with:
- 8 each UPD416-1 (16K Dynamic Rams) 250NS
- Documentation for conversion

TRS-16K **$75.00**

ok® JUST WRAP™

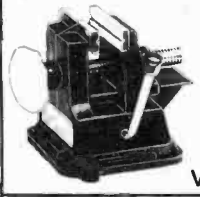
- 30 AWG wire
- Daisy chain or point-to-point
- No stripping or slitting required—just wrap
- .025" square posts
- Built-in cut off
- Includes 50 ft. wire

Part No.	Wire Color	Price
JW-1-B	Blue	$14.95
JW-1-W	White	14.95
JW-1-Y	Yellow	14.95
JW-1-R	Red	14.95

JUST WRAP™ Replacement Wire

Part No.	Color		Price
R-JW-B	Blue	50 ft. roll	$2.98
R-JW-W	White	50 ft. roll	2.98
R-JW-Y	Yellow	50 ft. roll	2.98
R-JW-R	Red	50 ft. roll	2.98

JUST WRAP™ Unwrap Tool $3.49



ok® Vacuum Vise

Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1½" jaws, 1¼" travel. Can be permanently installed.

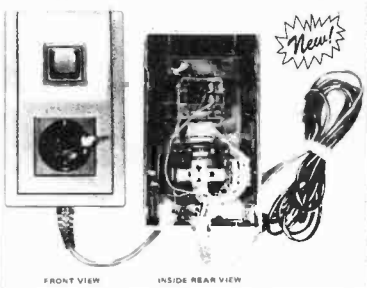
VV-1 ..... **$3.49**

ADJUSTABLE WRENCH

- Two Sizes: 6" and 10"
- Professional Quality
- Chrome Vanadium Steel

6"— AW-6 . . $4.95 10"— AW-10 . . $6.95

JOYSTICK VIDEO CONTROLLER



FRONT VIEW INSIDE REAR VIEW

- IDEAL FOR ALL VIDEO GAMES OR REMOTE CONTROL PROJECTS
- SMALL CASE SIZE: 1-1/2"H x 2-3/8"W x 4-5/16"L
- 2 MINIATURE POTENTIOMETERS—40K OHM EACH
- SPST PUSH BUTTON CONTROL
- 5-WIRE CONNECTION CABLE — 5 FEET LONG
- RUGGED PLASTIC CASE

JVC-40 ..... **$4.95 each**

7400 TTL

		SN7470N	.29		
		SN7472N	.29		
SN7400N	.16	SN7473N	.35	SN74160N	.89
SN7401N	.18	SN7474N	.35	SN74161N	.89
SN7402N	.16	SN7475N	.49	SN74162N	1.95
SN7403N	.18	SN7476N	.35	SN74163N	.89
SN7404N	.16	SN7479N	5.00	SN74164N	.89
SN7405N	.20	SN7480N	.50	SN74165N	.89
SN7406N	.29	SN7482N	.99	SN74166N	1.25
SN7407N	.29	SN7483N	.59	SN74167N	1.95
SN7408N	.20	SN7485N	.79	SN74170N	1.59
SN7409N	.20	SN7486N	.35	SN74172N	6.00
SN7410N	.18	SN7489N	1.75	SN74173N	1.25
SN7411N	.25	SN7490N	.45	SN74174N	.89
SN7412N	.25	SN7491N	.59	SN74175N	.79
SN7413N	.40	SN7492N	.43	SN74176N	.79
SN7414N	.70	SN7493N	.43	SN74177N	.79
SN7416N	.25	SN7494N	.65	SN74179N	1.95
SN7417N	.25	SN7495N	.65	SN74180N	.79
SN7420N	.20	SN7496N	.65	SN74181N	1.95
SN7421N	.29	SN7497N	3.00	SN74182N	.79
SN7422N	.39	SN74100N	.89	SN74184N	1.95
SN7423N	.25	SN74107N	.35	SN74185N	1.95
SN7425N	.29	SN74109N	.59	SN74186N	9.95
SN7426N	.29	SN74116N	1.95	SN74188N	3.95
SN7427N	.25	SN74121N	.35	SN74190N	1.25
SN7429N	.39	SN74122N	.39	SN74191N	1.25
SN7430N	.20	SN74123N	.49	SN74192N	.79
SN7432N	.25	SN74125N	.49	SN74193N	.79
SN7437N	.25	SN74126N	.49	SN74194N	.89
SN7438N	.25	SN74132N	.75	SN74195N	.69
SN7439N	.25	SN74136N	.75	SN74196N	.89
SN7440N	.20	SN74141N	.79	SN74197N	.89
SN7441N	.89	SN74142N	2.95	SN74198N	1.49
SN7442N	.49	SN74143N	2.95	SN74199N	1.49
SN7443N	.75	SN74144N	2.95	SN74S200	4.95
SN7444N	.75	SN74145N	.79	SN74251N	99
SN7445N	.75	SN74147N	1.95	SN74279N	.79
SN7446N	.69	SN74148N	1.29	SN74283N	2.25
SN7447N	.59	SN74150N	.89	SN74284N	3.95
SN7448N	.79	SN74151N	.59	SN74285N	3.95
SN7450N	.20	SN74152N	.59	SN74365N	.89
SN7451N	.20	SN74153N	.59	SN74366N	.89
SN7453N	.20	SN74154N	.99	SN74367N	.69
SN7454N	.20	SN74155N	.79	SN74368N	.69
SN7459A	.25	SN74156N	.79	SN74390N	1.95
SN7460N	.20	SN74157N	.65	SN74393N	1.95

