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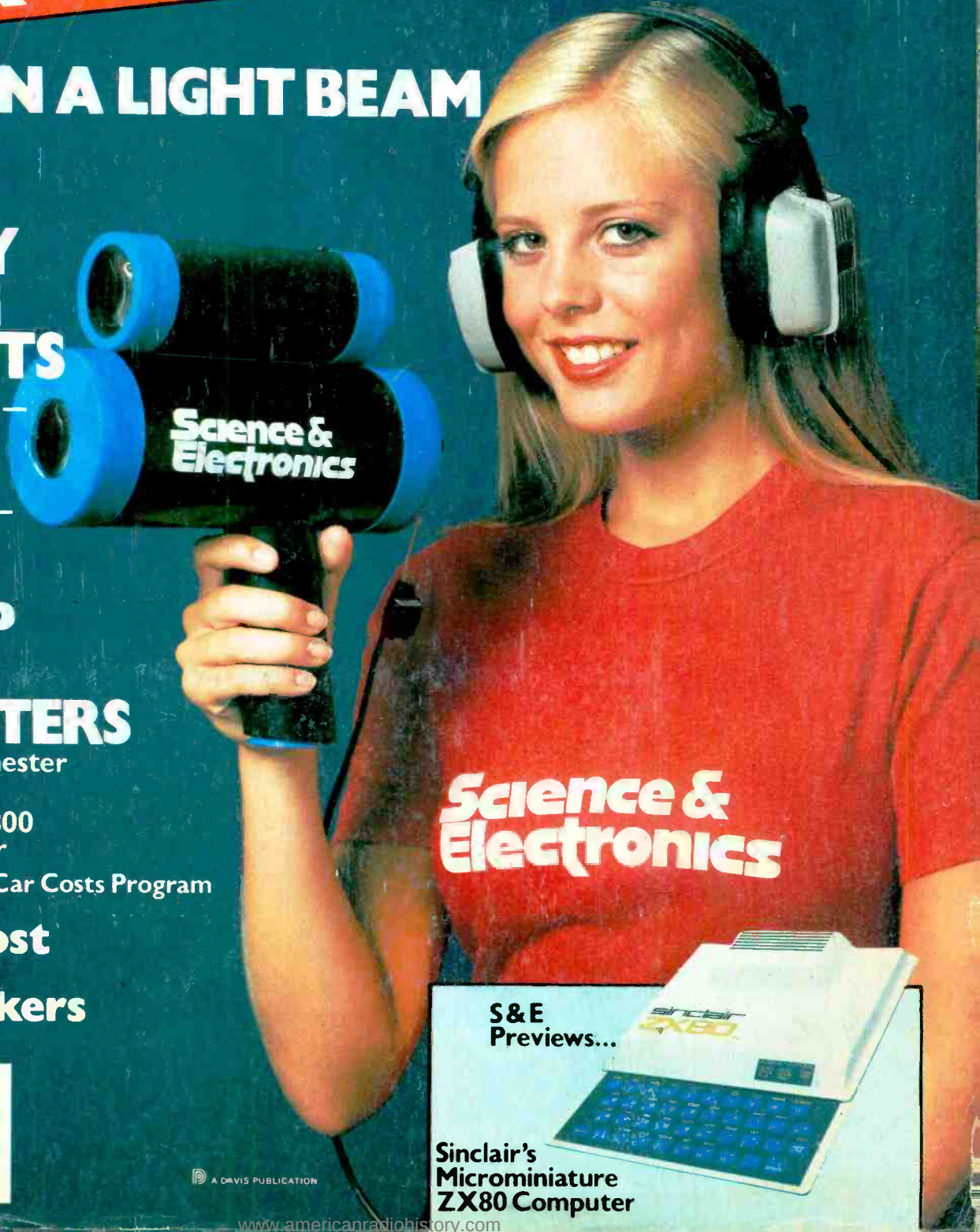

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A DAVIS PUBLICATION

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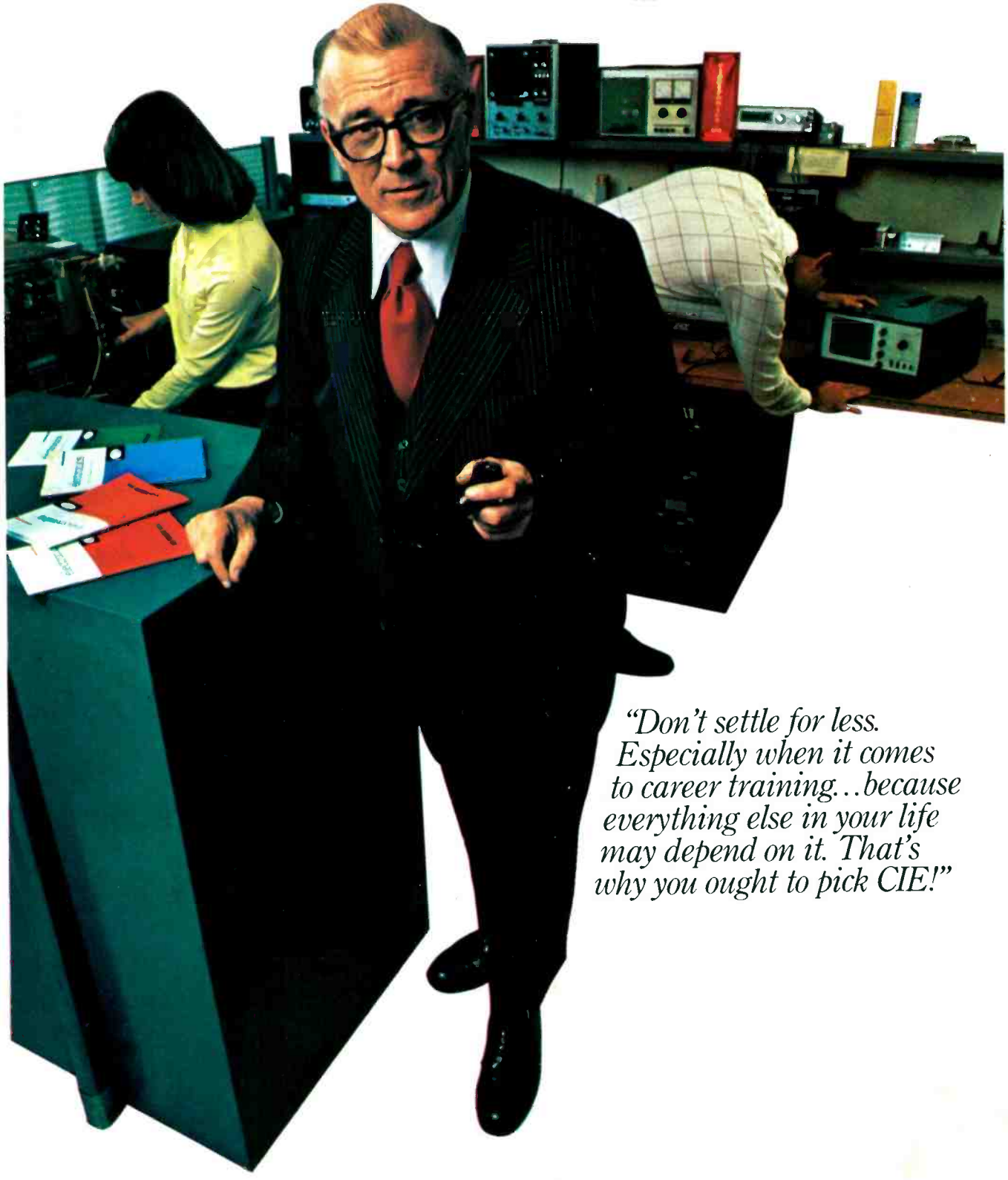

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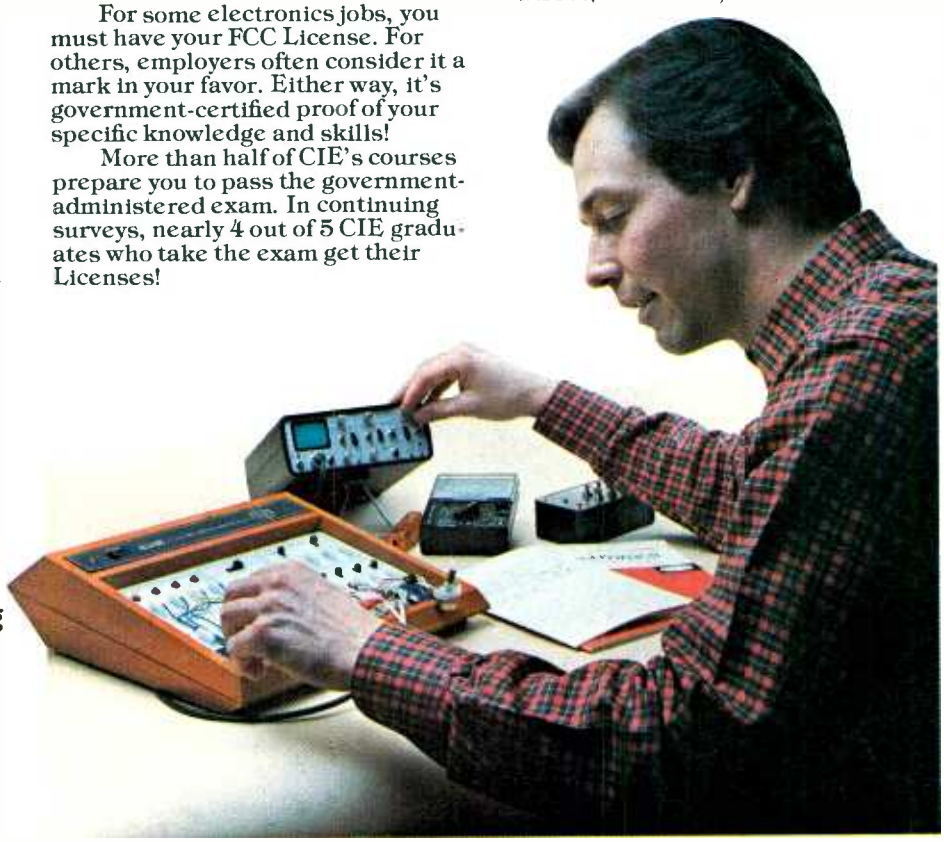

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November/December 1980
Volume 20, No. 6

Science & Electronics

☆ Cover Stories

ABC

MPA

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ISSN: 0013-595X

ELEMENTARY ELECTRONICS / SCIENCE AND ELECTRONICS is published bi-monthly by Davis Publications, Inc. Editorial and Executive offices: 380 Lexington Ave., New York, NY 10017; all subscription orders and mail regarding subscriptions should be sent to P.O. Box 2630, Greenwich, CT 06835. In U.S.A. and possessions, one-year subscription (six issues) $6.95; two-year subscription (12 issues) $12.95; three years (18 issues) $18.95; and four years $23.95. Elsewhere, add $1.00 postage for each year. For change of address, please advise 6 to 8 weeks before moving. Send us your current mailing label with new address. Advertising offices: East Coast; 380 Lexington Ave., New York, N.Y. 10017, 212-557-9100; Midwest; 360 N. Michigan, Suite 1022, Chicago, IL 60601, 312-527-0330; West Coast; J. E. Publishers' Rep. Co., 8732 Sunset Blvd., Los Angeles, CA 90069, 213-659-3810. Controlled Circulation. Postage paid at New York, New York, and Sparta, Illinois.

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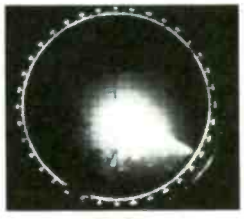

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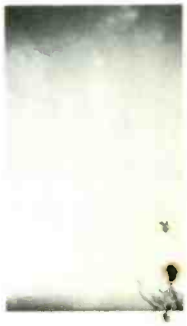

Direction Finders, Loran

No other home-study course gives you such complete, professional training in so many fields of communication. No other gives you the actual bench training with kits and demonstration units specially designed for learning. Only NRI gives you the thorough preparation and training you need to achieve professional competence in the wide world of communications.

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NRI training is "hands-on" training. You get honest bench experience as you build and test this industrial-quality two-way radio and power supply. You reinforce theory lessons as you induce and correct faults, study individual circuits and learn how they interface with others. Or, at your option, you can train with a fully-assembled forty-channel mobile CB and base-station power supply converter.

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NEW PRODUCTS PARADE

SHOWCASE OF NEW PRODUCTS

Adding Floppies

A floppy disk accessory for the Heathkit H89 All-In-One Computer, the H-77 Floppy Disk System, provides all the storage and programming capacity needed for most computer applications. When the H-77 is used with the H89, room is provided for up to three floppy disk drives. Operating system and program disks can be run at the same time for fast and efficient access to programs and data. The H-77 uses standard 5.25-in., hard sectored 40-track diskettes. Each diskette is capable of storing 100K bytes of data. The well-known and reliable SIEMENS 82 disk drive system is used in the H-77. This drive provides reliable high-speed access to data. Typical random sector access time is less than 250 milliseconds. The H-77 Floopy Disk System, mail order priced at $595.00, includes one disk drive. A handy diskette storage accessory fits into the space reserved for the second drive. The H-17-1 Disk Drive,

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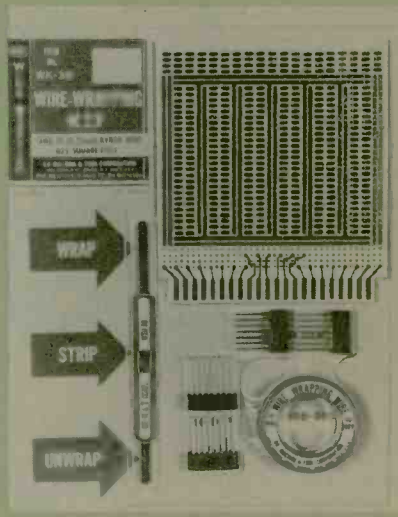
priced at $325.00, is available to provide two-drive capability for the H-77, giving the H89 a total of three drives including the drive built into the computer itself. The factory assembled and tested WH-87 Floppy Disk System, priced at $1195.00, includes two drives. The H-88-6 Adapter kit, mail order priced at $50.00, is required to install the WH-87. (All prices F.O.B. Benton Harbor, MI). For more information on the new H-77 Floppy Disk System. send for a free catalog to Heath Company, Dept. 570-510, Benton Harbor, MI 49022.

Ready for Your Project

A New Wire Wrapping Kit from OK Machine and Tool Corp. features selected items of value to the prototype engineer and hobbyist alike. The kit includes a unique new wire wrapping tool, a 50-ft. (15m) roll of wire wrapping wire, two 14-pin DIP Sockets and two 16-pin DIP Sockets. Specially



CIRCLE 37 ON READER SERVICE COUPON

featured is a new high quality PC Board, Model H-PCB-1, which has 22/22 edge connector contacts on standard .156 spacing. The tool, model WSU-30 is a combination tool that wraps and unwraps 30 AWG (0.25mm) wire on .025-in. (0.63mm) square pins, plus strips 30 AWG wire using handy built-in stripper. The wire is top quality Kynar insulated silver plated copper. The DIP Sockets are for plug-in packaging of integrated circuits

(Continued on page 11)

AMERICA'S, MOST SOPHISTICATED SCANNER IS ALSO THE EASIEST TO PROGRAM SCANNER.

Presenting the Bearcat® 300 Scanner with Service Search.

It's like having a frequency directory already pre-programmed in your set—to let you tune in all the action at the touch of a button.

The incredible, 50 channel Bearcat 300 Scanner with Service Search is another first in scanner innovation. Another triumph in synthesized spaceage technology. Another first from the leader in real excitement.

Over 2100 active frequencies are pre-programmed into the Bearcat 300 Scanner memory bank. These frequencies are arranged in eleven service categories, as allocated by the F.C.C.

Simply push the police service button, for example. You'll search and find only the frequencies allocated to police—and be able to monitor every local, active frequency. Then they are programmed into the normal scan operation via keyboard entry.

It's that easy. That automatic for every service category—fire, marine, HAM, emergency, air, etc. It's truly like having a frequency directory already pre-programmed in your set.

The 50-channel Bearcat 300 Scanner brings you every feature you've ever wanted, and then some. 7-band coverage. AM/aircraft and FM. Patented Track Tuning. Automatic squelch. Priority. Automatic lockout. Activity count. Selective scan delay. Direct channel access. Digital display, and a lot, lot more—even a digital clock, and mountings for mobile operation.

The Bearcat 300 Scanner. Possibly the ultimate Scanner. Certainly the most automatic, easiest to use Scanner ever.

Now that's real excitement.

CIRCLE 6 ON READER SERVICE COUPON

SCANNER TIPS

MONITOR THE AIRWAVES

BY ROBERT GROVE

Multi-Frequency Transmissions

While listening to low band on my scanner, I sometimes hear a woman's voice give the call letters "KCA712 Boston" on several frequencies at once, usually repeated every half hour. Can someone explain these transmissions?

—R.L.W., Stoneham, MA

The FCC requires licensees of two-way radio stations to announce their call-signs on a periodic basis. In your example, KCA712 is licensed to the Massachusetts Bay Transit Authority on 44.46 MHz. The fact that you are hearing it at several places at once on your scanner may be attributed to two possible causes: you may be located close enough to one of their 500 watt transmitters for your scanner to be overloaded by the signal; or you may be experiencing "intermodulation," whereby their signal is "mixing" with other local signals, producing spurious emissions on other frequencies which are received by your scanner.

That Fourth Decimal Place

Many frequencies I would like to hear on VHF high band and UHF are listed as having four decimal places (163.4125, etc.); programmable scanners only accept 3 decimal places. What gives?

—D.C., Portland, ME

When you enter 163.4125 into a programmable scanner, the circuitry will automatically round off your entry to the nearest 5 kHz (163.410 or 163.415 MHz) Since this is only 2.5 kHz away from the actual transmitting frequency, it is totally within the "passband" (receivable channel width) of any scanning receiver.

Code Words

While listening to our local ambulance service on 155.400 MHz, I hear them use coded expressions like "C code," "R code," and so on. What do they mean?

—B.G.F., Hallowell, MN

Most agencies use some type of encoding for voice transmissions. This is done for two reasons: privacy and speed.

SCANNER TIPS is edited from questions submitted to Columnist Robert Grove and answered by the Technical Advisor Corps of the Scanner Association of North America (SCAN). To get your scanner questions answered, write to Science & Electronics, 380 Lexington Ave., New York, NY 10017. If you would like more information about SCAN, write to them at Suite 1212, 111 East Wacker Drive, Chicago, IL 60601. ■

NEW PRODUCTS PARADE

(Continued from page 8)

and feature gold plated 3-level wire wrapping pins .025 inches (0.63mm) square on .100 inch (2.54mm) centers. Available complete in one kit, Model WK-3B, for $16.95 at your local electronics outlet or directly from OK Machine and Tool Corp., 3455 Conner Street, Bronx, NY 10475.

Solid-State Kilowatt Linear

Ten-Tec offers amateur radio their Model 444 "Hercules" 1-kW linear amplifier—the first solid-state unit with instant break-in. Absolutely no tuning is required—in fact, there are no tuning knobs! The sleek front panel of the amplifier has just four switches: power, mode, meter, and band.

CIRCLE 40 ON READER SERVICE COUPON

And if you have a Ten-Tec Omni transceiver, the Omni will change bands of the amplifier automatically from the Omni band switch by means of a motor driven stepping switch. Behind the 444's black-out upper panel are two large meters which light up when AC power is turned on. One meter measures collector current, the other measures collector voltage or power (forward or reverse). Also on the black upper panel are six status indicators with LEDs that light up to show a condition (overdrive, improper control switch setting, heat sink temperature, SWR, overvoltage/overcurrent and RF output balance). Any of these conditions will shut down the amplifier when set limits are exceeded. The design of the 444 Hercules uses two 500-watt push-pull transistor amplifier modules, operating at 45 VDC at 22.2 A, providing typically 600 watts RF output from the hybrid output combiner. Driving power required is 50 watts, typical. Frequency coverage is 1.8 MHz through 21.5 Mhz with provision for four auxiliary bands. Both input and output impedances are 50 ohms. unbal-

NEW PRODUCTS PARADE

(Continued from page 11)

anced. Priced at $1575. For further information, write or call Ten/Tec, Inc., Highway 411 East, Sevierville, TN 37862.

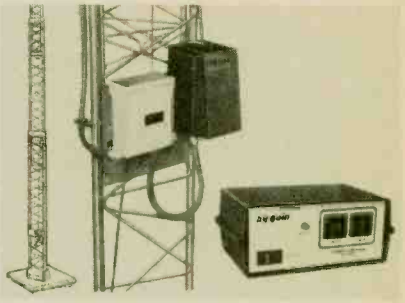
Low-Priced Satellite TV Receiver

The TV-4300 Satellite Receiver is now available from International Crystal Manufacturing Company. This new receiver, which sells for only $995.00, offers high performance on all channels within the 3.7 to 4.2 GHz band. Standard dual audio output is provided at 6.2 and 6.8 GHz, with other outputs available. The TV-4300 is a fully packaged and assembled receiver complete with built-in LNA power supply, built-in AFC, tuner, control circuitry and power cable. All output levels are compatible with video monitor and VTR input. There are several options including a remote tuning control and selectable audio with stereo output. For more information write International Crystal Manufacturing Company, 10 North Lee, Oklahoma City, OK 73102.

CIRCLE 42 ON READER SERVICE COUPON

Tower of Strength

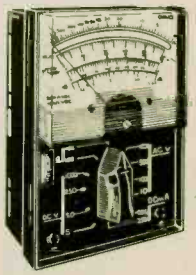
The HG-70HD, a 70 foot (21.3 m) self-supporting crank-up tower, is the tallest of seven towers now offered by Telex/Hy-Gain. The tower is all steel, and comes in four sections. The heavy—duty tower was designed for antenna loads of up to 16 sq. feet (1.5 sq. m) in winds of up to 60 mph (96.6 kmph). The top section is predrilled for thrust bearing bolts, and a rotor mounting plate is inmluded. The HG-70HD sells for $2,850. Hy-Gain has also developed an electric winch system, Model No. HG-EW, that fits the new HG-70HD. The winch control box can be locked, which secures the tower in either the extended or retracted position. A manual crank takes over in the event of an electrical power failure. The HG-EW is equipped with an automatic brake which is always in positive engagement when the winch is not operating. Priced at $650. This winch system can be converted to remote control operation by adding the new Hy-Gain tower control (HG-EWRC) which has been specifically designed as a modular addition to the HG-EW winch. This remote control unit allows the operator to conveniently raise and lower the tower from a remote location such as a ham shack. Both the winch and the remote control are available for 110 and 220 volt operation. Sells for $650. For further information regarding these products, write to Hy-Gain, Division of Telex Communications, Inc., 8601 Northeast Highway Six, Lincoln, NE 68505.



CIRCLE 38 ON READER SERVICE COUPON

Handy Multimeter

Olson's 20,000 ohms/volt Multitester Model TE-424 fits conveniently in a tool case or is handy size for bench use. Easy-view meter has color coded scales for greater accuracy with pop-out stand to keep meter upright when in use. Operating ranges are AC/DC volts from 0-10-250 and 1000; DC current 0-250 ma; Resistance 0-1,000,000 ohms. Unit includes battery and test leads. Available at $12.98 from Olson Electronics, Akron, Ohio 44327. ■



CIRCLE 45 ON READER SERVICE COUPON

The first personal computer for under $200.

The Sinclair ZX80. A complete computer—only $199.95 *plus $5.00 shipping.*

Now, for just $199.95, you can get a complete, powerful, full-function computer, matching or surpassing other personal computers costing several times more.

It's the Sinclair ZX80, the computer that independent tests prove is faster than all previous personal computers. The computer that "Personal Computer World" gave 5 stars for 'excellent value.'

The ZX80 cuts away computer jargon and mystique. It takes you straight into BASIC, the most common, easy-to-use computer language.

You simply take it out of the box, connect it to your TV, and turn it on. And if you want, you can use an ordinary cassette recorder to store programs. With the manual in your hand, you'll be running programs in an hour. Within a week, you'll be writing complex programs with confidence.

All for under $200.

Sophisticated design makes the ZX80 easy to learn, easy to use.

We've packed the conventional computer onto fewer, more powerful LSI chips—including the Z80A microprocessor, the faster version of the famous Z80. This makes the ZX80 the world's first truly portable computer (6½" x 8½" x 1½" and a mere 12 oz.). The ZX80 also features a touch sensitive, wipe-clean keyboard and a 32-character by 24-line display.

Yet, with all this power, the ZX80 is easy to use, even for beginners.

Your course in computing.

The ZX80 comes complete with its own 128-page guide to computing. The manual is perfect for both novice and expert. For every chapter of theory, there's a chapter of practice. So you learn by doing—not just by reading. It makes learning easy, exciting and enjoyable.

The ZX80's advanced design features.

Sinclair's 4K integer BASIC has performance features you'd expect only on much larger and more expensive computers. These include:

- Unique 'one touch' entry. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry and are stored as a single character to reduce typing and save memory space.
- Automatic error detection. A cursor identifies errors immediately to prevent entering programs with faults.
- Powerful text editing facilities.
- Also programmable in machine code.
- Excellent string handling capability—up to 26 string variables of any length.
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- Built-in random number generator for games and simulations.

Sinclair's BASIC places no arbitrary restrictions on you—with many other flexible features, such as variable names of any length.

And the computer that can do so much for you now will do even more in the future. Options will include expansion of 1K user memory to 16K, a plug-in 8K floating-point BASIC chip, applications software, and other peripherals.

Order your ZX80 now!

The ZX80 is available only by mail from Sinclair, a leading manufacturer of consumer electronics worldwide. We've already sold tens of thousands of units in Europe, so demand will be great.

To order by mail, use the coupon below. But for fastest delivery, order by phone and charge to your Master Charge or VISA. The ZX80 is backed by a 30-day money-back guarantee, a 90-day limited warranty with a national service-by-mail facility, and extended service contracts are available for a minimal charge.

Price includes TV and cassette connectors, AC adaptor, and 128-page manual.

All you need to use your ZX80 is a standard TV (color or black and white). The ZX80 comes complete with connectors that easily hook up to the antenna terminals of your TV. Also included is a connector for a portable cassette recorder, if you choose to store programs. (You use an ordinary blank cassette.)

The ZX80 is a family learning aid. Children 10 and above will quickly understand the principles of computing—and have fun learning.

Phone orders: (203) 265-9171. Mon.-Fri. 8 AM-6 PM EST. We'll deduct the cost of the call from your invoice. (For technical information, call (617) 367-2555, Mon.-Fri. 9 AM-5 PM EST.)

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Name _____

Address _____

City _____ State _____ Zip _____

Occupation: _____ Age: _____

Intended use of ZX80: _____

Have you ever used a computer? ☐ Yes ☐ No.

Do you own another personal computer? ☐ Yes ☐ No. *For Conn. deliveries, add 7% sales tax.

SE-11-0

SCIENCE NEWS

PROGRESS IN ELECTRONICS

Mailgram Via TRS-80

Radio Shack's TRS-80 Model I Microcomputer System will soon have the added versatility of being able to originate Mailgram messages when used with Radio Shack's new TRS-80 Mailgram software. Mailgram service, developed jointly by Western Union and the U.S. Postal Service, makes it possible to send a message electronically to the post office nearest an addressee anywhere in the United States (including Alaska and Hawaii) or Canada for delivery with the next business day's mail.

The new TRS-80 software application will allow small businesses to utilize electronic mail for customer relations, sales, administration and personnel, credit and collection, purchasing and expediting orders and much more.

Radio Shack Computer Division vice president Jon A. Shirley (l), and W. E. Thompson, Western Union's Dallas area vice president, look on as J. Michael Grubbs, operations manager for Radio Shack's computer applications department, demonstrates the use of the TRS-80 Microcomputer System to originate Mailgram messages.

Along with the new software package, the minimum system required to originate a Mailgram message is the TRS-80 Level II 16K Model I Microcomputer System with either cassette recorder or disk drive, an expansion interface, RS-232C serial interface board and the Telephone Interface II. An optional printer may be included if hard copy printouts of messages are desired.

Once the user has established an account with Western Union Electronic Mail, Inc., McLean, Virginia, a subsidiary of the Western Union Corporation, the TRS-80—plus Radio Shack's new software package—can be used on-line through the McLean facility as a word processor to compose letters for transmittal as Mailgram messages, or to transmit previously stored message texts. The user is billed by Western Union Electronic Mail, Inc. for the actual Mailgram messages sent each month.

Western Union Electronic Mail, Inc.'s Stored Mailgram service provides computer storage of a customer's frequently used letter texts, key paragraphs, mailing lists and sender names and titles for transmittal as Mailgram messages when required by the customer.

The rates for stored Mailgram service vary, depending on whether stored lists, stored texts or all non-stored information is involved. TRS-80 users will enjoy lower rates than those available to the general public. Additionally, these low rates can be reduced even further depending on volume of Mailgram messages.

Through the use of an identification number and special toll-free number, the TRS-80 user can access McLean to originate a Mailgram message which, in combination with previously stored texts or addresses, can be transmitted for delivery with the next business day's mail.

In addition, the TRS-80 need not be dedicated to originating Mailgram messages alone, but may be used for other functions.

Red Balling Data

Research scientists here have demonstrated a novel way of transmitting computer data without wires in an enclosed environment—by broadcasting on infrared wavelengths.

The experimental work, performed by IBM scientists, may prove useful for the increasing number of computer systems that employ small local terminals performing individualized tasks, such as sorting checks, controlling movement of inventory, supervising the activities of industrial robots, etc. Wireless data transmission may prove to be especially suitable in large offices and factory floor or warehouse environments. *(Continued on page 18)*

Announcing the FREE Heathkit Christmas catalog

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- **Digital Wind Computer** – a digital display computer that fits on any small corner of a desk or credence. It shows wind direction, speed – even remembers peak wind gusts!
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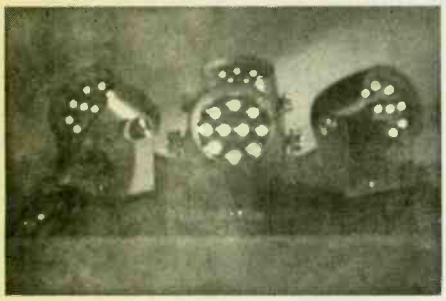
CIRCLE 27 ON READER SERVICE COUPON

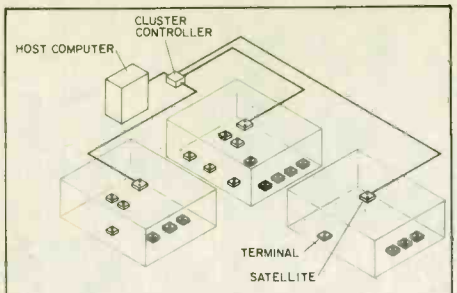
SCIENCE NEWS

Radio waves also could be used for wireless data transmission, but infrared waves—which occupy a different part of the electromagnetic spectrum—are not susceptible to electronic interference, and are more easily confined to a desired area.



This photograph, taken in infrared light, shows clusters of circular light-emitting diodes (LEDs) radiating in the infrared portion of the spectrum. The infrared data communications system envisioned by IBM scientists would use LEDs for transmitting the infrared signal, and photodiodes for receiving.

The IBM Research experiments were conducted at the company's Zurich Research Laboratory with a 64,000 bit per second infrared transmitter and receiver using carrier modulation.



IBM Research scientists here have demonstrated a novel way of transmitting computer data without wires in an enclosed environment—by broadcasting on infrared wavelengths. This drawing illustrates a hypothetical way in which the experimental infrared data communications system might operate to interconnect a cluster of terminals to a common cluster controller. Each terminal is equipped with a light-emitting diode (LED) and a photodiode for converting an electronic signal to one in infrared light, and vice versa.

The IBM scientists visualize an infrared data communications system this way: each terminal on the floor of the working area would be equipped with light-emitting diodes (LEDs), for sending the infrared signal, and photodiodes for receiving.

LEDs are cheap, small devices (used in digital display watches, for example) that, with proper filters, can be made to emit most of their light in the infrared spectrum. The wavelengths are in what is known technically as the "near infrared" part of the spectrum, close to the range of visible light. Wavelengths in the rest of the infrared region are sensed as heat, and would not be suitable for communications.

A central infrared station, installed in the ceiling of the room, would be the main control point for all the terminals. The station would poll each terminal in turn, asking, in effect, "Do you have any new data for me?" and the terminal would reply on a different frequency.

Terminals today are usually connected by copper coaxial cables to the host computer, or to a central controller that communicates with the computer over phone lines if the computer is somewhere else.

This means that every time you want to install a new terminal, you have to run a new cable; or even if if you just want to move around the terminals you've got, the wiring has to be redone. The cost of stringing wire is expensive because of the labor involved in putting the wire into place.

The experiments with the system have been performed under a variety of simulated interference conditions. For example, transmission took place successfully in the midst of arc welding, a powerful source not only of electrical static, but of heat as well, which might have been expected to disrupt the infrared system.

Automatic Police May Day

Most people are aware of this country's growing criminal violence, but not many realize how much of the violence is increasingly directed at the police. The statistics are so alarming that when the staff of ABC's "Good Morning, America" recently heard about a revolutionary new device to increase the police officer's safety, they wasted no time in putting the story on the air. The device is called the Rescu Emergency Location Alerting System.

"Good Morning, America" taped the story in Bedford, Ohio where the Police Department there is now evaluating the Rescu system. Basically,

(Continued on page 20)

ITEM NO.
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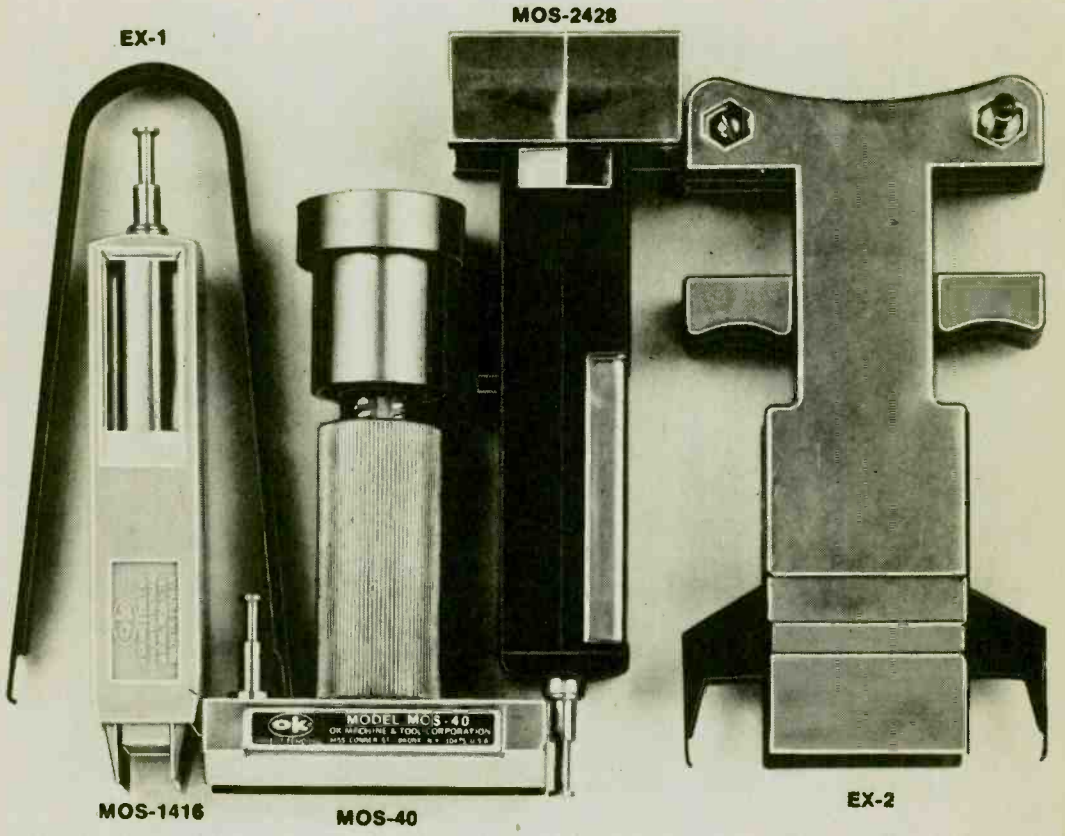

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CIRCLE 12 ON READER SERVICE COUPON

SCIENCE NEWS

the Rescu system is simple. The officer radios ID, location, and brief situation report before leaving the patrol vehicle, which is standard procedure. This "last location" voice message is stored in a small solid-state trunk-mounted Rescu unit connected to the 2-way radio. If the officer encounters a problem after leaving the vehicle and needs help, he triggers a small belt-carried remote actuator which sends a silent, coded signal back to the patrol vehicle. This keys the 2-way mobile radio and transmits the previously recorded Rescu location message along with an emergency "May Day" beep tone. Now the dispatcher and all the other mobile units on the channel immediately know an officer is in trouble, and, more important, where! Back-up can be on the way in less than 30 seconds.