C/MOS

CD4000	.23			CD4070	.55
CD4001	.23			CD4071	.23
CD4002	.23	CD4028	.89	CD4072	.49
CD4006	1.19	CD4029	1.19	CD4076	1.39
CD4007	.25	CD4030	.49	CD4081	.23
CD4009	.49	CD4035	.99	CD4082	.23
CD4010	.49	CD4040	1.19	CD4093	.99
CD4011	.23	CD4041	1.25	CD4098	2.49
CD4012	.25	CD4042	.99	MC14409	14.95
CD4013	.39	CD4043	.89	MC14410	14.95
CD4014	1.39	CD4044	.89	MC14411	14.95
CD4015	1.19	CD4046	1.79	MC14419	4.95
CD4016	.49	CD4047	2.50	MC14433	19.95
CD4017	1.19	CD4048	1.35	MC14506	.75
CD4018	.99	CD4049	.49	MC14507	.99
CD4019	.49	CD4050	.49	MC14562	14.50
CD4020	1.19	CD4051	1.19	MC14583	3.50
CD4021	1.39	CD4053	1.19	CD4508	3.95
CD4022	1.19	CD4056	2.95	CD4510	1.39
CD4023	.23	CD4059	9.95	CD4511	1.29
CD4024	.79	CD4060	1.49	CD4515	2.95
CD4025	.23	CD4066	.79	CD4518	1.29
CD4026	2.25	CD4068	.39	CD4520	1.29
CD4027	.69	CD4069	.45	CD4566	2.25

74C00

74C00	.39			74C163	2.49
74C02	.39			74C164	2.49
74C04	.39	74C85	2.49	74C173	2.60
74C08	.49	74C90	1.95	74C192	2.49
74C10	.39	74C93	1.95	74C193	2.49
74C14	1.95	74C95	1.95	74C195	2.49
74C20	.39	74C107	1.25	74C922	7.95
74C30	.39	74C151	2.90	74C923	6.25
74C42	1.95	74C154	3.00	74C925	8.95
74C48	2.49	74C157	2.15	74C926	8.95
74C73	.89	74C160	2.49	80C95	1.50
74C74	.89	74C161	2.49	80C97	1.50

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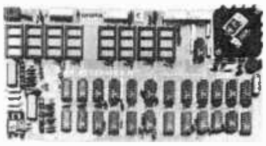
78MG	1.75			LM710N	.79
LM108H	.99			LM711N	.39
LM300H	.80	LM340K-18	1.35	LM723N/H	.55
LM301CN/H	.35	LM340K-24	1.35	LM733N	1.00
LM302H	.75	LM340T-5	1.25	LM739N	1.19
LM304H	1.00	LM340T-6	1.25	LM741CN/H	.35
LM305H	.60	LM340T-8	1.25	LM741-14N	.39
LM307CN/H	.35	LM340T-12	1.25	LM747N/H	.79
LM308CN/H	1.00	LM340T-15	1.25	LM748N/H	.39
LM309H	1.10	LM340T-18	1.25	LM1310N	1.95
LM309K	1.25	LM340T-24	1.25	LM1458CN/H	.59
LM310CN	1.15	LM358N	1.00	MC1488N	1.95
LM311N/H	.90	LM370N	1.95	MC1489N	1.95
LM312H	1.95	LM373N	3.25	LM1496N	.95
LM317K	6.50	LM377N	4.00	LM1556V	1.75
LM318CN/H	1.50	LM380N	1.25	MC1741SCP	3.00
LM319N	1.30	LM380CN	.99	LM2111N	1.95
LM320K-5	1.35	LM381N	1.79	LM2901N	2.95
LM320K-5.2	1.35	LM382N	1.79	LM3053N	1.50
LM320K-12	1.35	NE501N	8.00	LM3065N	1.49
LM320K-15	1.35	NE510A	6.00	LM3900N(3401)	.59
LM320K-18	1.35	NE529A	4.95	LM3905N	1.49
LM320K-24	1.35	NE531H/V	3.95	LM3909N	1.25
LM320T-5	1.25	NE536T	6.00	MC5558V	.59
LM320T-5.2	1.25	NE540L	6.00	8038B	4.95
LM320T-8	1.25	NE544N	4.95	LM75450N	.49
LM320T-12	1.25	NE550N	1.30	75451CN	.39
LM320T-15	1.25	NE555V	.39	75452CN	.39
LM320T-18	1.25	NE556N	.99	75453CN	.39
LM320T-24	1.25	NE560B	5.00	75454CN	.39
LM323K-5	5.95	NE562B	5.00	75491CN	.79
LM324N	1.49	NE565N/H	1.25	75492CN	.89
LM339N	.99	NE566CN	1.75	75493N	.89
LM340K-5	1.35	NE567V/H	.99	75494CN	.89
LM340K-6	1.35	NE570N	4.95	RC4136	1.25
LM340K-8	1.35	LM703CN/H	.89	RC4151	3.95
LM340K-12	1.35	LM709N/H	.29	RC4194	4.95
LM340K-15	1.35			RC4195	4.49

74LS00TTL

74LS00	.29			74LS138	.89
74LS01	.29			74LS139	.89
74LS02	.29	74LS47	.89	74LS151	.89
74LS03	.29	74LS51	.29	74LS155	.89
74LS04	.35	74LS54	.29	74LS157	.89
74LS05	.35	74LS55	.29	74LS160	1.15
74LS08	.29	74LS73	.45	74LS161	1.15
74LS09	.35	74LS74	.45	74LS162	1.25
74LS10	.29	74LS75	.59	74LS163	1.15
74LS11	.75	74LS76	.45	74LS164	1.25
74LS13	.59	74LS78	.49	74LS175	.99
74LS14	1.25	74LS83	.89	74LS181	2.49
74LS15	.35	74LS85	1.25	74LS190	1.15
74LS20	.29	74LS86	.45	74LS191	1.15
74LS21	.35	74LS90	.59	74LS192	1.15
74LS22	.35	74LS92	.75	74LS193	1.15
74LS26	.35	74LS93	.75	74LS194	1.15
74LS27	.35	74LS95	.99	74LS195	1.15
74LS28	.35	74LS96	1.15	74LS253	.99
74LS30	.29	74LS107	.45	74LS257	.89
74LS32	.35	74LS109	.45	74LS258	1.75
74LS37	.45	74LS112	.45	74LS260	.69
74LS40	.35	74LS123	1.25	74LS279	.75
74LS42	.89	74LS125	.89	74LS367	.75
		74LS132	.99	74LS368	.75
		74LS136	.49	74LS670	2.49

Cromemco
incorporated



8K Bytesaver II

Cromemco's 8K BYTESAVER® card provides a built-in programmer for the popular 2708 PROM and has the capacity for a full 8K bytes of PROM memory storage. The BYTESAVER® II also offers a number of new features including convenient switch selection of board address and Cromemco's powerful memory bank selection. The BYTESAVER® II is assembled and tested (Model 8K BS-W) for $245.

Memory Capacity: 8K bytes
Memory Type: 2708 PROM or equivalent
Memory Access Time: 450 nanoseconds
Wait States at 2MHz: none required
Wait States at 4MHz: one per machine cycle
Bus: S-100
Power Requirements: +8V @ 0.8A
+18V @ 0.4A
−18V @ 0.2A
Operating Environment: 0-55°C.

Assembled
8KBS-W....$245.00

DISCRETE LEDS

.200" dia.			.125" dia.		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			.185" dia.		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV108	red	4/$1	.190" dia.		
.085" dia.			XC111R	red	5/$1
MV50	red	6/$1	XC111G	green	4/$1
			XC111Y	yellow	4/$1
			XC111C	clear	4/$1

INFRA-RED LEO
1/4"x1/4"x1/16" flat
5/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY
CLASS II
FIELD EFFECT

4 DIGIT — .5" CHARACTERS
THREE ENUNCIATORS
2.00" × 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive $7.95
T1001A-Reflective 8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.75	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	49	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	49	DL746	Common Anode-red ± 1	630	1 49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	1 50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	1 50
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

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CA2023T	2 56	CA3083N	1.60
CA3035T	2 48	CA3086N	.85
CA3039T	1 35	CA3089N	3.75
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CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	85	CA3401N	59
CA3081N	2 00	CA3600N	3.50

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8 pin LP	.$17	.16	.15
14 pin LP	.20	.19	18
16 pin LP	.22	.21	.20
18 pin LP	29	28	.27
20 pin LP	34	.32	30
22 pin LP	$ .37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

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16 pin ST	.30	.27	.25
18 pin ST	.35	32	.30
24 pin ST	.49	45	.42
28 pin ST	$ .99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100
8 pin SG	$.30	.27	.24
14 pin SG	.35	.32	.29
16 pin SG	38	.35	.32
18 pin SG	52	.47	.43
24 pin SG	$ .70	.63	.57
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	$.39	.38	31
10 pin WW	45	41	.37
14 pin WW	.39	38	37
16 pin WW	.43	42	41
18 pin WW	.75	.68	.62
20 pin WW	.85	.79	.72
22 pin WW	$ .95	.85	.75
24 pin WW	1.05	.95	.85
28 pin WW	1.40	1.25	1.10
36 pin WW	1.59	1.45	1.30
40 pin WW	1.75	1.55	1.40

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ASST. 3	5 ea	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
ASST. 5	5 ea	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 PCS	1.75
ASST. 6	5 ea	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 PCS	1.75
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 PCS	1.75

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DIODES

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				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4733	5.1	1w	28
1N965	15	400m	4/1.00	1N4734	5.6	1w	28
1N5232	5.6	500m	28	1N4735	6.2	1w	28
1N5234	6.2	500m	28	1N4736	6.8	1w	28
1N5235	6.8	500m	28	1N4738	8.2	1w	28
1N5236	7.5	500m	28	1N4742	12	1w	28
1N5242	12	500m	28	1N4744	15	1w	28
1N5245	15	500m	28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

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C36D	15A @ 400V	SCR(2N1849)	$1.95
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2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

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MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2905	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
PN2907 Plastic	7/1.00	2N3724A	65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1.00	2N5951	3/1.00

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50 VOLT CERAMIC DISC CAPACITORS

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10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	05	04	.03	.0047µF	05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	10	.07	.047mf	.21	.17	.13
.0047mf	.12	10	.07	.1mf	.27	.23	.17
.01mf	.12	10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/35V	.35	.31	.27
.22/35V	.28	.23	17	3.3/25V	.35	.31	.27
.33/35V	.28	.23	.17	4.7/25V	.33	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.49	.45	.35
.68/35V	.28	.23	.17	15/25V	.75	.68	.59
1.0/35V	.28	.23	.17	22/6V	.75	.60	.50
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

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8214	3.95	6820	3.95	6520	6.95
8216	2.95	6821	3.95	6522	9.95
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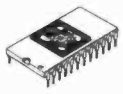
2N3772	1.95	100V	NPN	TO-3
2N3773	2.50	160V	NPN	TO-3

Universal SCR

C106D	.34	400V	5.0 AMP	TO-220

EPROM'S



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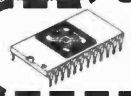

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LM324N	.59	TBA810DAS	1.29
LM339N	.99	LM1458N-8	.49
LM348N-14	.55	LM1488N-14	.69
LM358N-8	.99	LM1489N-14	.29
LM555N-8	.59	LM3403N-14	.99
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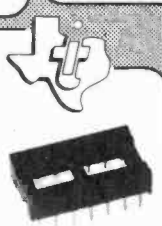