The Rescu unit on the patrolman's belt gives no indication as to its purpose. Once activated, it flashes a signal to the patrol car initiating a repeat of the last transmitted signal with an added beep.

The Rescu system will also trigger automatically if the officer falls or lies prone for any reason whatever—ambush, accident, a fall, or even a medical emergency.

A number of law enforcement agencies across the country are presently evaluating the Rescu system. Results so far indicate that it has significant potential to improve emergency response capability and increase the officer's sense of security, and safety.

An interesting note to this story is that the Antenna Specialists Co., a leader in CB radio products for 22 years, holds the responsibility for the development, manufacturer and marketing of the Rescu system. Their experience in two-way radio communications will be used to save the lives of those who protect us. Who said CB never grew up?

Squirrels Climb and Cars Race

Its always difficult to teach a two-year-old to speak properly, but when the two-year-old is almost completely deaf, the task can seem impossible.

That was the situation the parents of Chad Wojciechowsky were faced with. Chad, a bright, alert two-year-old, lost almost all his hearing due to a virus when he was eight months old. "We made a decision early on that we would do everything possible to encourage Chad to use his voice," Anne Wojciechowsky, Chad's mother, explained. "From his infant days, we know he has a voice and feel that with proper training, he can be taught to speak."

And the tan car moves ahead . . . as two-year-old Chad plays with his new race car set given to him by the Telephone Pioneers organization. When Chad speaks into the microphone, the cars race around the track. When he is silent, the cars stand still.

Chad's problem came to the attention of the Telephone Pioneers organization at Western Electric's Reading (PA) Works, where Chad's father, Tony, works. Telephone Pioneers are long-service Bell System employees involved in a variety of social and community service activities. Thanks to the work of the Pioneers, Chad was presented with a race car set designed to make any two-year-old—and especially Chad—squeal with delight.

Bob Sels, one of the WE engineers involved in the project, explained that they got the original design for a toy like this from another Telephone Pioneer group in Jackson, MS. The group down there was approached by the Magnolia School for the Deaf which teaches children with needs similar to Chad's. Their mechanism was a toy animal, which, when activated, climbed a pole. ■

- Spring-loaded, pure brass coil contact pin assures solid, corrosion-free cable connection.
- Exclusive screw-in antenna cable connector (patent no. 4,090,030) provides simple, low loss solderless connection.
- Weather resistant Noryl coil cover is impervious to the elements. Outlasts others, even in salt spray areas. Holds like-new appearance longer.
- Base plate triple chrome plated for corrosion-free, attractive appearance.
- Double thick trunk lip bracket will not break.
- Entire antenna is at d.c. ground for super, low noise reception.

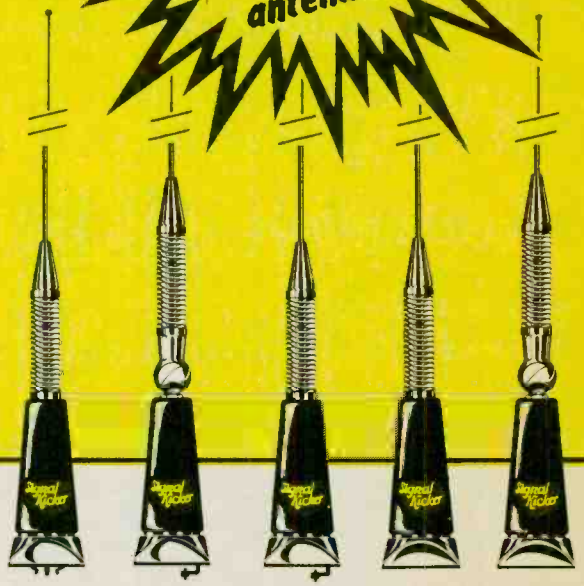
- Three grippers adapt mount to any hole 3/8 to 3/4 inch in diameter

Exclusive roof top mount (patent no. 3,492,769) allows quick, solid mounting on vehicle surface.

Look at these extras not found in other antennas!

Turner outperforms others on the four most important factors: power, performance, quality and engineering. When choosing your next CB antenna - check us out.

- ✓ **500 watt power capacity**
- ✓ **1.1:1 SWR**
- ✓ **Built to last**
- ✓ **Easy to install**



SK110 Roof	**SK210** Trunk lip	**SK211** Trunk lip with swivel	**SK260C** Combo. trunk & roof	**SK261C** Combo. trunk & roof with swivel

Turner Base Loaded Antennas are available in five different models including swivel ball models for slant backs. Convenient combination mount models include mounting brackets for both trunk lip and roof mount in one antenna.

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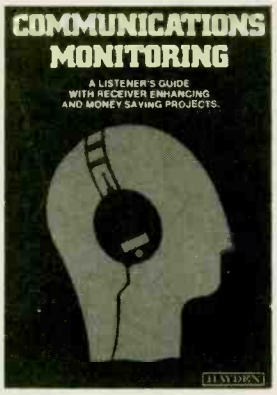
COVER TO COVER

YOUR ELECTRONIC BOOKSHELF

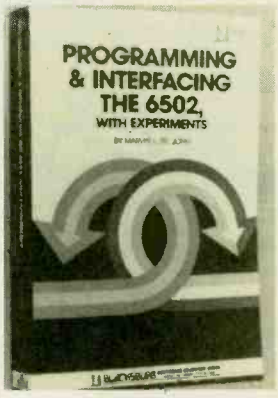
Tune in the Guys! For the reader with a hobby interest in radio, *Communications Monitoring* by Robert B. Grove provides a thorough background in basic hobby listening. In the first part of the book, the topics covered are users of the spectrum (VLF through UHF) with charts and tables, equipment for the listener (receivers, antennas, accessories), hints on buying equipment, designing an effective antenna system and techniques for successful monitoring. The second part of the book covers projects for converters, power supplies, receivers, amplifiers, antennas, filters, descramblers, and receiver modifications. The projects are clever, simple answers to commonly encountered problems, such as: What is the best antenna for my interests? Can I use a TV antenna for my scanner? Is grounding necessary? The text includes easy-to-follow illustrations, and all projects have been built and tested before publication. Published by Hayden Book Company, Inc., 50 Essex St., Rochelle Park, NJ 07662. Circle No. 60 on the Reader Service Coupon.



Soft cover
128 pages
$5.45

A listener's guide to the communications bands.

Discovering the Big Chip. *Programming & Interfacing the 6502* by Dr. Marvin L. DeJong conducts the reader step-by-step toward an understanding and competence in assembly-language communication with 6502-based microcomputers. Experiments and examples are written so that a KIM, AIM, or SYM system may be used to reinforce the material presented. The author examines logical operations, arithmetic operations, branches and loops, register-shift instructions, indexed addressing, subroutines, the stack, interrupts and interval timers. The experiments reinforce the concepts, building confidence in the reader to perform increasingly complex operations. Interfacing discussions concentrate on interfacing integrated circuits and devices up to and including I/O ports. The final chapter illustrates several finished projects including digital-to-analog and analog-to-digital conversion, a timer and data logging module, and a precision keyer among others. Distributed by Group Technology, Ltd., P.O. Box 87, Check, VA 24072. Circle No. 64 on the Reader Service Coupon.



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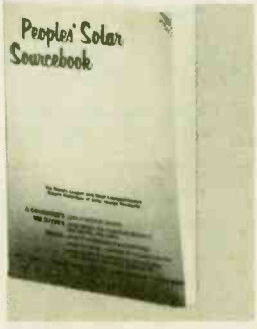
A guide to this powerful microprocessor chip.

Solar Sourcebook. Saving energy will be easy in the 1980s with the help of the *Peoples' Solar Sourcebook*. This 8½ x 11 catalog offers over 350 pages of solar equipment, conservation devices and hardware.



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To obtain a copy of *Solar Sourcebook*, send a check or money order to Solar Usage Now, Inc., Department H-1, 450 Tiffin Street, Bascom, Ohio 44809. Circle No. 61 on the Reader Service Coupon. ■

Five new Scanners! New 800 MHz!

Communications Electronics,™ the world's largest distributor of radio scanners, welcomes the addition of Fanon to our product line. Fanon introduces *two* new high performance hand-held scanners. More importantly, Fanon has a complete selection of useful accessories to compliment their *Slimline* models.

Electra Company, manufacturers of *Bearcat* brand scanners introduces *three* new scanners *including* a model that can monitor the exciting 800 MHz. band. The new *Bearcat* models will be available Fall, 1980, so reserve your scanner now!

A new product made by Electra, the *Freedom Phone*® is now available from **CE**. This is the ultimate *cordless* extention phone that can make and take your calls.

Bearcat®† 300

The Ultimate Synthesized Scanner!

Allow 90-120 days for delivery after receipt of order due to the high demand for this product.

List price $519.95/**CE price $339.00**

4-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 $279.00**

50 Channels • Crystalless • Searches Stores • Recalls • Digital clock • AC/DC Priority Channel • 3-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.

Bearcat® 220

List price $419.95/**CE price $279.00**

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 $229.00**

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 three-band coverage. Dual scan speeds. Color-coded keyboard. Even a digital clock. All at a modest price. More scanning excitement than you bargained for.

NEW! Bearcat® 210XL

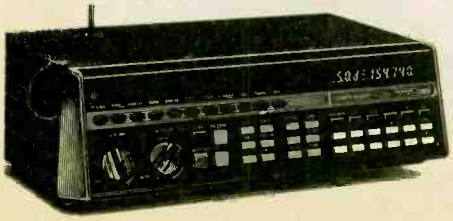
This is a new model. Shipments will begin in Fall, 1980.

List price $319.95/**CE price $219.00**

18 Channels • 3 Bands • Crystalless

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second generation of the world's best selling crystalless programmable scanner–the *Bearcat* 210. It has almost twice the scanning capacity with 18 channels plus dual scanning speeds and a bright green fluorescent display.



NEW! 50-Channel Bearcat 300

Bearcat® 210

List price $319.95/**CE price $209.00**

10 Channels • 3 Bands • Crystalless

Frequency range: 32-50, 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!

NEW! Bearcat® 160

This is a new model. Shipments will begin in Fall, 1980.

List price $279.95/**CE price $199.00**

16 Channels • 3 Bands • AC only • Priority Dual Scan Speeds • Direct Channel Access

Frequency range: 32-40, 144-174, 440-512 MHz.

The *Bearcat* 160 presents a new dimension in scanning form and function. The keyboard is smooth. No buttons to punch. No knobs to turn. Instead, finger-tip pads provide control of *all* scanning operations, including On/Off, Volume and Squelch. Green easy to read fluorescent display. Requires (2) 9 Volt batteries to retain memory when disconnected from AC Power.

Bearcat® 12

List price $179.95/**CE price $119.00**

10 Crystal Channels • 3 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® 5/800 MHz

The world's first 800 MHz. scanner!

This is a new model. Shipments will begin in Fall, 1980.

List price $179.95/**CE price $129.00**

8 Crystal Channels • 4 Bands • AC only

Frequency range: 33-50, 144-174, 440-512, 806-870 MHz.

The *Bearcat* 5/800 MHz is the only scanner on the market today that offers coverage of the 800 MHz. public service band and the other public service bands. Individual channel lockout. Scan Delay. Manual Scan.

Bearcat® 5

List price $129.95/**CE price $94.00**

8 Crystal Channels • 3 Bands • AC only

Frequency range: 33-50, 146-174, 450-508 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® 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 three 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.

NEW! Fanon Slimline 6-HLU

List price $169.95/**CE price $109.00**

World's smallest 6-channel, 3-band scanner!

The new *Fanon* Slimline 6-HLU gives you six channels of crystal controlled excitement. Unique Automatic Peak Tuning Circuit adjusts the receiver front end for maximum sensitivity across the entire UHF band. Individual channel lockout switches. Frequency range 30-50, 146-175 and 450-512 MHz. Size 2¾ x6¼ x 1." Includes rubber ducky antenna.

NEW! Fanon Slimline 6-HL

List price $149.95/**CE price $99.00**

6-Channel performance at 4-channel cost!

Frequency range: 30-50, 146-175 MHz.

If you *don't* need the UHF band, get this model and save money. Same high performance and features as the model HLU without the UHF band. Order crystal certificates for each channel.

FANON SCANNER ACCESSORIES

CHB-6 AC Adapter/Battery Charger	$15.00
CAT-6 Carrying case for Fanon w/Belt Clip	$15.00
AUC-3 Auto lighter adaptor/Battery Charger	$15.00

OTHER SCANNER ACCESSORIES

SP50 AC Adapter	$12.00
SP51 Battery Charger	$12.00
SP58 Carrying Case for *Bearcat* 4-6 ThinScan™	$15.00
FB-E Frequency Directory for Eastern U.S.A.	$15.00
FB-W Frequency Directory for Western U.S.A.	$15.00
FFD Federal Frequency Directory for U.S.A.	$18.00
SM220 Service manual for *Bearcat* 220	$15.00
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B-5 Replacement memory battery for Bearcat 210	$6.00
B-7 1.5 V AAA Alkaline battery (Pack of 4)	$4.00
B-9 9 V Alkaline battery	$3.00
A-135cc Crystal certificate	$4.00

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

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 $30.00 and $3.00 for UPS shipping in the continental United States.

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 original condition with all parts in 31 days, for a prompt refund (less shipping/handling charges and rebate credits).

Regency®‡ K500

List price $419.00/**CE price $279.00**

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

Aircraft Touch 720-A	$239.00
Touch K100	$199.00
Touch M100	$199.00

NEW! Telephone Products

Electra's cordless *Freedom Phone* does everything an ordinary phone does and more. Because it is cordless, you can take it anywhere, inside or outside—on the patio, by the pool, in the garage, in the workshop...even next door at the neighbor's.

Model **FF-500** has pushbutton dialing. Rechargeable ni-cad batteries included. Battery low light. Secure feature. Telescopic antenna. Your cost is $179.00. Model **FF-1500** has the same features as the FF-500 but also includes a charger/cradle that allows the phone's handset to be recharged away from the base station. Your cost for this cordless phone is $199.00. The model **FF-3000** has all the standard features (except charger/cradle) plus interchangeable telescopic and rubber ducky antenna. Redial feature. Belt clip. Carrying case. Greater range. Your cost is $229.00.

World Scanner Association™

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CIRCLE 26 ON READER SERVICE COUPON

INPUT/OUTPUT

Got a question or a problem with a project—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Personal replies cannot be made. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott
SCIENCE & ELECTRONICS
380 Lexington Avenue
New York, NY 10017

Soon to be 39

I have a 1942 RCA radio in good physical condition. I intend to restore it, since it does not work. Schematics, I've got, but the question is, should I replace all wiring and discrete components by stripping it down to the chassis, or should I only replace defective items? I wanted to go "whole hog," but I was told that this would destroy the set's value. Also, should I refinish the cabinet or just polish it?

—C.B., Rock Hill, SC

Repair only what is defective. In fact, some buffs pirate parts from old chassis, so replacement can be as close in age as possible. I find it difficult to replace some electrolytic capacitors that are bunched in one wax cylinder. Always try to restore 100 percent, or else, as best you can. As for the finish—if it's in good shape, just polish it; otherwise, refinish.

Look For the UL Label

I always tell my friends to look for the UL label because they can be sure the product has been tested. My buddy claims it means Union Label. Who is correct?

—L.W., Meridian, MS

Neither of you. UL stands for Underwriters' Laboratories, an insurance industry standards organization for fire and electrical safety. UL approval means that product samples meet stringent testing, and that the labels and instructional literature for a product comply with certain UL guidelines. This means you may buy a TV receiver with a UL label that is safe for your home, but may not work.

VHF/UHF U-Make-It

I'd like to build an inexpensive VHF/UHF antenna for my cabin. It must be inexpensive because the local kids tear it down every winter.

—W.J., Hillside, NJ

Cut five pieces of stiff No. 10 or 12 copper wire, clothes-hanger wire, thin solid or tubular brass tubing into 18-inch lengths. Solder, braze, silver solder or aluminum solder these to an SO-239 coax connector. Four wires go into the mounting holes of the SO-239, and one goes to the center terminal. Before the soldering is started, bend the four radial wires in the mounting hole to the plane of the flush mount on the SO-239. When the antenna is held upright after soldering, bend the radials down 45 degrees. That should do it. If you plan to listen to one particular station, you may want to trim.

Ring Those Bells

I'd like my beeper on my computer to beep when I want it to. What do I do?