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WIRE WRAPPING TOOLS

O.K.'s Model BW-630 battery operated wrapping tool, uses two size "C" batteries (not included) for making "Modified" wrap of No. 30 wire around .025" square post. This unit is lightweight, and has positive indexing and anti-overwrapping device.
CATALOG NO. 25-00630. . . . . $34.95

O.K.'s Model BW-2628 tool is same as above, but is for wrapping Nos 26 to 28 wires.
CATALOG NO. 25-02628. . . . . $39.95

O.K.'s Model WSU-30M Manual wire wrapping tool is a three in one hand tool that strips No. 30 wire, makes "Modified" wraps and even unwraps previously wrapped posts.
CATALOG NO. 25-16000. . . . . $7.95

O.K.'s Model WSU-30 is the same as above, but makes "Regular" instead of "Modified" wraps.
CATALOG NO. 25-15000. . . . . $6.95

VECTOR's Model P178-1 Wiring Pencil guides and wraps insulated wire onto circuit leads from replaceable bobbins. Connections are made by soldering with a 750°F iron. When heat is applied, wire coating melts, permitting solder that is under the coating to bond the junction.
CATALOG NO. 23-81781. . . . . $7.95

VECTOR's Model 55X Kit includes above mentioned wiring pencil, plus a Vectorboard and host of other useful accessories.
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VECTOR's Model P180 Slit-N-Wrap hand tool uses 130°C rated Poly-Nylon wire for wrapping gas-tight wraps around .025" square posts. The tool slits the wire before wrapping and can make "Daisy-Chain" connection, so no pre-cut or pre-stripping is required. It comes complete with two 100' spools of wire and a P183 Knife Tool.
CATALOG NO. 23-81800. . . . . $25.00

VECTOR's Model P160-4T is a battery powered high speed wrapping gun that incorporates Model P180 Slit-N-Wrap tool above for high speed wrapping applications. With built-in Ni-Cads and recharger unit.
CATALOG NO. 23-86490. . . . . $99.50

VECTOR's Model P160-4T1 is same as above, but it operates from 110V AC for continous operation.
CATALOG NO. 23-86491. . . . . $99.50

VECTOR's Model P184 Slit-N-Wrap hand tool is the same as Model P180 Tool described above, however, it uses 150°C rated Teflzel wire for ultimate in reliability.
CATALOG NO. 23-81840. . . . . $30.00

VECTOR's Model P184-4T is a battery powered wrapping gun that incorporates Model P184 Slit-N-Wrap Tool for high volume production. Complete with Ni-Cads and recharger unit.
CATALOG NO. 23-88490. . . . . $105.00

VECTOR's Model P184-4T1 is AC powered version of above for non-stop continous operation.
CATALOG NO. 23-88491. . . . . $105.00

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This month I.C.C. offers the widest selection of pre-cut and pre-stripped AWG 30 wrapping wire available anywhere. The Kynar insulated wire has a rating of 105°C and is available in ten contrasting colors for ease of tracing. There are four package sizes, so you may buy only the quantities that you need. Each piece is stripped 1.0" from each end and is packaged in an air-tight reuseable platic tube to prevent corrosion of the stripped ends.

In order to specify the color of insulation, please replace the "X" in price table below with the proper color number from the following table:

BLACK	0	GREEN	5
BROWN	1	BLUE	6
RED	2	VIOLET	7
ORANGE	3	GRAY	8
YELLOW	4	WHITE	9

INSULATED LENGTH	PACKAGE OF 50 CATALOG NO.	PRICE	PACKAGE OF 100 CATALOG NO.	PRICE	PACKAGE OF 500 CATALOG NO.	PRICE	PACKAGE OF 1000 CATALOG NO.	PRICE
1.0"	30-1002X	$0.90	30-1003x	$1.60	30-1004X	$4.80	30-1005X	$8.80
1.5"	30-1502X	0.94	30-1503X	1.68	30-1504X	5.04	30-1505X	9.24
2.0"	30-2002X	0.98	30-2003X	1.75	30-2004X	5.25	30-2005X	9.63
2.5"	30-2502X	1.02	30-2503X	1.83	30-2504X	5.49	30-2505X	10.06
3.0"	30-3002X	1.05	30-3003X	1.90	30-3004X	5.70	30-3005X	10.45
3.5"	30-3502X	1.14	30-3503X	1.98	30-3504X	5.94	30-3505X	10.89
4.0"	30-4002X	1.18	30-4003X	2.05	30-4004X	6.15	30-4005X	11.28
4.5"	30-4502X	1.22	30-4503X	2.13	30-4504X	6.39	30-4505X	11.72
5.0"	30-5002X	1.25	30-5003X	2.20	30-5004X	6.60	30-5005X	12.10
6.0"	30-6002X	1.33	30-6003X	2.35	30-6004X	7.05	30-6005X	12.93
7.0"	30-7002X	1.45	30-7003X	2.50	30-7004X	7.50	30-7005X	13.75
8.0"	30-8002X	1.52	30-8003X	2.65	30-8004X	7.95	30-8005X	14.58
9.0"	30-9002X	1.60	30-9003X	2.80	30-9004X	8.40	30-9005X	15.40
10.0"	30-1012X	1.68	30-1013X	2.95	30-1014X	8.85	30-1015X	16.23
15.0"	30-1512X	2.05	30-1513X	3.70	30-1514X	11.10	30-1515X	20.35