—S.C., Columbus, OH

The string function CHR$ (exp) converts a number to the corresponding ASCII code number 7 rings a bell on a teletypewriter or causes a beep at many terminals. To get a beep anywhere in your program, just type after the line number:

PRINT CHR$ (7)

Two Barrels

I'm becoming an active shortwave listener on my portable 4-band transistor radio. I need a better rig, but can't afford

(Continued on page 30)

EQUIPMENT AND TRAINING NO OTHER SCHOOL CAN MATCH!

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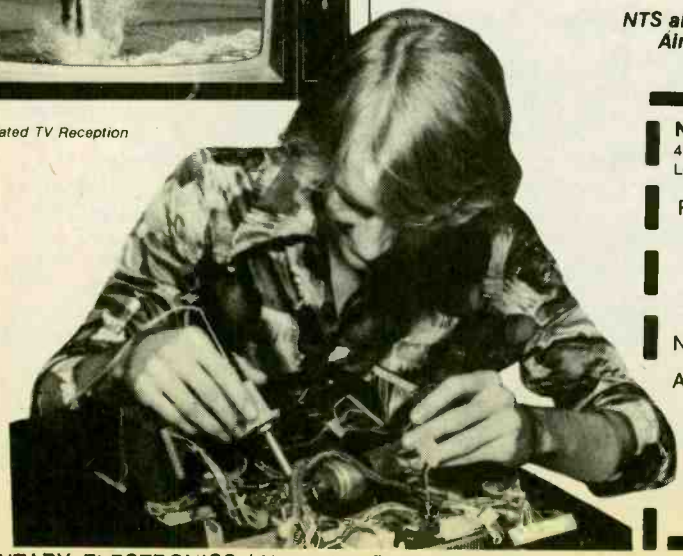

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SPEAKING SOFTLY

BY MICHAEL KAYE

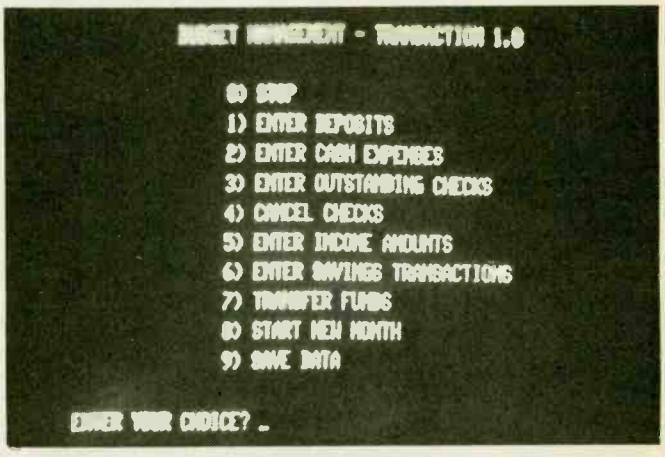
LOOKING AT THE BEST IN SOFTWARE

THIS COLUMN IS for those of you with light wallets and small software libraries. All you have to do is look at what software is available for your TRS-80 or Apple and you can go quietly mad trying to decide what to acquire. Wouldn't it be nice if there was someone around who tried out all the programs on the "menu" and recommended the good ones? That is precisely the purpose of this column.

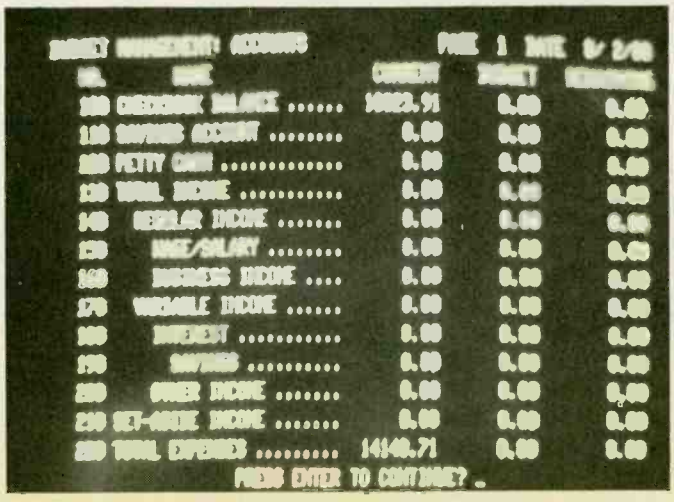
I will discuss software that has been thoroughly tested, and programs will range from games to machine language utilities. Emphasis will be on software that will give many hours of either practical use or pleasure, and that I think is worth buying.

For my grand opening, I am going to review two programs that deal with high finance; one deals with painful realities, and the other is a game. These are Budget Management, a program from Radio Shack designed to keep your personal finances in order; and Santa Paravia and Fiumaccio, a game program from Instant Software that deals with managing the finances of an imaginary kingdom.

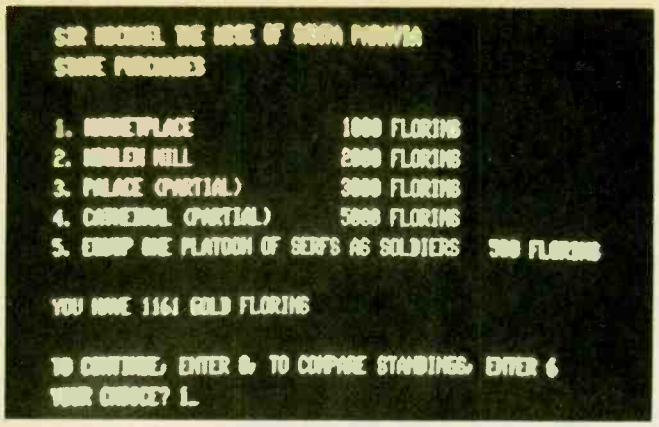
Budget Management. To begin with, I'll ask the musical question, "How can you balance your checkbook without unbalancing your mind?" The solution is, of course, to let ye olde computer do the figuring. If your checkbook has led a checkered career then check out Radio Shack's Budget Management package. This little goodie has been put together with the Level II user in mind and comes complete with loads of documentation, including the full listings of the BASIC programs involved. This makes life so much easier when you have to pry open a program to add your own flourishes to it. One of the things that I look for and suggest that you look for when purchasing software is the amount and quality of the docu-



Radio Shack's Budget Management program for the TRS-80 Level II with 16K memory is a personal finance program par excellence. This segment, Transaction, handles all financial transactions, including deposits, outstanding checks, and savings account.



The thoroughness with which Budget Management accounts for your finances can be unnerving. This photo of CRT readout shows nearly every possible aspect of one's finances. If you're like most of us, the right hand category is liable to be disappointing.



Play ruler-for-day (or evening or into wee hours of the morning) with this fascinating game of "kingdom management." You must guide your imaginary 15th century Italian city-state to prosperity and keep its inhabitants healthy, happy and out of war.

mentation that comes with it; Radio Shack really came through with the goods on this one.

The Budget Management (Radio Shack No. 26-1603) package consists of four separate programs on cassette that let you set up a whole bookkeeping system for your home. It can be customized for up to 60 different budgeted accounts, including checking, savings, cash expenses and household accounts. These last items have their own budget account numbers that are selected when you initialize the program. The budget numbers are used when you want to find all of the checks written in a specific category (like your electric bill) and for obtaining figures on how much you spent in that category.

You can set up predetermined budget figures on a month to month basis, and the computer will then keep track of where your money is going and whether you are going over budget. In addition the computer will keep records of deposits, savings, petty cash, outstanding checks and cancelled checks. The four programs consists of:

INIT—Which sets the program up according to your custom specs.

TRANS—Which handles all of the transactions including deposits outstanding checks, savings etc.

EDIT—Which makes you look good after you've made yourself look bad by helping you correct mistakes.

REPORT—This is where the buck stops. You are told where your money is going (as if you didn't know) and how well you are keeping to a budgeted amount. Info can be displayed on screen or on a printer.

Now, why they didn't stick all of this in one program? The answer is that there just isn't enough memory space in 16K Level II to handle all of it at once and still have enough space left over to stash the vital statistics. This leads me to the only gripe that I have about this package, and it applies only to cassette users: You have to do quite a juggling act with your tapes—disk users don't have this hassle. However, this is a small inconvenience, considering the versatility of this package.

All of the programs were written so that they can be used later on with minimal changes when you graduate to a larger system. There are provisions for hard copy if you add a printer. Due to the memory space limitations in a 16K system, the program is designed to keep records on a monthly basis.

I run this micro accountant once a month and muse with pinpoint accuracy over where the money (that I don't have) is going.

Royal Stakes. After I have gotten over my financial traumas, I set the clock back and engage my computer in a round of fantasy. I am speaking of a game called Santa Paravia and Fiumaccio by George Blank, which is available from Instant Software (Peterborough, NH 03458) for under ten dollars. This little tidbit can hold the attention of up to six adults for as many hours, and is known to be highly addictive. It has been known to generate laughs, groans and glazed eyeballs into the wee hours of the morning. It's basically a game of management—kingdom management, that is.

Of course, you don't start out with a kingdom, you have to build one. You start out as the nominal head of a small fifteenth century Italian city-state. The object of the game is to manipulate your resources and fend off the ravages of pestilence, war, chance and time in such a manner as to increase the size, health, and population of your state.

So much for SPEAKING SOFTLY for this issue. I hope that you'll give these two programs a RUN for their money, and I'll see you soon with more goodies when we sit down at the keyboard again. ■

INPUT/OUTPUT

it; but I can pick up a vintage Hallicrafters receiver. Should I buy it (it works), or wait until I have more money?
—I.W., Dayton, OH

Buy it! The old rigs are fun to operate, easy to repair and align, and you have the beginning of a new hobby—antique radio collecting.

Crossover

I have a 12-in. woofer and a 3-in. tweeter. What size capacitor should I use in the crossover circuit for the high pass filters?
—L.W., Winona, MN

The size of the capacitor should be selected to give a 6 dB per octave roll-off rate. Start with a 1 uF and increase, or decrease, as the case may be. Some experts can use their ears in selecting the capacitor for best results. I can't. I prefer to buy the crossover circuit matched with the speakers. Once you have your tweeter working correctly, you have to find a suitable series coil for the woofer.

White's is Complete

Why doesn't White's Radio Log, which appears in COMMUNICATIONS WORLD *once a year, list FM stations by call letters?*
—J.N., Long Beach, CA

DXing FM stations is just not practical. Very seldom does one need such a listing. If you don't find the call letters in the FM listing for your state, then examine adjacent states along the axis of the FM antenna. Some signals may skip in, but don't bet on it. Also, a few may sneak in from behind, so always examine the state behind you. The original Mr. White didn't list FM stations by frequency, nor do we see any reason to do so. As for errors in White's Radio Log—they happen because we are human (we're not blaming it on the computer). However, most errors are traceable to inaccurate data and changes that occur during the year. Did you know there are over 1000 listing changes in White's Radio Log each year? You can help. Should you spot an error, jot down the old (incorrect) data and the new data. We'll update the list.

Long Line Ground

My car stereo works fine on the workbench when I power it with a battery eliminator, but reception is poor in the car. I know the antenna system is O.K. What's wrong?
—E.J., Rapid City, SD

Take a good look at your DC ground return. Considering the amount of plastic used in a car today, the radio may be floating in non-metallic space. Keep that DC return short! Connect the case of the radio to the metal on the car with one foot or less of braided copper wire rated at No. 14 or 12. I once fixed a radio in a car that had no ground return in its plastic mounting slot. The ground strap, a piece of cheap steel, broke when the radio was pulled out. When I connected the hot line and slid the radio in place, no grounding occured.

Computer Power

Should I run a special AC line to my PET computer, as is done with commercial computers?
—C.H., Loyalton, CA

Why? If the power fails, start all over. Should you be working on a very long program, constantly LOAD it into your cassette or disk drive. Should the switch be pulled or the power fail, you will only lose the last 10 minutes of work. The magnetic memory never fails. But, it is wise to take power from an outlet that does not share a circuit breaker with kitchen appliances that blow breakers often. Also, the outlet should not be controlled by a wall switch which could accidently be flipped off.

Bond It

My serviceman suggested I "bond my chassis." He meant that the engine compartment leaked RF which interfered with my radio reception. How do I do it?
—W.N., Oceanside, NY

Check your auto parts supply outlet for bonding straps. If you can't get any, use the wire braid from an RG-8/U cable. Take off the outer jacket and inner insulation and center wire. It's easy to do, and you'll need strips of about one foot in length. Now, connect the hood to the firewall with one strap. Connect each fender to the firewall. (The firewall is the metal between the engine compartment and the passenger section.) Check to see that the cable from the battery ground to the engine makes a good connection and is not damaged. That should do it.

It's a Cannon

What is an XL-type connector?
—D.M., Boston, MA

It's any of several varieties of audio connectors having 3 or more conductors plus an outer metal shell which shields the mating pieces and locks them in place. The most common type is the 3-pin XL-type connector used to make balanced mic and line level connections on professional audio systems. It is not uncommon for XL-type connectors to be connected to unbalanced lines. Very often the XL-type connector is called a "Cannon connector," so named for the original manufacturer. Presently, many companies now manufacture compatible 3-pin connectors.

Sound Off

Hank, I am writing in response to the letter from "T.H., Great Fall, MT" in the

(Continued on page 75)

Yesterday you could admire all-band digital tuning in a short wave receiver.* Today you can afford it.

RF—4900

Tune in the Panasonic Command Series™ top-of-the-line RF-4900. Everything you want in short wave at a surprisingly affordable price. Like fluorescent all-band readout with a five-digit frequency display. It's so accurate (within 1 kHz, to be exact), you can tune in a station even before it's broadcasting. And with the RF-4900's eight short wave bands, you can choose any broadcast between 1.6 and 31 MHz. That's all short wave bands. That's Panasonic.

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To help you control all that sophisticated circuitry, Panasonic's RF-4900 gives you all these sophisticated controls. Like an all-gear-drive tuning control to prevent "backlash." Separate wide/narrow bandwidth selectors for crisp reception even in crowded conditions. Adjustable calibration for easy tuning to exact frequencies. A BFO pitch control. RF-gain control for improved reception in strong signal areas. An ANL switch. Even separate bass and treble controls.

And if all that short wave isn't enough. There's more. Like SSB (single sideband) amateur radio. All 40 CB channels. Ship to shore. Even Morse communications. AC/DC operation. And with Panasonic's 4" full-range speaker, the big sound of AM and FM will really sound big. There's also the Panasonic RF-2900. It has most of the features of the RF-4900, but it costs a lot less.

The Command Series from Panasonic. If you had short wave receivers as good. You wouldn't still be reading. You'd be listening.

*Short wave reception will vary with antenna, weather conditions, operator's geographic location and other factors. An outside antenna may be required for maximum short wave reception.

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CIRCLE 17 ON READER SERVICE COUPON

Why the smallest digital scanner is also one of the smartest.

We started with very fast, sophisticated microprocessors. Then we made some highly complex circuitry very simple to operate. Just one touch tells the new M400 to monitor any active police, fire, weather and emergency frequency in your area. That's a lot of return for practically no effort. And it makes the M400 perfect for your home or car.

scan modes — whichever is best for you. We've also set aside a priority channel so you can monitor your favorite frequency every second. There's even a digital quartz clock and elapsed timer. And the control panel is backlighted for the best possible visibility — day or night.

575 Channels, No crystals.

We've preprogrammed 545 channels with commonly used public service frequencies. Then we coded the touch sensitive keyboard with symbols for police, fire, marine, mobile telephone and weather. So all you have to do is touch the symbol for the type of activity and band you want to monitor. The M400 does the rest. If you want to search for unknown frequencies, the M400 lets you do that, too. And for those channels you want to store and hear again, you have 30 programmable channels to use. Plus you can use either manual or

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CIRCLE 28 ON READER SERVICE COUPON

Light Beam Communicator

Talk over a beam of light with this transceiver

BY ROBERT IANINNI

HAVE YOU EVER TRIED to communicate when skip was coming in over the CB band? Interference from local stations, was only exceeded by interference from long distance stations. The channels were so crowded that stations were as tight as packed sardines. Communication was impossible. There is an intriguing solution to this common problem. Leave the roaring CB crowd behind, and escape up to the light waves.

The Light Beam Communicator described here demonstrates how a light beam can be used for voice transmission. This communicator is also useful to trap intruders at a remote location, and as a top secret communications link between two stations.

The clarity and quality of audio reproduction is crystal clear, with more than enough pick-up sensitivity and modulation power than normally would be needed. Range of the units should be line of sight up to 1000 meters or better. Alignment is easily accomplished by sighting along the barrels of the units. Short range communication (several hundred meters) is easily accomplished by simple sighting to one another's respective units. Long range setups are more conveniently obtained using a camera tripod. Units are built in a pistol-type configuration with all power and optics self-contained. A rear panel contains the necessary controls for operating along with jacks for headsets and a built-in microphone. The device is designed so that it also can be used for actual "listening" to other light sources such as TV pictures, scopes, fluorescents and many other infra-red and invisible radiation sources.

Normally, the units are built using a visible red transmitter for ease and convenience in nighttime alignment. For serious longer range, low noise performance they can be equipped with optional filters for invisible infra-red transmitting capabilities.

Looking at The Circuit. The light beam transmitter-receiver consists of a phototransistor receiver which picks up modulated light that is fed through a high gain amplifier and then to headsets or a loud speaker. When in the transmit mode, the amplifier becomes a sensitive mike pre-amp that drives a current amplifier modulating a light emitting diode as the transmitter.

The receiver section consists of a phototransistor (Q4) positioned at the focal point of lens LE2 inside enclosure EN2 (A separate enclosure, lens and phototransistor for transmitting and receiving enhances the flexibility and performance of the device. This, however, adds to the cost. Duplicating these components for both functions could be done, however, overall performance is sacrificed.)

Q4 is mechanically secured to a sliding dowel DO1 that is adjusted to its proper distance from LE2 and secured with a screw. The signal from Q4 is fed into J1 via a shielded cable to keep hum and other electrical pick-up to a minimum. Switch S2A now selects J1 in the *receive* mode and feeds the signal to the amplifier via C1. The signal is now matched and amplified via the integrated circuit U1. A gain control R7 controls the sensitivity of the amplifier and also serves as an ON/OFF switch for the receiver section. The output of U1 is now further amplified by Q1 and impedance matched via transformer T1. S2B now connects T1 and J2 for feeding 8-ohm headsets or an external speaker.