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7402	0.17	7492	0.43	74198	1.45	74LS125	0.48	74S04	0.36	74C73	0.71
7403	0.17	7493	0.43	74199	1.45	74LS126	0.48	74S05	0.36	74C74	0.48
7404	0.18	7496	0.65	74251	1.09	74LS132	0.80	74S09	0.38	74C76	0.71
7405	0.18	7497	2.45	74283	2.20	74LS136	0.38	74S10	0.35	74C83	1.37
7406	0.24	74107	0.29	74290	0.89	74LS138	0.93	74S11	0.38	74C85	1.37
7407	0.24	74109	0.32	74293	0.89	74LS139	0.93	74S15	0.38	74C86	0.49
7408	0.20	74121	0.34	74298	0.97	74LS151	0.74	74S20	0.35	74C89	3.95
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7410	0.17	74123	0.49	74366	0.62	74LS153	0.84	74S30	0.35	74C93	0.97
7411	0.20	74125	0.39	74367	0.62	74LS154	1.09	74S40	0.35	74C95	1.09
7412	0.24	74126	0.39	74368	0.62	74LS155	0.74	74S64	0.38	74C107	0.69
7413	0.25	74132	0.65			74LS156	0.74	74S65	0.38	74C151	1.89
7414	0.70	74145	0.69	**74LSxx**		74LS157	0.74	74S74	0.58	74C154	2.90
7416	0.24	74147	1.60	74LS00	$0.27	74LS158	0.74	74S76	0.58	74C157	1.89
7417	0.24	74148	1.29	74LS01	0.27	74LS160	1.01	74S78	0.58	74C160	1.17
7420	0.19	74150	0.89	74LS02	0.27	74LS161	1.01	74S86	0.58	74C161	1.17
7423	0.25	74151	0.59	74LS03	0.27	74LS162	1.01	74S112	0.58	74C162	1.17
7425	0.25	74152	0.59	74LS04	0.28	74LS163	1.01	74S113	0.58	74C163	1.17
7426	0.24	74153	0.59	74LS05	0.28	74LS164	1.01	74S114	0.58	74C164	1.09
7427	0.25	74154	0.99	74LS08	0.28	74LS168	1.13	74S133	0.38	74C165	1.09
7430	0.19	74155	0.69	74LS09	0.28	74LS169	1.13	74S134	0.38	74C173	1.29
7432	0.24	74156	0.69	74LS10	0.27	74LS170	1.72	74S135	0.49	74C174	1.15
7437	0.24	74157	0.64	74LS11	0.27	74LS173	1.33	74S140	0.47	74C175	1.15
7438	0.24	74158	0.64	74LS12	0.27	74LS174	1.05	74S151	0.69	74C192	1.37
7439	0.29	74160	0.87	74LS14	0.32	74LS175	0.83	74S153	0.75	74C193	1.37
7440	0.19	74161	0.87	74LS15	0.27	74LS181	2.50	74S157	0.75	74C195	1.08
7441	0.88	74162	0.87	74LS20	0.27	74LS190	1.17	74S158	0.75	74C200	7.50
7442	0.48	74163	0.87	74LS21	0.27	74LS191	1.17	74S206	3.75	74C221	1.89
7443	0.69	74164	0.87	74LS22	0.27	74LS192	0.97	74S258	1.15	74C901	0.48
7444	0.69	74165	0.87	74LS26	0.32	74LS193	0.97	74S280	2.25	74C902	0.48
7445	0.69	74166	1.20	74LS27	0.27	74LS194	0.87	74S287	3.20	74C903	0.59
7446	0.69	74167	1.95	74LS30	0.27	74LS195	0.85	74S300	1.60	74C904	0.59
7447	0.62	74170	1.55	74LS32	0.32	74LS196	0.85	74S305	1.90	74C905	6.00
7448	0.69	74173	1.20	74LS37	0.32	74LS197	0.85	74S310	2.85	74C906	0.59
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7454	0.19	74177	0.78	74LS47	0.78	74LS258	0.74	74S341	4.10	74C910	6.00
7459	0.19	74179	1.80	74LS48	0.78	74LS259	1.25	74S342	1.20	74C914	1.19
7460	0.19	74180	0.69	74LS51	0.27	74LS266	0.38	74S343	4.95	74C918	1.49
7470	0.29	74181	1.95	74LS54	0.27	74LS279	0.58	74S346	1.25	74C925	7.80
7472	0.29	74182	0.79	74LS55	0.27	74LS283	0.99	74S348	4.70	74C926	7.80
7473	0.29	74184	1.95	74LS73	0.38	74LS290	0.64	74S362	2.15	74C927	7.80
7474	0.29	74185	1.95	74LS74	0.38	74LS295	0.99	74S387	4.70	74C928	7.80
7475	0.48	74188	3.25	74LS76	0.38	74LS365	0.66				
7476	0.31	74190	0.95	74LS78	0.38	74LS366	0.66	**74Cxx**			
7480	0.49	74191	0.95	74LS83	0.78	74LS367	0.66	74C00	$0.24		
7482	0.55	74192	0.80	74LS85	0.97	74LS368	0.66	74C02	0.24		
7483	0.59	74193	0.80	74LS86	0.38	74LS386	0.38	74C04	0.26		
7485	0.79	74194	0.82	74LS90	0.56	74LS390	1.69	74C08	0.25		
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4048	0.95	40175	1.15
4049	0.39	40192	1.37
4050	0.39	40193	1.37
4051	1.19	40194	1.08
4052	1.19	40195	1.08
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4071	0.22	NE565A	1.20
4073	0.22	uA709V	0.28
4075	0.22	uA710A	0.29
4076	1.29	uA711A	0.39
4077	0.59	uA723A	0.49
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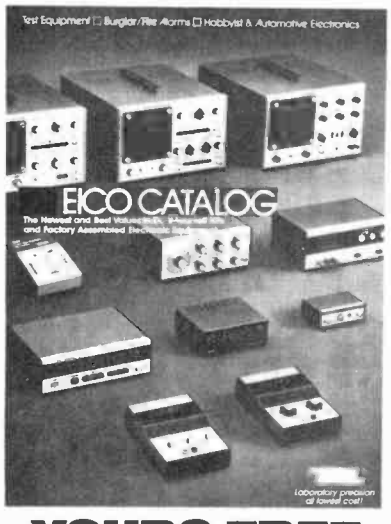

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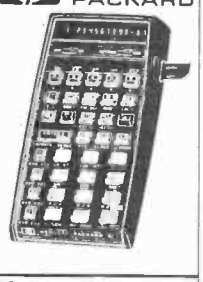

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Expandable to 256 x 192 high resolution color graphics. 6847 with all display modes computer controlled. Memory mapped. 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

Gremlin Color Video Kit $59.95
32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. Not expandable to high resolution Graphics.

Elf II Adapter Kit $24.50
Plugs into Elf II providing Super Elf 44 and 50 pin bus plus S-100 bus expansion (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

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1802/S-100 expandable to 32K, Hidden refresh w/clocks up to 4 MHz w/no wait states Addl. 16K RAM **$79.00.**

Quest Super Basic

Quest, the leader in inexpensive 1802 systems announces another first. Quest Is the first company worldwide to ship a **full size Basic** for 1802 systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range ±.17E^{38}), 32 bit integer ±2 billion; Multi dim arrays; String arrays; String manipulation; Cassette I/O, Save and load, Basic, Data and machine language programs; and over 75 Statements, Functions and Operators.

Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user programs. Cassette version in stock now. ROM versions coming soon with exchange privilege allowing some credit for cassette version.

Super Basic on Cassette $40.00

Tom Pittman's 1802 Tiny Basic Source listing now available. Find out how Tom Pittman wrote Tiny Basic and how to get the most out of it. Never offered before. $19.00

S-100 4-Slot Expansion $ 9.95

Super Monitor V1.1 Source Listing $15.00

Coming Soon: Assembler, Editor, Disassembler, DA/AD, Super Sound/Music, EPROM programmer.

RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There Is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded** with **additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, Input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95, Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95**. Expansion Cabinet with room for 4 S-100 boards **$41.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic Cassette **$10.00**, on ROM **$38.00**, original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This Is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and Is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 Is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor Is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/D Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector** set with ribbon cable is available at $15.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply).

Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

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Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Crown model SCP-71FW 3 band radio-cassette. Need schematic. John E. Beray, Box 201011, Dallas, TX 75220.

Symphonic model TPS-5050 mini TV. Need service manual or schematic diagram. A. Rozbicki, 4341 Lakeshore Rd., Kelowna B.C., Can. V1W 1W2.

RCA model AR8507 radiomarine receiver. Need schematic and parts list. Bruce Myers, 9915 Oleander Ave., Vienna, VA 22180.

B & K model 1075 television analyst. Need schematic and manual. Jack Ingwersen, 1709 Frederick Dr., Sioux Falls, SD 57105.

Collins CV-157/URR converter. Need schematic and manual. Bob Hughes, 2302 Briargrove Ct., Richmond, VA 23233.

Measurements model 62 VTVM and **Ballantine** model 314 VTVM. Need schematics and service manuals. P. Young, 16W761 White Pines, Bensenville, IL 60106.

Precision Radiation Instruments model 111 scintillation counter. Need operating manual, schematic and battery connections. Steve Rimmer, 9 Sir Kay Dr., Markham, Ontario Canada L3P 2Y9.

Belair model CDH-401 8-track FM stereo. Need schematic and service manual. Tom Houlihan, 2 Willow Road, Saugerties, NY 12477.

Akai model X-1800SD cross field recorder. Need service manual and schematic. C. A. Howlett, 3 Hickory Nut, Clover, SC 29710.

Hartman Electronics Manufacturing Co., serial No. 8965 radio receiver. Need schematic. W. R. Sherman, 4023 Justine Dr., Annandale, VA. 22003.

Heathkit W-5M power audio amplifier. Need power transformer. Charles Schmitz, 30 Thompson Ave., Croton-on-Hudson, NY 10520.

Precision model ES550B oscilloscope. Need schematic and operation manual. Thomas O. Harris, 18 Fabyan Place, Newark, NJ 07108.

Hy-Gain model 2716 mobile AM CB transceiver. Need schematic. Tom Gioitta, Box 4353, Patrick AFB, FL 32925.

Philco model 46-1209 radio phonograph (1948). Need schematic, operation manual, and information about short wave antenna requirements. Ralph Hesson, 903-A Simpson Rd., Victoria, TX 77901.

Dumont No. 702 oscilloscope. Need schematic and alignment information. T. Peterick, 4430 NW 2nd Ave., Boca Raton, FL 33432.

Grundig model SO-191-CA stereo. Need schematic diagram and tube numbers. B. B. Tingley, 210 Habitat 67, Montreal, H3C 3R6, Can.

RCA model K80 radio chassis. Need schematic and service information. Paul E. Goley, 133 Cedar Ave., Woodlynne, NJ 08107.

Toshiba model 19L-825F radio. Need owners manual. Scott Markarian, 1730 W. Dovewood, Fresno, CA 93711.

Heintz and Kaufman type 900 and type 930 receivers. Schematic diagrams needed. H. L. Chadbourne, 530 Midway St, La Jolla, CA 92037.

Hoch Manufacturing Co. earadio. Need schematic. Chuck Ermatinger, 3185 S. Grand, Apt. 206, St. Louis, MO 63116.

Estey model 101 travelorgan. Need schematic or any other information. S. Meadow, 26 Concord Rd., Danbury, CT 06810.