The transmitter section consists of a narrow beam visible red or optional infra-red light emitting diode LED1 located at the focal point of lens LE2 inside enclosure EN1. EN1 also contains the electronics and controls for hand grip EN3. A mike M1 is lo-

cated on the rear panel RP1 and is fed to the amplifier U1 through C1 via mode select switch S2A. The amplifier now becomes a pre-amp for the mike. The output of the preamp is further amplified by Q1 and impedance matched by T1. The output of T1 is fed to Q2 via S2B. Q2 is DC coupled to Q3 whose quiescent state is selected via R15 in determining the DC current through LED1. A modulation signal is AC coupled to Q2 via C8. The hole is covered to minimize random light or noise in the circuit.

Power for the transmitter section Q2, Q3 and LED1 is from battery B3, is controlled by S2C and is used only during transmit mode. This enables the device to be used as a receiver. used as a receiver.

Construction. Begin by making the following parts. The parts list supplies details on how to purchase the items already fabricated. The main enclosure EN1 is an 8-inch long piece of PVC tubing, with a 3½-inch outside diameter. This is sometimes called schedule 40 PVC tubing. PVC tubing is obtained in plumbing supply stores, hardware stores or building supply outlets.

Cut a 2-inch hole for the handle, using a hole saw. As the assembly diagram shows, this hole is located 3 spectively from the rear end. File a ¼-inch slot on each side of the hole that is 2½-inches from the back of EN2. Remember to curve the slot to take into account the pivoting action of EN2's other screw when optical alignment is later attempted.

piece of PVC tubing with a 2⅜-inch outside diameter. Next, drill a ¾-inch hole approximately 3 inches from the rear end of the receiver enclosure. This hole is for optical alignment. There are two mating holes to secure the receiver enclosure to EN1. These holes are on top of the piece to allow access with a screwdriver. The bore axis of these two tubes must be parallel. The large ¾-inch hole can be covered with a plug or a piece of tape.

Transformer T1 has a 3:1 turn ratio of 1500 to 500 turns.

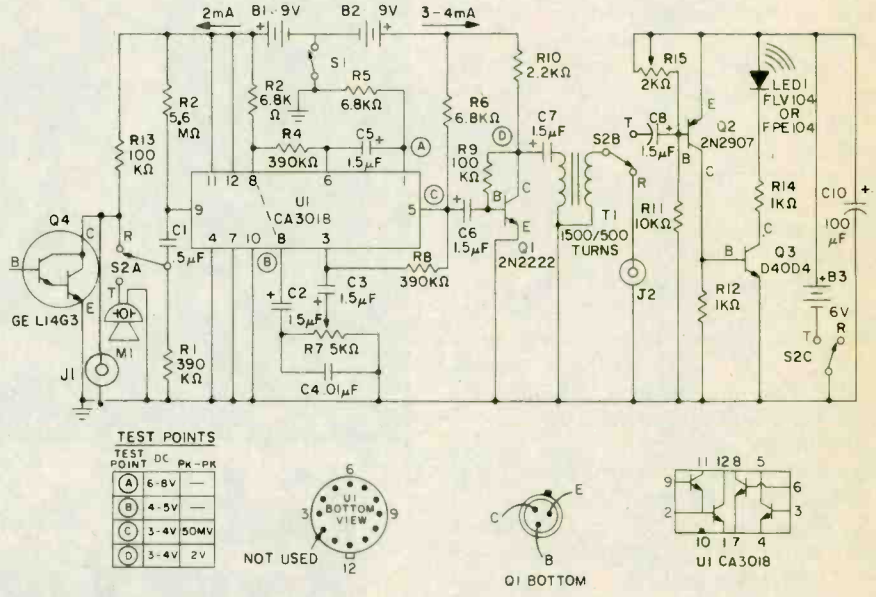
The handle and battery enclosure EN3 is a 6-inch long piece of PVC tubing (schedule 40) with a 2-inch outside diameter. Insert the handle after everything has been assembled, and glue it with PVC cement.

PARTS LIST FOR LIGHT BEAM COMMUNICATOR

C1—0.5-mF, 25-VDC disc capacitor
C2, 3—1.5mF, 35-VDC tantalum capacitors
C4—.01-mF, 25-VDC disc capacitor
C5-8—1.5mF, 35-VDC tantalum capacitors
C9—.01-mF, 25-VDC disc capacitor, across battery, omitted in this model.
C10—100-mF, 25-VDC electrolytic capacitor
J1, 2—RCA jacks
LED1—Small light emitting diode, visible red, FLV104 or infra-red, FPE104
M1—small crystal mike (any type)
Q1—2N2222 NPN transistor
Q2—2N2907 PNP transistor
Q3—D40D4 NPN transistor
Q4—GE L14G3 phototransistor
R1—390,000-ohm ¼-watt, 10% resistor (all resistors 10% unless otherwise noted)
R2—5,600,000-ohm, ¼-watt resistor
R3—6,800-ohm, ¼-watt resistor
R4—390,000-ohm, ¼ watt resistor
R5, 6—6,800-ohm, ¼ watt resistors
R7—5,000-ohm potentiometer with SPST switch (see S1 below)
R8—390,000-ohm, ¼-watt resistor
R9—100,000-ohm ¼-watt resistor
R10—2,200-ohm, ¼-watt resistor
R11—10,000-ohm, ¼-watt resistor
R12—1,000-ohm, ¼ watt resistor
R13—100,000-ohm, ¼ watt resistor
R14—27-ohm, ½-watt resistor
R15—2,000-ohm trimmer potentiometer
S1—SPST switch, part of potentiometer R7 above.
S2—Switch, 3-pole, 2-position rotary
T1—Transformer, 1500 turns primary winding, 500 turns secondary winding
U1—CA3018, high gain amplifier

Misc.

BH1—4 AA battery holder snaps
CA1, 2—3½-inch plastic cap
CA3, 4—2⅜-inch plastic cap
CA5—1⅝-inch plastic cap
EN1—8-inch, 3½-inch OD PVC
EN2—6½-inch, 2⅜-inch OD PVC
EN3—6-inch, 2-inch OD PVC



BU1—nylon ⅜-inch bushing
CL1, 2, 3—10-inch battery clips, 9-V
WR1—10-inch shielded cable
P1—RCA plug
TA1—3-inch double sided tape, ½-inch
DO1—2-inch wood dowel, 1½-inch diameter
RP1—Rear panel, 3¼ x 3¼ inch, 22 gauge
MP1—Mounting plate, 2⅞ x 5½ inch, 22 gauge
SW1—2-each, 6-32 x ¼-inch screws & nuts
SW2—2-each, 6-32 x 1-inch screws & nuts
LE1, 2—Lenses, 54 x 89mm
PC1—Printed circuit board
KN1, 2—small plastic knobs
HS1—8-ohm headsets with matching transformer (not included in kits)
B1, 2—9-volt transistor batteries
B3—Four 1½ volt AA batteries

FTR1—Filter for infra-red light emitting diode
WR2—24-inch piece of #24 blue stranded hook up wire
WR3—24-inch piece of #24 red stranded hook up wire
WR4—6-inch of No. 24 buss wire

The Light Beam Communicator is available in three different kit formats. They are:
Electronic kit for one set (two units) . . $59.50
All the mechanical and optical parts for 1 set (2 units) $39.50
Combination of electronic, mechanical, and optical parts to fully assemble 1 set (2 units) $99.00
The kits are available from: INFORMATION UNLIMITED, INC., P.O. Box 716, Amherst, N.H. 03031. Please include $4.00 for postage.

The rear plate RP1 can be fabricated from a 3¼ x 3¼-inch square piece of No. 22 galvanized sheet metal or .035 aluminum. Use the RP1 template shown to locate the holes. The mounting plate MP1 is made from a 2⅞ x 5½-inch square piece of galvanized sheet metal (No. 22) or .035 aluminum. This time, use the MP1 template to locate the holes in this piece.

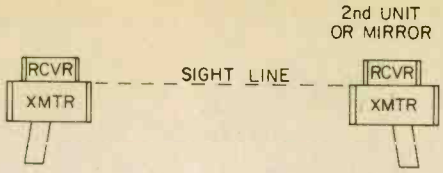
Centering dowel DO1, has a 2-inch length and an outside diameter of 1½-inches. It should fit smoothly in to EN2. The cable, WR1, is fed to the phototransistor, Q4, through a slightly off center feed hole in the dowel. The connection is made by soldering to the exposed leads of Q4. The leads should be as short as possible, and glued with RTV cement. The leads should be only long enough to allow touch up, re-positioning to the true optical axis.

The plastic cap CA1 is 3½ inches, with a 1⅝-inch hole in the center. Use a sharp knife or small snips. If you are not neat in this procedure, the appearance of the device can be ruined. Four small pieces of double sided tape (TA1) are used for securing the lens LE1 to the cap. Be sure that the tape does not contact the ridge of EN1, otherwise it will be difficult to remove for checking. The other plastic cap CA2 is 3½-inch. It has a ¼-inch lip to hold the sub-assembly into EN1.

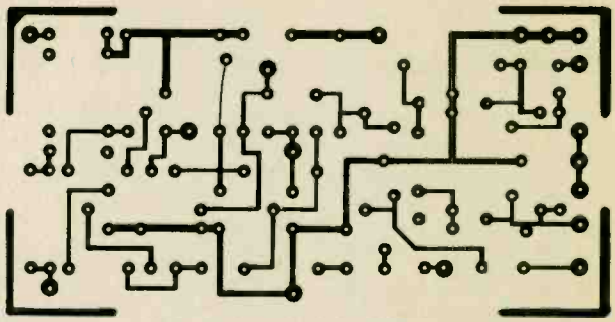
CA3 is the 2⅜-inch plastic cap. Remove the ⅜-inch lip, to retain lens, LE2, and optional filter FTR1. These are fitted against the end of EN2. CA4 is a 2⅜-inch plastic cap. Place a small hole for cable WR1, to create a friction hold and prevent DO1 from sliding once set. After alignment, secure with RTV cement. These plastic caps are available from Information Unlimited (refer to parts list).

It would be preferable to construct all circuits on a board, unless you are very familiar with perf-board assembly. If so, a 3 x 1½-inch perf-board, with a .01-inch grid, may be used. Follow the layout as shown in the printed circuit board layout. As always, use resin-core solder when you build this project. Remember to remove any excess solder from the PC board to prevent shorting.

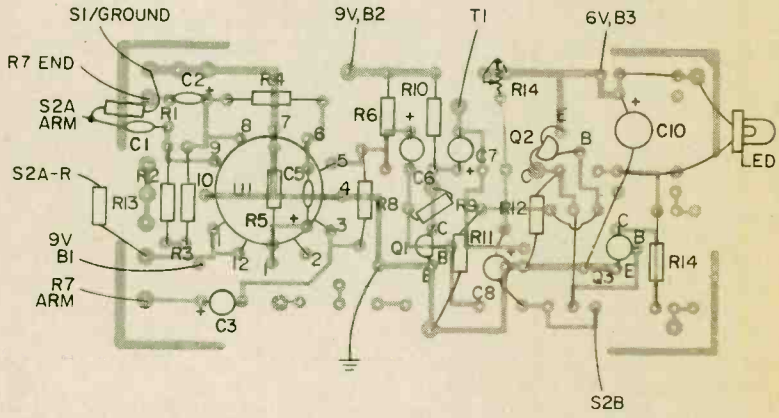
Assemble RP1 as shown in Figure three. Attach R7 to RP1 as illustrated in Figure two; the leads from R7 must be twisted and as short as possible. Connect C4 to S2 and then attach the assembly to RP1. Twist all wires together leading to S2. Route these leads close to metal. Switch leads are all identified in the schematic. Attach microphone M1 using RTC cement. Position and wire as shown. Assemble jacks J1 and J2.



Positioning Light Beam Communicator for two-way communication is line-of-sight. With ideal conditions, it is possible to send and receive up to a mile.



If you are not an expert at etching your own circuit boards, we suggest you buy the kit from Information Unlimited, which includes PC board and parts.



The parts overlay shows components on top of PC board. Note that all of the electronic components fit handily on board, making for easy assembly.

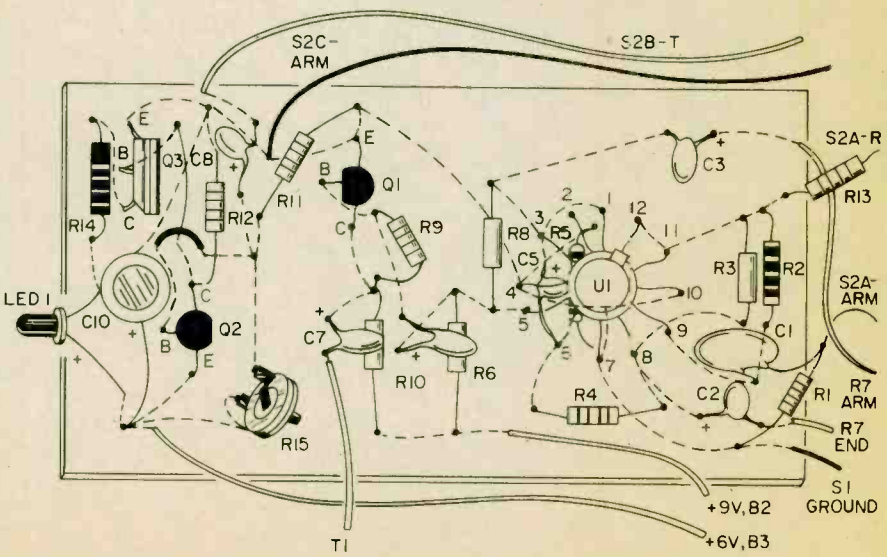


Fig. 1. Actual parts placement on the Light Beam Communicator's board is not critical; however, you must identify all of the leads going to the components to avoid confusion.

Attach RP1 to MP1 via screws SW1 (6-32 x ¼-inch)

Construct PC1 according to the circuit foil pattern given on the preceeding page. Assemble the board by using the schematic diagram given and Figures one and two. Note polarity of tantalum and electrolytic capacitors and the position of U1, Q1, Q2, Q3 and LED1.

Connect the wires from RP1 assembly to board noting identification of leads shown in sketches. Position as shown in Fig. 2, but do not adhere to tape at this time. Carefully position LED1 into B3 as shown. Attach battery clips CL1, 2 and 3 to respective points, as shown in Fig. four. It is advantageous at first to allow the board freedom to be moved for total access during preliminary trouble shooting and testing. Leads may be further shortened after several minutes of proper operation have been verified.

Next, attach T1 to MP1, bending tabs in the small holes. Solder one lead from primary to secondary and sandwich between core of T1 and plate. This makes the ground contact of the transformer. You may want to solder these wires directly to the plate for a positive contact. Use a heavy iron for this. Note ungrounded 500-ohm lead going to S2B and ungrounded 1.5K ohm (winding marked P) going to C7 on board.

Connect PL1 phone plug to WR1 cable from receiver section.

Testing The Units. It is assumed that the assembled unit, to this point, has been wired correctly, with no shorts, and good solder connections. You will note that the complete working unit is conveniently built on a single removable assembly. This assembly should have the battery clips CL1, 2 and 3 connected to their respective batteries.

Testing The Receiver. Turn S2 and R7 fully counterclockwise.

Connect one terminal of a fresh 9-volt battery to CL1 and connect a 100-mA ammeter between the contact of the battery and the clip. Turn on R7. Current reading should be approximately 2-mA. Fully connect battery and designate B1.

Repeat above using a second battery connected to CL2. Turn on R7/S1. Current reading should be 3 to 4-mA. Fully connect battery designated B2.

Plug a high impedance set of headphones into J2. HS1 is a standard 8-ohm headset with a spliced in matching transformer that steps up to 1000 ohms. This is suggested, as high impedance headsets are scarce and uncomfortable to wear). Plug PL1 from Q4 (receiving phototransistor) into J1.

Side view of the Light Beam Communicator specially made for Science & Electronics.

Turn on R7/S1 and slowly turn up gain until a loud 60-cycle hum is heard. This is the normal AC room lighting frequency being picked up by Q4. At normal ambient lighting conditions it will completely block the amplifier. Reduce the gain and attempt to point Q4 at various objects indicating different levels of signal, depending on reflection characteristics of surfaces, etc. You will note that the circuit is relatively prone to power line hum pick up. It is assumed that testing will be done in normay electrical lighting for this step. If not, you may not obtain the 60Hz hum.

If everything above checks out OK, you can proceed to the transmitter section. If not, troubleshoot the faulty circuit. It may be convenient to use the test points shown on the schematics and thoroughly familiarize yourself with the circuit description given in the beginning of the plans.

Testing The Transmitter. With all switches full counterclockwise, connect CL3 to 6-volt B3 as done with B1 and B2. Connect a 100-mA meter in series and turn S2 clockwise to the transmit position. Adjust R15 to read 25-50-mA. LED1 should light to about one-half maximum brilliance. Turn R7/S1 and note LED1 changing brilliance with sounds. Whistle. The current meter should jump to nearly 100mA. *Note:* LED1 increases in brilliance with sound indicating upward modulation. The device seems to work all right with the

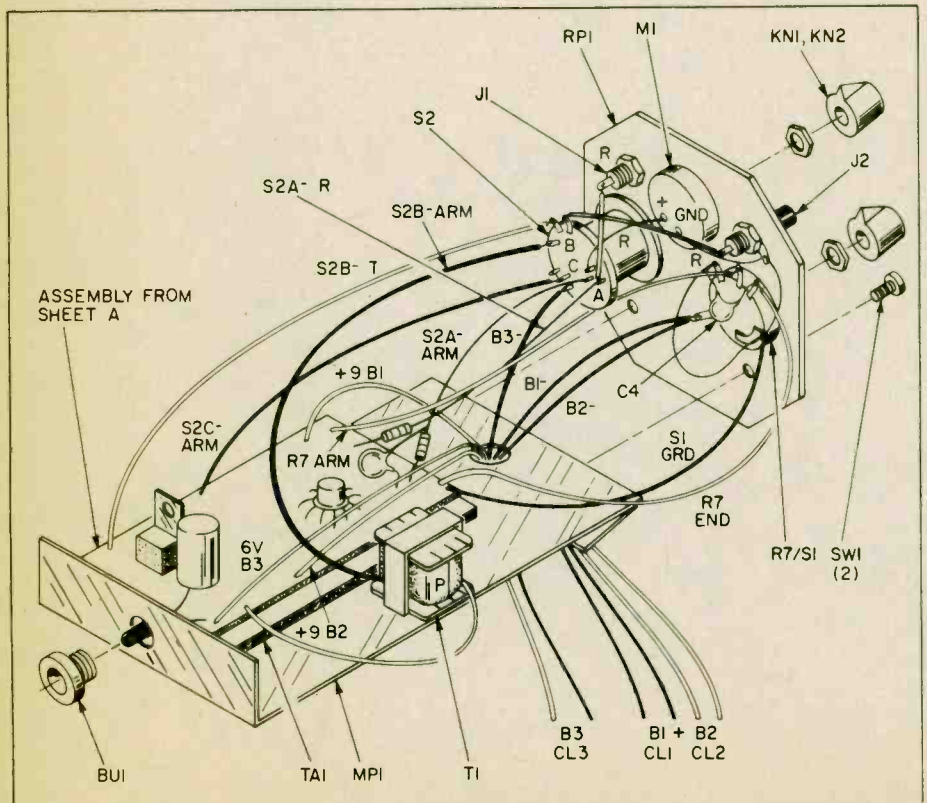
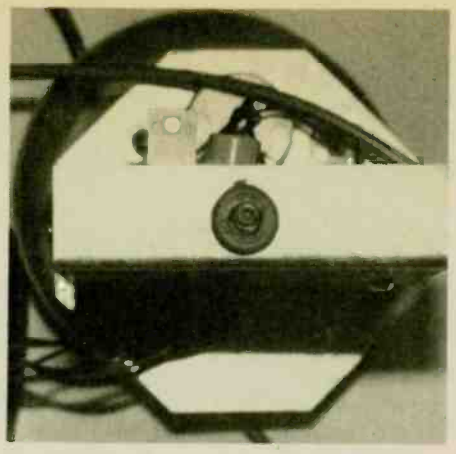


Fig. 2. Leads from the board to the rear plate assembly (RP1) are positioned as shown here. Leave plenty of free play in the leads to allow for adjustments to the device.

This photo of the back end of the transceiver shows mike, mode, volume controls.



The LED, either in normal or infra-red configuration, is the heart of the transmitter.

LED1 downward modulating, but we recommend upward modulating. Certain diodes may require less current than 50-mA for good upward modulation.

You are now ready for final assembly of the unit, and optical alignment. Note that LED1 should automatically center itself inside of EN1.

Optical Alignment. In order to obtain maximum performance from your light beam communicator, it is necessary to properly optically align both transmiter and receiver according to the sight line diagram.

You will note that the receiver tube EN2 is secured to EN1 via screws. The rear hole is slotted to allow a side to side movement of the receiver enclosure in respect to the transmitter enclosure. The up and down position usually self-adjusts simply by the abutting of the two enclosures. Remember that both receiver and transmitter sections must be optically aligned to view the same area for maximum two-way communications.

The method we demonstrate here is not necessarily the only way to align these devices and is only suggested as a possible means. The builder may have his own ideas and methods for accomplishing the above.

The following steps were used at our lab and found to be relatively easy in accomplishing acceptable alignment.

1. Remove transmitter lens and cover and place some thin paper over open end. Adjust LED1's output to the center of paper (this is the bore sight of enclosure). Secure and replace the lens and cover.

2. Secure communicator in vise or other similar holding attachment.

3. Locate a mirror about 20 feet from the device.

4. With transmitter properly aligned and secured, adjust mirror for reflection of output light occuring in receiver lens. This is adjusted by sighting mirror reflection along sight line at surface intersection of the two enclosures (note drawing).

(Continued on page 77)

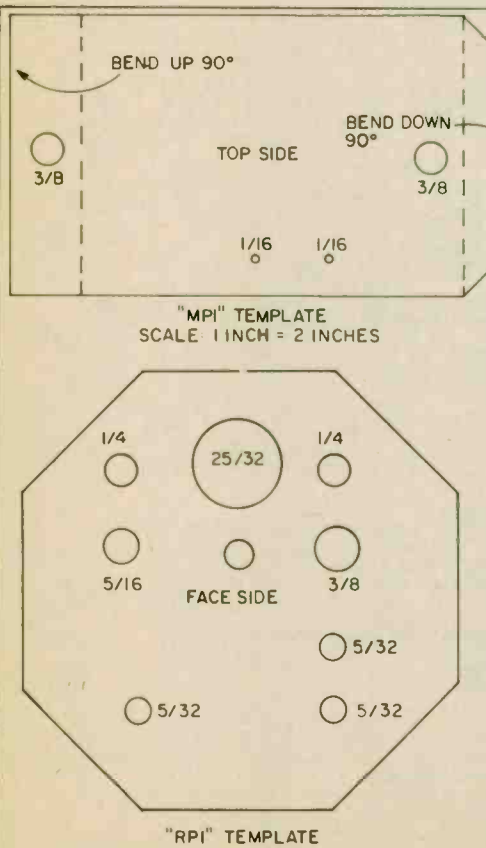


Fig. 3. This diagram shows the dimensions of the board and back plate mountings for Light Beam Communicator unit assembly.

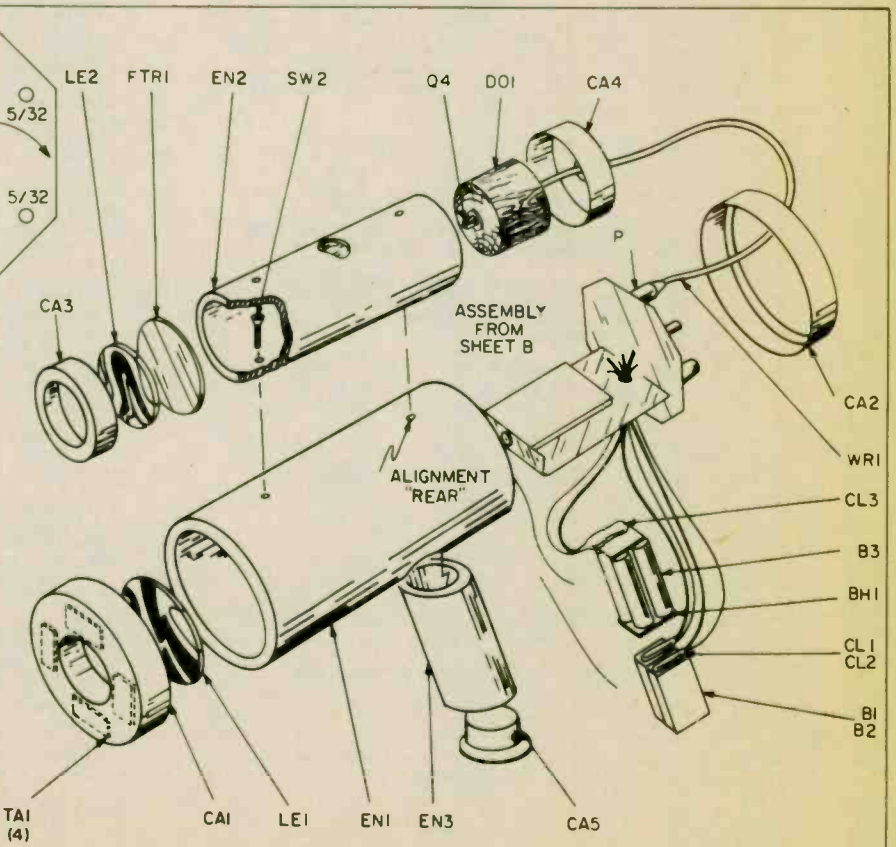


Fig. 4. This exploded view diagram shows the placement of the boards, housing, lenses and other parts necessary for construction and operation of Light Beam Communicator.

IT'S SIMPLY BASIC

List of Formulas and Computations

BY LARRY FRIEDMAN WB2AHN

THIS MONTH'S PROGRAM, *Scratchpad*, is designed to record variables and calculated answers and record them for further analysis. The program is capable of handling many calculations without requiring a formula each time a problem is processed. *Scratchpad* can be used for virtually any formula, from Ohm's Law to the Pythagorean Theorem. You simply enter a constant for the formula into the program, and the answers will be printed each time a variable is entered. The computer will store each variable in a data file, and will print a list of all variables and answers when the PRINT command is entered.

Scratchpad is a user-assisted program: you simply enter your own formula into the program (at line 460), and then add your own constant (at line 370). The program shown uses Ohm's Law (E = I x R) as an example, but you can use any formula

(Continued on page 76)

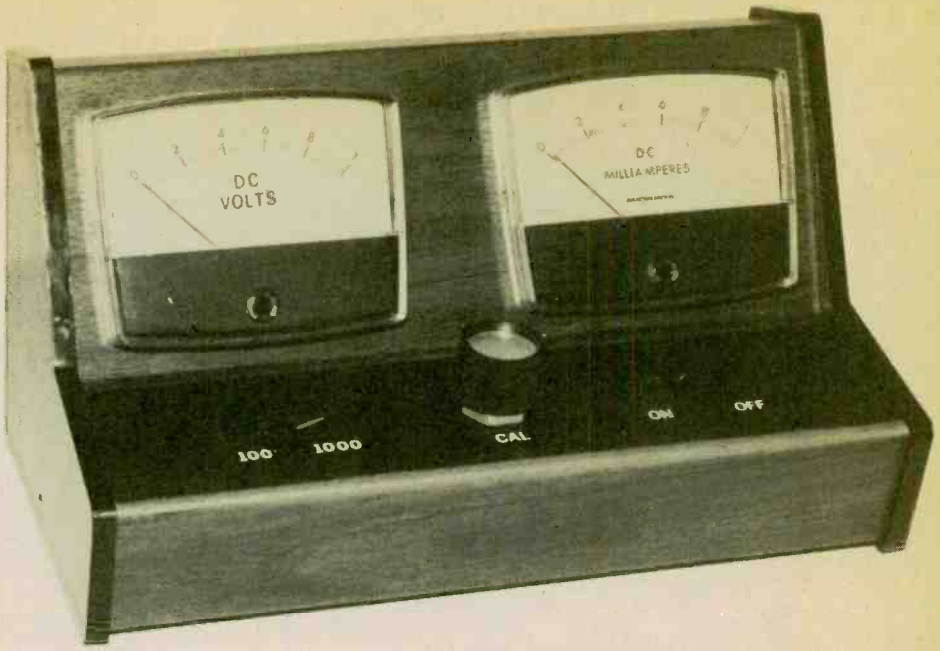
```
LISTING OF "SCRATCHPAD"

100 REM
110 REM          "SCRATCHPAD"
120 REM        BY LARRY FRIEDMAN
130 REM    FOR ELEMENTARY ELECTRONICS
140 REM
142 REM * THIS PROGRAM SERVES AS A "SCRATH PAD" WHEN
143 REM *  CALCULATING THE ANSWERS TO MANY VARIABLES,
144 REM *  USING AT LEAST ONE FIXED CONSTANT, SUCH AS
145 REM *  OHM'S LAW.
150 REM * TO USE THIS PROGRAM:
160 REM * ENTER FORMULA INTO PROGRAM AT LINE 460
170 REM *  (THIS VERSION USES OHM'S LAW - E=I * R
180 REM *  AS AN EXAMPLE AT LINE 460)
190 REM *  (USE 'A' FOR ANSWER AND 'V' FOR VARIABLE:  A=V*R)
200 REM * ENTER CONSTANT AT LINE 370
210 REM *  (THIS VERSION USES RESISTANCE AS A CONSTANT:
220 REM *  370 R=75, AS AN EXAMPLE)
230 REM * OPTIONAL: SPECIFY VARIABLE NAME AT LINE 410
240 REM *  (THIS VERSION USES:  410 PRINT "ENTER CURRENT"
250 REM *  AS AN EXAMPLE)
260 REM * THE COMPUTER WILL SAVE VARIABLES AND ANSWERS
270 REM *  ON DISK, AND/OR PRINT LISTINGS OF VARIABLES
280 REM *  WITH THEIR ANSWERS.
290 REM
300 DIM A(100),V(100)
310 GOTO 560
320 I=1
330 PRINT "ENTER 0 (ZERO) TO EXIT VARIABLE MODE"
340 PRINT
350 REM * LINE 370 IS AN EXAMPLE OF A CONSTANT; ACTUAL
360 REM * FORMULA CONSTANTS WILL BE ENTERED BY THE USER.
370 R=75
380 REM * LINE 410 IS AN EXAMPLE OF A PRINT STATEMENT TO
390 REM * DEFINE THE VARIABLE; ACTUAL PRINT STATEMENTS ARE
400 REM * OPTIONAL AND WILL BE ENTERED BY THE USER
410 PRINT "ENTER CURRENT"
420 INPUT V
430 IF V=0 THEN 560
440 REM * LINE 460 IS AN EXAMPLE; ACTUAL FORMULAS WILL
450 REM * BE ENTERED INTO THE PROGRAM BY THE USER.
460 A=V*R
465 PRINT "ANSWER = ";A
470 REM * A=E,  V=I
480 REM * A=ANSWER, V=VARIABLE  FOR ALL FORMULAS.
490 PRINT
500 A(I)=A
510 V(I)=V
520 I=I+1
530 REM * CHANGE LINE 550 TO:  550 GOTO 420
540 REM * IF THERE IS NO LINE 410.
550 GOTO 410
560 PRINT:INPUT "ENTER COMMAND  (TYPE 'LIST' FOR LIST)";C$

570 CLS
580 DATA LIST,DISK,PRINT,UPDATE,FIND,FORMULA,END
590 RESTORE
600 FOR P=1 TO 7
610 READ X$
620 IF X$=C$ THEN 660
630 NEXT P
640 PRINT "SORRY, COMMAND DOES NOT EXIST."
650 P=1
660 ON P GOTO 670 ,780 ,870 ,990 ,1070 ,1150 ,1160
670 CLS
680 PRINT "COMMANDS"
690 PRINT "--------"
700 PRINT "LIST        PRINTS THIS LIST"
710 PRINT "DISK        SAVES ALL DATA ONTO DISK"
720 PRINT "PRINT       PRINTS VARIABLES AND ANSWERS"
730 PRINT "UPDATE      ADD NEW DATA TO FILE"
740 PRINT "FIND        GET FILE FROM DISK TO DISPLAY"
750 PRINT "FORMULA     ENTER COMPUTATION MODE"
760 PRINT "END         ESCAPE FROM PROGRAM"
770 GOTO 560
780 OPEN "O",1,"DATA:0"
790 FOR Y=1 TO 100
800 IF V(Y)=0 THEN 830
810 PRINT#1,A(Y);",";V(Y);",";
820 NEXT Y
830 CLOSE#1
840 PRINT "DATA HAS BEEN PRINTED TO DISK."
850 PRINT
860 GOTO 560
870 PRINT
880 CLS
890 PRINT "VARIABLE","ANSWER"
900 FOR Y=1 TO 100
910 IF V(Y)=0 THEN 980
920 PRINT V(Y),A(Y)
930 IF Y/12+1=INT(Y/12+1) THEN 950
940 NEXT Y
950 PRINT@675,"HIT 'ENTER' TO CONTINUE";:INPUT@$
960 CLS:PRINT "ANSWER","VARIABLE"
970 GOTO 940
980 PRINT:GOTO 560
990 PRINT "UPDATE MODE"
1000 FOR Y=1 TO 100

1010 IF V(Y)=0 THEN 1050
1020 NEXT Y
1030 PRINT "FILE IS FULL."
1040 GOTO 560
1050 I=Y
1060 GOTO 370
1070 OPEN "I",2,"DATA:0"
1080 FOR Y=1 TO 100
1090 IF EOF(2) THEN 1120
1100 INPUT#2,A(Y),V(Y)
1110 NEXT Y

1120 PRINT "FILE HAS BEEN FOUND."
1130 CLOSE#2
1140 GOTO 560
1150 GOTO 320
1160 END
```

```
SAMPLE RUN OF "SCRATCHPAD"

RUN

ENTER COMMAND  (TYPE 'LIST' FOR LIST)? LIST
COMMANDS
--------
LIST        PRINTS THIS LIST
DISK        SAVES ALL DATA ONTO DISK
PRINT       PRINTS VARIABLES AND ANSWERS
UPDATE      ADD NEW DATA TO FILE
FIND        GET FILE FROM DISK TO DISPLAY
FORMULA     ENTER COMPUTATION MODE
END         ESCAPE FROM PROGRAM

ENTER COMMAND  (TYPE 'LIST' FOR LIST)? FORMULA
ENTER 0 (ZERO) TO EXIT VARIABLE MODE

ENTER CURRENT
? 10.13
```

Solar Cell Tester

Measure photovoltaic characteristics with this unique meter

BY T. J. BYERS



PHOTOVOLTAIC SOLAR CELLS may hold the promise for the future, but you can experiment with them today. Before utilizing the units in a project, it's necessary to know their capabilities.

All makers list a maximum output current rating, with some listing of power levels for a given light source (usually 100 mw/cm²).

So what? You need to know what it will do for you—under your parameters, your light source, and your load! How? With a handy-dandy solar cell tester.

The Rating Game. Silicon cell output varies with the light level, and with the load as well. If a cell is too heavily loaded, the power drops appreciably. Glance at the power graph. Notice it peaks when the voltage across the cell is 460 millivolts.

This is where the manufacturer tests his units, to determine *maximum performance*. He uses variable load, placed across the cell. With no load, the solar generator exhibits an open circuit voltage higher than its working voltage. As the load is increased (more current), the potential across the junction drops.