Dumont model 3044 oscilloscope. Need schematic and tube layout. Levi Usher, Box 313, Markham, Ontario, Can. L3P 3J8.

Harman-Kardon model 930 stereo receiver. Need schematic and any information available. Philip Dion, 5251 Taylor St., N.E., Fridley, MN 55421.

Philco model 40-216 shortwave radio. Need service manual and schematic. Patrick Malone, Yawgoo Valley Rd., Apt. 10, Slocum, RI 02877.

Heathkit model O-4 oscilloscope. Need grid screen, part No. 082. David Tunbo, 747 N. Neblett, Stephenville, TX 76401.

Hallicrafters SX 62A receiver. Need operation manual and schematic. Carl Backmen, 845 Central Park Ave., Paradise, CA 95969.

Hallicrafters model SX 122 receiver. Need schematic and manual. Douglas Graves, Rt. 4 103 Lee Lane, Georgetown, KY 40324.

Grundig model 2099 radio. Need schematic and parts list. Hector Gillis, 2672 So. 298th St., Federal Way, WA 98003.

Browning Drake model 5R receiver, serial No. P3375. Need schematic, original tube types or substitute tubes or available source. CDR R. A. Morin, MSC, USN, Naval Medical Research Inst., Bethesda, MD 20014.

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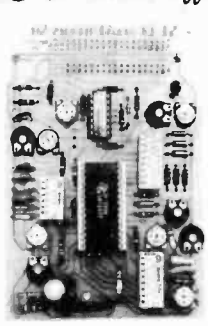

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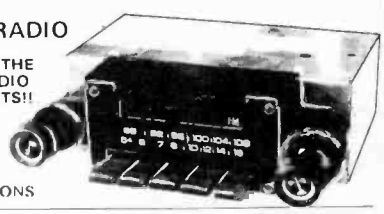

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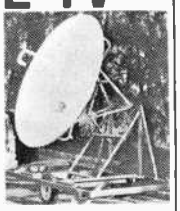

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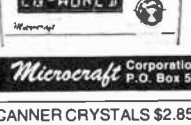

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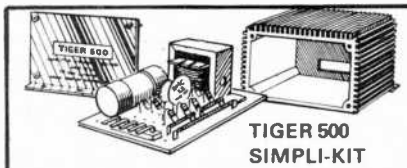

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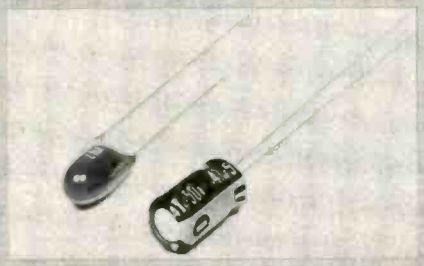
Personal Electronics News

SOFTWARE PERSONNEL are desperately needed to integrate computers with digital telecommunications equipment. This critical problem is the subject of a study called for by ITT president and chief executive Rand V. Araskog. The object is to determine the "human problems" causing the shortage. Mr. Araskog stated that this personnel shortage will grow more severe and is the most important factor limiting growth rate in the telecommunications industry. He further stated that industry must find, train, and develop personnel for the future. (Sounds like a good career opportunity.)

THE FIFTH WEST COAST COMPUTER FAIRE will be held in San Francisco's Civic Auditorium and Brooks Hall on March 14, 15, 16. More than 250 exhibitors are expected and more than 60 conference sessions are promised. University credit for a tutorial course about computers will also be offered through the University of California at Berkeley in conjunction with the Faire. Admission is $8 for preregistration through local computer stores, $10 at the door for all three days.



ULTRAMINIATURE ALUMINUM ELECTROLYTICS, comparable in size to tantalum capacitors of the same capacity, have been developed by Panasonic. The K series capacitors come in 17 values ranging from 0.1 to 100 μF and have dc ratings from 6.3 to 63 volts. Maximum length is only 7 mm (0.28"), while diameters are 4, 5, and 6.3 mm (0.157", 0.177", and 0.248"). Currently available with radial leads only, the new capacitors are priced to start at less than 10¢ in production lots.

A $500 VIDEO-DISK PLAYER from RCA can successfully compete with existing players and video recorders, according to some of RCA's largest dealers, but a higher-priced player could not. Opinion is divided, however, on just how successful a $500 player can be. Some dealers see it as a "hot" item, while others feel it will receive a lukewarm reception from the buying public. Cost of disks to play on the RCA system is also seen to be a major factor in determining the company's product success. The feeling is that the disks should sell for $6 to $15. If they should sell for much more than $15, the price might undermine the system's success.

NEW COMPUTER NOISE STANDARDS may force some home computer manufacturers to redesign their products. The new FCC standards, which go into effect July 1, specify a maximum of 100 microvolts/meter radiation at a 3-meter distance. So far, Apple, Radio Shack, and Heath have indicated that their personal computers would have to be modified to meet the interference potential standards. Texas Instruments' 99/4 and Commodore's Pet 2000 computers already met the new specs. Atari did not submit its computers to the FCC because its Models 400 and 800 had both met Class I TV device type-approval standards. Note, though, that a petition of reconsideration could possibly cause the rule adoption to be suspended.

NEW-STYLE AUTO RADIOS are highly popular with motorists, according to research sponsored by Ford Motor Co. The study sampled owner reaction to Ford's electronic search AM/FM-stereo radio with 8-track tape player introduced in the 1979 model year. Queried were 300 Continental Mark V and Lincoln Continental owners, half with the new radios and half with traditional equipment. Satisfaction with the new radio and its features was high, with 84% of the owners completely or very satisfied, compared to 79% satisfied with traditional radios. Strong preference was shown for digital frequency display, slide controls, and rocker switches in the new models; among best-liked features were seek-and-scan functions and touch control. Ninety-one percent of owners of the new radio said they would buy it again.

"TALKING" MICROWAVE OVEN from Quasar contains a voice synthesizer that "speaks" to the user during various cooking operations. Typical synthesized announcements include food temperature, remaining cooking time, and a call to enjoy a hearty repast when ready.

no loose ends

Computer, floppy, smart terminal, 16K RAM. $1595*

H89 All-In-One Computer

Heath takes the risk out of selecting a balanced computer system. Now, video terminal, floppy, keyboard and 8-bit computer are brought together in one self-contained, compact unit. Nothing hangs out.

Two Z80's

The personal computer has never been simpler. Or smarter. Two Z80 microprocessors mean terminal never shares power with computer, as do most desk-top units. So this terminal is capable of a multitude of high-speed functions, all controllable by keyboard or software.

100K bytes storage

Built-in floppy disk system gives you fast access to programs and data. Each 5¼-inch diskette has 100K bytes of storage area, enough to hold entire files. The All-In-One comes with 16K RAM, expandable to 48K.

Innovative software

The All-In-One Computer runs programs written in MICROSOFT™ BASIC™ and Assembly Languages. And it accepts all current software written for the popular Heathkit H8 Computer, including scores of practical programs for home and business.

Learn by building

What better way to learn about computers than to build one yourself? Like all Heath electronic kits, it comes to you with its own easy-to-follow assembly manual and a nationwide network of service centers to assure smooth sailing.

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*$1195 without floppy. Mail order kit price, F.O.B. Benton Harbor, MI. Heathkit Products are also sold and serviced at Heathkit Electronic Centers (Units of Veritechnology Electronics Corporation) in major cities throughout the U.S. See your white pages. Prices subject to change without notice.

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CP-178

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In one year our K40™ antenna has become the largest selling CB antenna in the world!

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And when you pay more, you expect more!

MORE PERFORMANCE: The K40 is guaranteed to transmit further or receive clearer than any antenna it replaces. We know it will. We've tested it with 771 CB'ers just like you for one year.

MORE FLEXIBILITY: You can fit your K40 to any mounting surface. It will fit any vehicle you'll ever own! That includes choppers, dune buggies, gutters, mirror mounts, luggage racks, trunks, hatchbacks, through roofs, semis, pick ups and RV's.

MORE QUALITY: It's not imported. It's not made in Taiwan, Korea or Japan. It's American made in an American town. It's made with better materials that cost more and by professional people we pay more. And we designed it right here in the U.S.A.

*Including optional mounts at extra cost.

2. It's made better...

3. It's proven best!

...Here's what the leading CB publications said.

CB TIMES: "... it's not often that a product bursts onto the market scene, dominates and improves CB'ing for everyone. American Antenna and the K40 are doing it—repeated tests showed the K40 could out-perform the major competitive brands."

RADIO ELECTRONICS: "The results of our tests showed that, in three different positions of the monitoring receiver, the *model K40* equaled or out-performed the competitive antenna. Apparently, American Antenna's advertising is not merely Madison Avenue showmanship."

PERSONAL COMMUNICATIONS: "... an impressive 95% of the trials, the K40 out-performed the existing mobile antennas. We had to try one for ourselves.
"... in every case, the K40 either equaled or out-performed its competitor.
"No ifs, ands, or buts! The K40 Antenna from American Antenna would have to be just about the best antenna around.

CB MAGAZINE: "Introduced in October, 1977, the K40 quickly became the top seller and in mid 1978, became the number one selling antenna in the nation."

...Here's what CB'ers all across the country said.

ANTENNA SPECIALISTS: "... truck driver and CB'er for 10 years ... 50% further than my M410 'Big Momma'."
—J.H. Collett, 207 McFee, Bastrop, LA

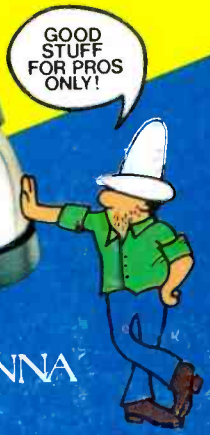
AVANTI: "I'm an electronic technician with a Second Class FCC license ... I was able to transmit 70% further and tune the SWR 75% lower than my Avanti."
—H.R. Castro, VRB, Monserrante D-67, Salinas, Puerto Rico

PAL: "... 20% better in transmission and reception than my 5/8 wave Pal Firestik."
—John A. Blum, Box 446, Zelienople, PA

SHAKESPEARE: "... I've been a CB'er for three years and the K40 is the best I've ever had. Better in reception and transmission than my Shakespeare."
—H. Bachert, Jr., 15 King Rd., Park Ridge, NJ

HUSTLER: "Compared to my Hustler XBLT-4, the K40 can consistently transmit 40% further and the reception was better. The K40 is the perfect way to complete a CB system."
—Jerome R. Brown, 7800 S. Linder, Burbank, IL

...This Antenna is so DYNAMITE you receive a ...



DOUBLE GUARANTEE

GUARANTEE I: The K-40 will transmit farther and receive more clearly than the antenna it replaces or the customer will receive a prompt and full refund from the Registered K-40 Dealer who installed and tuned it.

GUARANTEE II: Unconditionally guaranteed for 12 months. Guaranteed against cracking, chipping, or rusting. Guaranteed against mechanical failure. Guaranteed against electrical failure. Guaranteed against accidental breakage. No exclusions. No gimmicks. For a full 12 months.

(SPECIAL NOTE) IF YOU'RE A BEGINNER:

Our K40 Dealers will be happy to sell you any of the older style and less expensive antennas that are great bargains for any beginning CB'er.

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K40 POWER!

...Sold exclusively by 3500 American K40 Dealers throughout the U.S. & Canada.

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