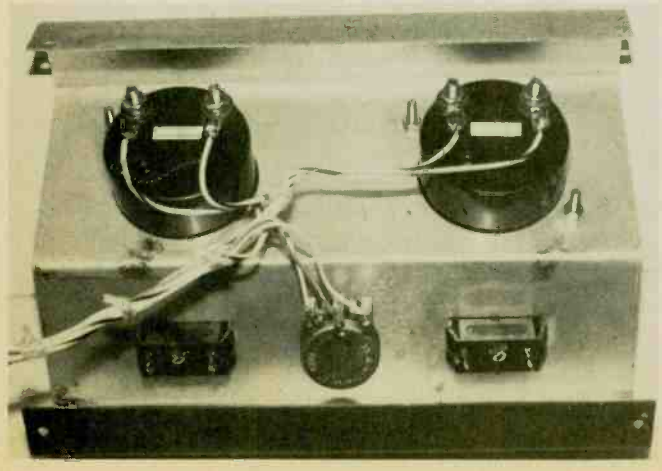
At one point, the current begins to dip along with the voltage—thus further reducing power. The maker sets the resistance so the voltage across the cell under test is optimum.

Figure 1, shows a simple circuit for performing just such a test. One meter monitors current . . . the other voltage. Adjusting the variable resistor to the peak power voltage (460 mv) will net you the device's current! But, the output current differs from cell to cell, necessitating a corresponding change in resistor value. That's fine if you're testing one or two units, but how do you efficiently check 20, or 50, or ??? With a dynamic variable load; one that adjusts itself to the correct voltage.

About The Circuit. The easiest way to achieve a dynamic variable load (DVL) is using a transistor. In figure 2, the solar cell is connected across the emitter and collector. As current is metered through the base, the VCE changes—loading the cell accordingly.

Now, add a feedback loop, an amplifier, a couple of meters, and we have a professional solar cell checker.

The feedback resistor, R_2, determines the amplifier gain, while the noninverting input monitors the voltage across the cell and compares it to the reference voltage at the inverting input.



Looking down at the Solar Cell Tester. Chassis, meters, switches, and the calibration control can be seen. If you look carefully, you will notice the wire shunt (Rm) across the panel meter on left.

Let's Make One. The tester can easily be duplicated, using any method of construction available to you: perfboard, PC board, point to point, etc. You'll notice, a PNP transistor is used for the load, making the ground positive in respect to the cell's input voltage. That's because the silicon cell has a *positive* backing, with the front contacts *negative* polarity.

The IC amplifier is a 741, but any stable operational amplifier should suffice. Don't forget the external compensation, should your choice require it. The only requirement—output current. As the transistor reaches higher current levels, the HFE (gain) decreases accordingly, requiring more base current through the transistor.

The sink transistor (Q1) may be any silicon PNP capable of passing 1 amp safely and able to dissipate about 1 watt. No heat sink is required.

My test instrument was designed to measure 1 ampere, but you can make it any range you desire by changing RM. If you use a 0-1 ma meter with an internal resistance of 50 ohms, follow the chart for your selected value. If it is 100 ohms, double that figure—it'll be close enough to be accurate.

Connect R_4 and R_5 to the Vcc power supplies as shown. The power supplies should be tracking—or, at least regulated. Otherwise, the reference voltage at the inverting input will shift, throwing off your calibration setting. (Actually, I've even used two 9 volt batteries and had good results. If the cells are within reasonable tolerance, the shift is negligible. But, for precision, a well regulated power supply is a *must.*)

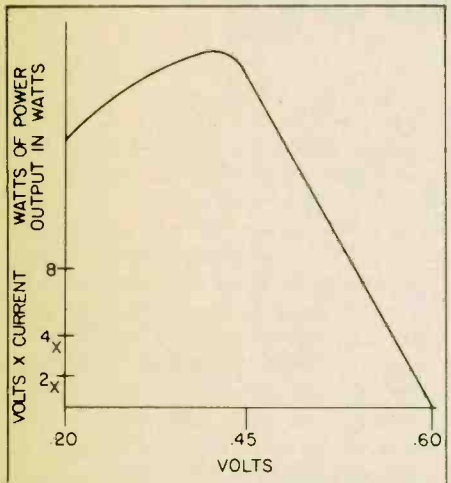
Using It. Connect the cell under test to the input leads, observing polarity.

Illuminate the surface with the light it will be subjected to (sunlight, desk lamp, etc.) and set the CAL control for the voltage—in most cases .46 volts. The current of the cell will be displayed on the other meter—don't forget your multiplication factor!

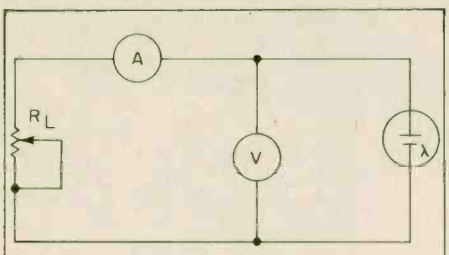
The tester will adjust to any cell automatically, regardless of the output current of the load.

A nice feature about the instrument is you can change the calibration to give you the output voltage at a specific current. Twist the calibration knob to your current value, then read the voltage. Of course, it won't regulate at that current value as it does voltage, but you will know the output voltage under the actual operating conditions.

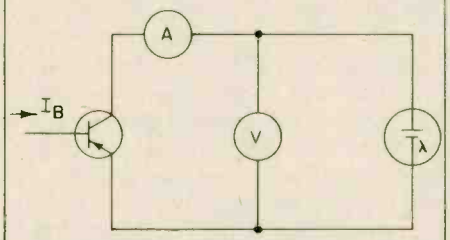
Obtain some solar cells you intend to use for your next solar project. Using your photovoltaic tester, you can now design your load to yield maximum power output. ■



Graph above shows how the solar cell's power output in watts will vary according to voltages above and below rated voltage.



The diagram above shows the basic circuit. The voltmeter shows cell voltage, while Ammeter (A) indicates the load, which can be adjusted by potentiometer, called RL.



In above diagram, the same output voltage can be obtained at different loads. This is accomplished by placing the calibration potentiometer in the transistor's base.

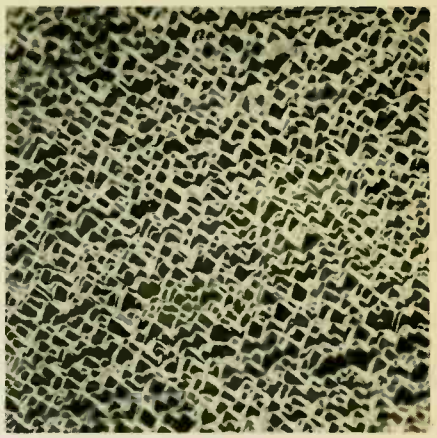
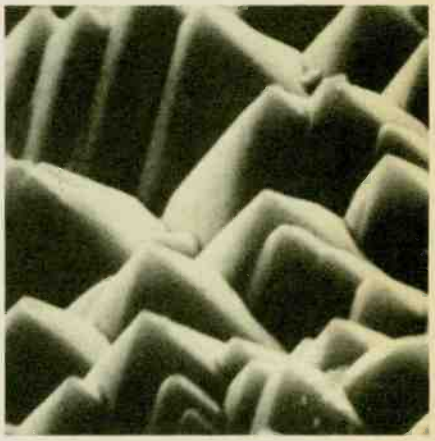
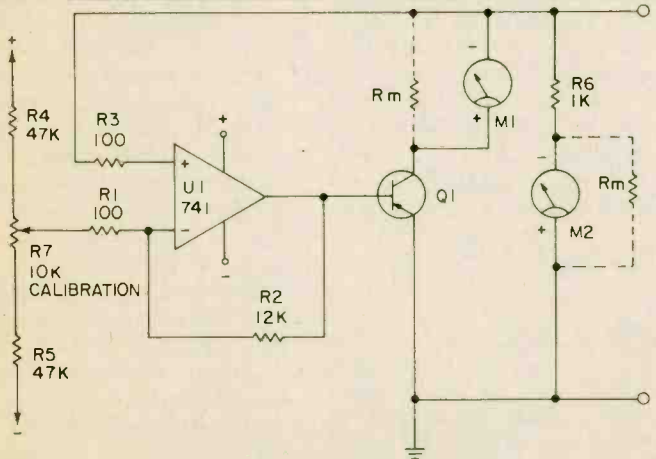


Photo above shows 400 times magnification of a photovoltiac silicon cell surface.



With cell surface magnified 4,000 times, tetrahydrons or peaks stand out sharply.



PARTS LIST FOR PHOTOVOLTAIC TESTER

M1, 2—0-1 ma panel meter (Radio Shack #270-1752)
Q1—transistor, ECG 129, or equivalent
R1—resistor, 100 ohms, ½ watt, 10%
R2—resistor, 12,000 ohms, ½ watt, 10%
R3—resistor, 100 ohms, ½ watt, 10%
R4-5—resistor, 47,000 ohms ½ watt, 10%
R6—resistor, 910 ohms, ½ watt, 1%
R7—(VR1) potentiometer, 10,000 ohms
U1—integrated circuit 741,1458, etc., operational amplifier

Note: The Radio Shack meter listed has 100 ohms internal resistance.

WHAT'S YOUR Rm VALUE ?

X1	0-1	NONE
X10	0-10	5.00 10.00
X100	0-100	.500 1.00
X1000	0-1000	.050 .100
	RANGE (MA)	OHMS

TOP VALUE IS FOR METER WITH 50 OHMS, BOTTOM IS FOR 100 OHMS.

Rm, or meter shunt value is determined by the meter's internal resistance. Using a shunt we can multiply the meter's face value by 10X, 100X, or 1000X. As we increase the multiplied range, the resistance value of the shunt (Rm) goes down.

S&E LAB TESTS...

the Atari 800 Computer

This sophisticated microcomputer has plug-in modules and a full line of peripherals

CIRCLE 70 ON READER SERVICE COUPON

THE WORLD of personal computing will never be the same. Atari, a company that has made a name for itself in the field of electronic toys and games, has now entered the home computer market with their Atari 400 and Atari 800 computers.

We took a look at the Atari 800 and we can tell you this is one personal computer that means business—and home finance, recreation, computer assisted instruction and everything any other machine in its class is capable of.

At The Keyboard. The Atari 800 is a handsome machine; we found our first evidence of its quality right under our fingertips. The keyboard is one of the best of any personal computer we have used. This may seem a minor point to start off a review with, but the keyboard is the part of the computer the owner will use the most. The keyboard is the interface between the human's gray matter and the computer's silicon chips. Typing in a three hundred line program on the Atari 800 isn't a rest cure, but it won't drive you bananas either!

The keyboard gives you upper and lower case, shift lock, graphics characters (more on those in a moment) and an inverse video key, all in normal typewriter format. The reset key is well off to one side so it is impossible to hit by accident. (Important, since an accidental resetting could lose you programs, data, time and money.)

Plug-In Wonders. The 800 features a number of touches that will appeal to both beginner and pro. One of the nicest is the way in which additional memory is added.

Additional memory for the Atari comes in handy plug-in RAM cartridges. You can add up to 48K of memory to this system as fast as you can pop in the cartridges. This memory system is a bit more expensive than individual RAM chips (each cartridge contains some support chips) but it is not prohibitive. However, we feel that the ease and security of installation make up for the slight cost differential.

And here's something to fire the imagination: plug-in languages! Right now Atari only offers BASIC on a plug-in ROM pack, but it seems certain that other languages will follow. The concept of plug-in languages is one more assurance that the machine will not be obsolete should the hobby ever leave the Microsoft BASIC standard. Pascal, FORTRAN, and perhaps some esoteric but useful computer tongues such as LISP and FOCAL—I think we may confidently predict their arrival sooner or later on a plug-in Atari ROM pack. What we hope comes sooner than later is a plug-in *monitor* language. Right now the machine language programmer cannot set directly at the 800 CPU (central processing unit).

Now we come to another plug-in feature: software programs on ROM pack. The 800 accepts Atari programs that are being marketed in firmware—cartridges much like those used for video games.

If you have a child who will use the computer, or someone who just can't (or won't) take the time to learn how to use a cassette recorder, these plug-in programs will enable the computer to be used without supervision. There are, however, disadvantages to this system. The most serious disadvantage is that programs on ROM pack cannot be listed and changed.

Everyone who has a computer changes his store-bought programs to better fit his needs. Perhaps it is only changing the wording of the printed output, or maybe it is adding an entirely new subroutine. The point is: The only real difference between a home computer and a video game is the computer's programmability. These ROM packs do detract from that feature.

It is not only Atari, of course. Most new computers now have this plug-in software capability. The reasoning behind it may well have its roots in the hobbyist phenomenon of software piracy. A program on tape or floppy disk may be easily copied and the copies handed out like two-cent candy—and there go the company's profit and the programmer's royalties.

Programs in firmware ROM cannot be changed, and they cannot be copied either, at least by most consumers. On the plus side, this might make the software business more profitable and result in better programs. On the other hand, there is the matter of decreased programmability.

We hope Atari (and other companies) will continue to offer programs on both floppy disks and audio cas-

While BASIC is the only language offered in these handy, plug-in ROM cartridges for the moment, others are slated for the near future, making the 800 even more attractive.

settes, as well as in plug-in versions. Already we have seen a number of secondary manufacturers gearing up to offer Atari-compatible software. So far most seems to be planned for cassette; and that, we think, is a hopeful sign.

Color, Sound, Action! The 800 is a full color computer. As you would expect from Atari, this is a computer with great graphic capability, and the graphics are backed up by good sound effect circuitry. For games and recreation, we predict a plethora of software offerings for this computer.

There are four different graphics modes available. Each graphic mode changes the size of the smallest pixel of color on the screen. In other words, it changes the resolution of the picture.

A mode with big pixels will mean quickly drawn splashy color, but without the capability of smooth curves. Small pixels will mean harder-to-program design graphics, but graphics that look almost as good as those from much more expensive systems.

(The manual, by the way, claims eight different graphic modes. However, four of these seem to do exactly the same as the others. Possibly these other modes or resolutions will be more fully implemented when Atari comes out with other languages or a machine language monitor.)

The BASIC commands used to draw on the screen are just about self-explanatory. Commands such as DRAWTO, PLOT, COLOR, SETCOLOR are quick to memorize and easy to use.

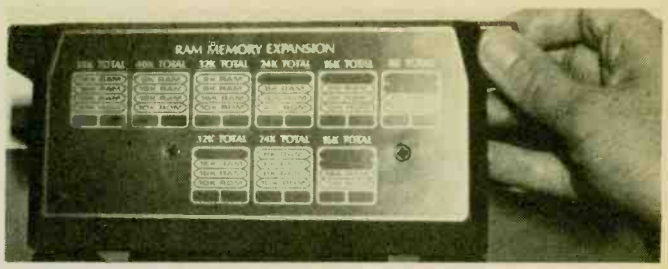
There is also a keyboard full of preprogrammed graphics characters available. These squares, circles, lines, dots, hearts, clubs and many other forms can be used in simple PRINT statements to add to the 800's graphic possibilities.

Backing up the 800's color enhancements are some nice programming possibilities for sound as well. Up to four different melodies (voices) may be programmed to play simultaneously.

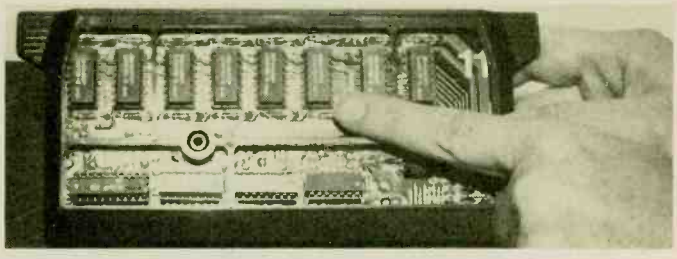
To program a note requires the programmer to assign values to four variables: Voice, Note, Tone and Loudness. Any note on the diatonic scale can be easily figured out and entered into your program.

Nowadays it is almost expected that a new personal computer will offer great color. But we were surprised at just how great *both* the color and sound were on this unit.

Peripherals. We looked at the 5¼-inch floppy disk drive system and the 40-column printer that Atari has made available for the 800. The Atari peripherals connect in a non-standard manner to the computer, in something that Atari calls "daisy-chaining."



The Atari RAM memory modules are entirely self-contained, complete with all the necessary chips, both support chips and also those dedicated to memory functions.



This inside view of a RAM memory module illustrates the convenient system chosen by Atari. While more expensive than adding individual chips or boards, it's worth it.

You can add up to 48K RAM to the system as fast as you can slip the cartridges into it.

Any one peripheral's cable will plug directly into the 800. The next peripheral plugs into that one, and so on. Connecting both printer and disk took less than a minute. We have never seen a system of computer, printer and disk go together so quickly and surely.

If there is a drawback, it would seem that you are only able to use Atari peripherals with the 800. But this may change as more and more hobbyists set their hands on the 800 and devise ways to attach regular RS-232 devices. And other manufacturers are likely to hop aboard the Atari bandwagon and supply equipment for the 800.

Even if that does not come about, the printer ($495) and disk ($595) are competitively priced with other comparable units on the market. Sticking with Atari for peripherals will not hurt monetarily.

How about performance? Well, the printer was as good as any other 40-column machine we have seen. It is quick, quiet and reliable.

The printer's capabilities are fully supported by the 800's version of Extended BASIC. You can list or print direct from the keyboard or call the printer from within a program.

The disk drive is fast and reliable, too. However, the Atari DOS or Disk Operating System (the software which lets you use the disk) does have a few rough spots, compared to Radio Shack's TRSDOS or Apple's 3.2 DOS.

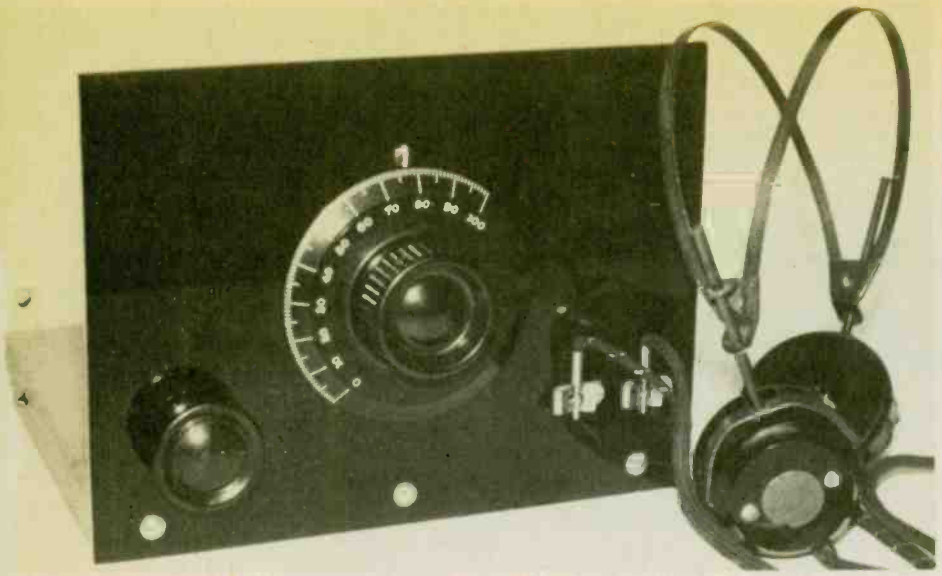
It is a bit difficult to progrom random access files and keep them to a predetermined byte length. Obviously, this will only affect the more advanced programmers. A business will most likely set turn-key software and not even have to worry how the program is accomplished.

For normal, everyday saving of programs and data, the disk does fine. Most computers now on the market have gone through two, three, or even four revisions of their Disk Operating Systems and we expect that Atari will do the same. (By the way, since the DOS of a computer is *software*, updates are always very cheap and quick to implement.)

Read All About It. The documentation that arrives with the 800 will take you by the hand and lead you from opening the box, to setting up the system, to programming in BASIC. The BASIC reference manual is complete and—for neophytes—Atari includes the book, ATARI BASIC by Albrecht, Finkel and Brown.

The book, available separately from Wiley and Sons Publishers, is a programmed learning course to teach Atari BASIC. Read at the keyboard, it should

(Continued on page 78)



One-Tube Regenerative Receiver

Build this broadcast receiver from the early days of radio

BY JAMES ROZEN

MANY EXPERIMENTERS NEW to electronics have never worked with tubes. This is unfortunate because while transistors don't require large amounts of power, and ICs can cram huge circuits into dust grains, the vacuum tube has an aestheic advantage over solid state components. In addition, the tube's elements are physically large and the principles involved are simpler and easier to understand. So, here is a one-tube broadcast band regenerative receiver project. The finished radio is much superior to the beginner's crystal set, yet is not much more difficult to build. It only requires a modest antenna (20 feet or so) and a good ground to perform well. Incidentally, the circuit is a real oldtimer. Lee De Forest and E. H. Armstrong simultaneously discovered it around 1912, and were involved in a long patent dispute over it.

Theory. For those of you who don't remember those two gentlemen, I'm going to give a bit of theory about vacuum tubes and this particular radio. I apologize to those of you who are well versed on these subjects, and beg your indulgence.

The simplest tube is a diode (di- two, ode- element), which is a hairpin of tungsten wire surrounded by a cylindrical metal tube. Both are sealed in a glass bulb from which all the air has been pumped. Connecting a battery across the *filament* wire causes it to glow red hot (much like an ordinary incandescent lamp) and the electrons in the wire are given enough energy to boil off into the vacuum.

If a battery's plus terminal is connected to the metal cylinder (the *plate*) and its minus terminal is connected to the filament, a current of these electrons (electrons have a negative charge) will flow through this plate circuit. *No* current, however, will flow if the plate battery is connected backwards, because electrons cannot leave the plate's surface (see Fig.1). Although this diode will function as a rectifier (one-way valve) or as a rudimentary radio detector, it is good for little else.

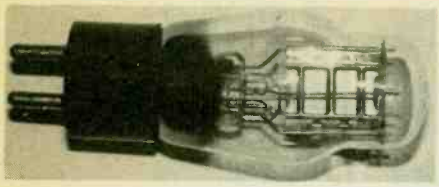
Around 1906, Lee De Forest changed this by adding a small twist of wire in between the filament and the plate. This *grid* can be used to control a large power (in the plate circuit) with a small power (in the grid circuit). Here's how: putting a negative voltage on the grid diminishes the plate current, because electrons traveling from filament to plate are repelled by the electrons sitting on the grid. Remember, like charges repel; see Fig. 2. There's a smooth relationship; many electrons on the grid cause a very weak plate current, or Ip, and only a few sitting there allow a stronger plate current. Figure 3 is a graph of just such a relationship. In this case, no plate current flows when the grid voltage is negative seven volts. Of course, the tube (a triode) is still a rectifier, but now it amplifies, too!

Okay, first diode, then triode, now radio: our simple receiver consists of a tuner, a radio frequency (or RF) amplifier, a detector, and an audio amp.

All of the receiver's components are mounted in full view on the spacious rear board.

Our versatile tube is both detector and amplifier. The tuner is the parallel combination of L2 and C1. Here's the scheme: many different RF signals exist at the antenna input (see Fig. 4), and are coupled to L2 through the antenna coil, L1. The LC tuner (L2 and C1) looks like a short circuit for all frequencies but one, and this one is sent through C2 and R1 to the grid of V1. They make V1 act like a detector by fixing it so two signals appear: the rapidly varying RF signal (1 MHz or so) and a slowly changing audio signal (200 to 5000 cycles or so). Pretending for a moment that R2 is fully shorting L3, we see electrons flowing from ground, through V1, where they pick up the two signals in an amplified form, and then flow either through C3 to ground or through L4, the earphones. the 90 volt plate battery (which supplies all the electrons' energy) and thence to ground. Note, however, that the RF signal goes through C3 because that capacitor is too small to pass the low audio frequencies, and conversely the audio travels through L4 (an ***RF choke***), which presents an open circuit to the high radio frequencies. Thus an amplified version of the audio that was once impressed on the RF carrier wave appears in the earphones.

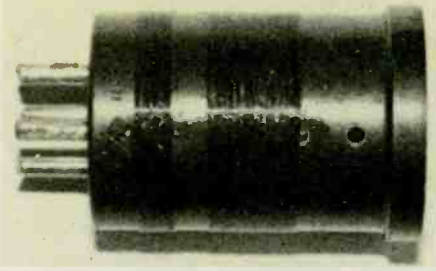
So, what's L3 for? Well, I wasn't telling the whole truth when I said our LC tuner selected only *one* frequency. It tuned in on *mostly* one frequency, but some others sneaked in, too. The width of this tuning curve (see Fig. 5) determines the selectivity, or station selection ability of our radio. This bandwidth, depends on the Q, or quality factor, of the LC combination. A high-Q circuit has thick wires, no energy losses, and consequently a sharp tuning curve. Unfortunately, the Q of our L2, C1 combination is low, and *that's* why a small amount of RF energy in the plate circuit has to be fed (via L3) back into the grid circuit to account for



While a Type 30 tube was used in the author's set, any tube in the table is good.

energy losses there.

Feeding more and more energy back (turn R2 clockwise) forces the Q sky high, along with the selectivity. The RF amplification increases, too. When we feed more energy into the tuner than is lost, the tube starts oscillating, or producing its own RF signal, at the frequency the tuner is set for. This is undesirable, because it distorts the signals and reduces the set's gain. Obviously, the best setting for R2 is where the tube almost oscillates (see Fig. 6). Now that some of the fundamentals are clear, we discuss next building a real live regenerative receiver.



Coil forms such as this one are becoming rare items, so you may have to substitute.

Finding the Parts. Unfortunately, few electronics shops stock battery tubes (some don't stock any tubes at all!) so here are some hints: a type 30 tube (called for in the parts list) is not necessary. Any of the tubes in the tubetable could be used, but just be sure to use the right filament voltage and the right pin diagrams when you wire. Obviously you will need an appropriate socket, and you may have to up the plate voltage on some tubes to obtain sufficient regeneration. Those tubes marked AC can use alternating current for their filaments because the actual electron emitter is a metal sleeve (called a cathode) insulated from the filament. Without it, hum would be too loud. These types will, of course, use DC as well, but to save the batteries, you would use a transformer to run the filament, and connect the cathode to top of L3 and to R2.

Triode Type Tubes

Remarks	Tube type	Filament Voltage
4 pin	199, 299	3 V
4 pin	201-A, 301-A	5 V
4 pin	30	3 V
5 pin	227, 327	2.5 V AC
8 pin octal	1LH4	1.5 V
8 pin octal	1G4GT	1.5 V
8 pin octal	1H4GT	1.5 V
8 pin octal	6C5	6.3 V AC
8 pin octal	1/2 6SN7	6.3 V AC
8 pin octal	6J5	6.3 V AC

This table gives a list of the tubes that may be used in the regenerative receiver.

Enough about tubes. Plug in coil forms are hard to find (I don't know if they're still made) but they can be had if you scrounge enough. More on that later. You can salvage the coil wire from an old power transformer by pulling the laminations apart and unwinding the core—number 30 wire is about sewing thread size. The wire, along with the tuning capacitor, earphones, dials and tube sockets, came from my junk box, but any of these items could be purchased commercially (note: don't try to use low impedence hi-fi earphones or the crystal type, either. These won't work). Any wood will do for the base (pine is easy to work with) and the front panel doesn't have to be fancy black plastic: plywood, fiber-

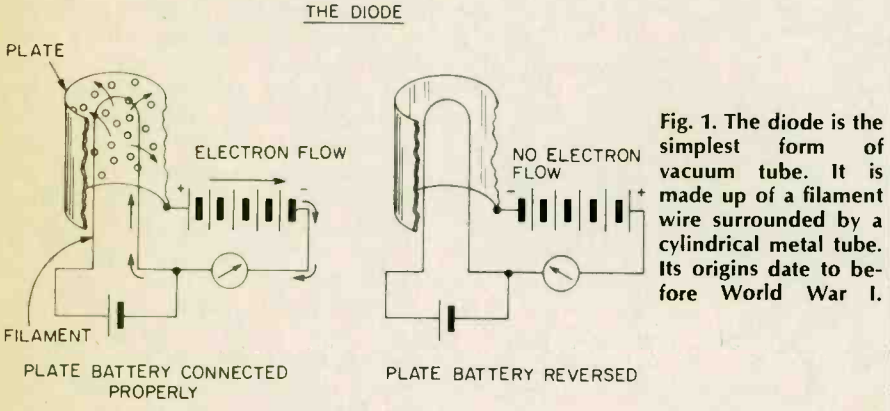


Fig. 1. The diode is the simplest form of vacuum tube. It is made up of a filament wire surrounded by a cylindrical metal tube. Its origins date to before World War I.

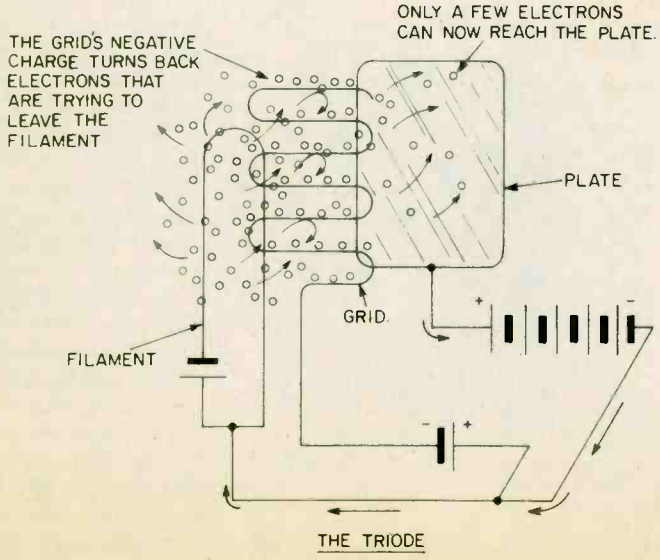


Fig. 2. The triode, a refinement of the diode, has a grid between the plate and filament. This made a rectifying tube into a tube with amplifying capabilities.

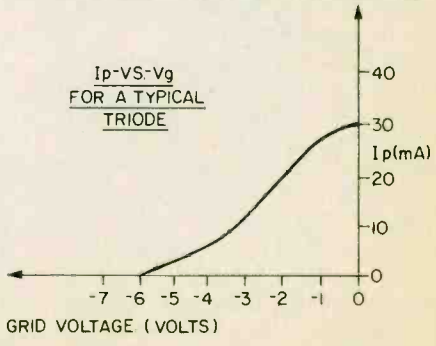


Fig. 3. This graph shows the relationship between the grid voltage and plate current.

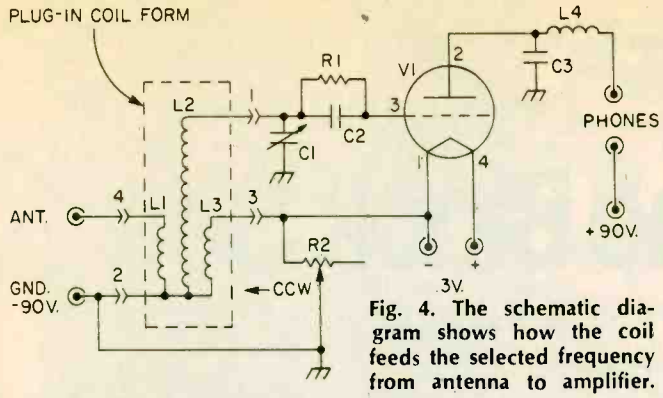
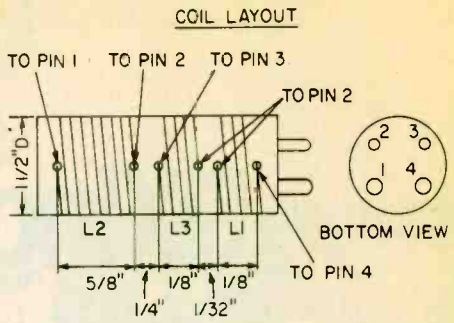


Fig. 4. The schematic diagram shows how the coil feeds the selected frequency from antenna to amplifier.



L1-11 TURNS #30 ENAMELED WIRE
L2-55 TURNS #30 ENAMELED WIRE
L3-12 TURNS #30 ENAMELED WIRE

NOTE: ALL COILS ARE CLOSE WOUND IN THE SAME DIRECTION.

Fig. 7. The coil winding guide shows the wiring configuration of the important coil.

PARTS LIST FOR REGENERATIVE RECEIVER

C1—350 pF, variable capacitor
C2—250 pF, mica capacitor
C3—470 pF, disc ceramic capacitor
L1—11 turns, No. 30 enameled wire, close wound on 1½-inch coil form
L2—55 turns, same construction parameters as L1
L3—12 turns, same construction parameters as L1
L4—2.5 mH RF choke
R1—2,000,000-ohm resistor, ½ watt, 10%
R2—1,000-ohm variable resistor, ½ watt or more
V1—type 30 vacuum tube or similar, see Tube Table
Misc.—Wood base 7-in. x 8-in. x ¾-in., black acrylic front panel 8-in. x 6-in. x ¼-in., 1 large knob, 1 small knob, 7 binding posts, 14 prong plug-in coil form, No. 30 enameled wire, hook-up wire, 2 sockets (4 pin), 4 spacers (¾ inch long), wood screws, machine screws, solder lugs, batteries, earphones (hi-Z type), antenna, ground.

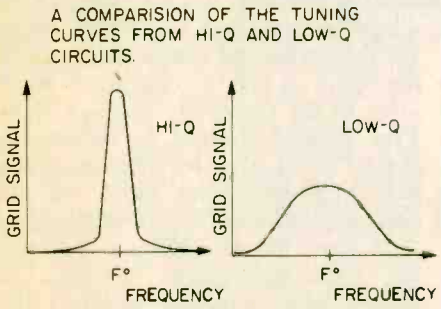


Fig. 5. The width of the tuning curve is the determining factor in set's selectivity.

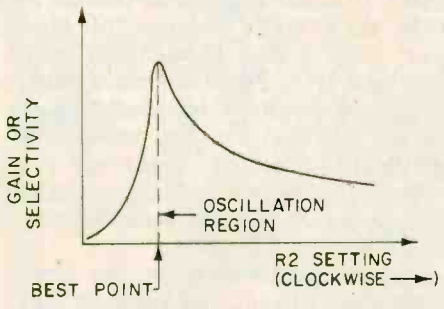


Fig. 6. Too much oscillation is undesirable; R2 must be set to give the minimum.

board or metal would all work. My panel, however, was free, courtesy of the local plastic distributor (they even cut it to size!) and it only took a bit of abrasive paper to clean up the edges. The filament, or A battery, can be anything from number six dry cells to storage batteries to flashlight cells soldered together. The B, or plate battery, is a rather esoteric item, and while some stores still stock them, a substitute might be 9 volt transistor (yuch!) radio batteries soldered in series, or a myriad of worn out flashlight cells. Plate current (Ip) is only about 6 mA.

Construction. Now that all the parts are at hand, begin by cutting and finishing the wood base. A quick sanding and a coat of linseed oil or shellac will give it a glossy surface, but avoid paint, as paint often has metallic pigments that could short out connections. Then, mark and drill the front panel to fit your particluar way of mounting R2, C1, and the binding posts for the earphones. Some capacitors have threaded holes on their bottoms, so you may have to fashion an L bracket to hold it to the front panel, or mount it from the base using spacers. Drill three holes ⅜-inch up from the bottom of the panel to fasten it to the base. In all cases, be sure to drill slowly and carefully to avoid splitting the plastic as the bit pops through. Drill pilot holes on the front of the base, and screw the front panel on. After mounting C1, R2, and the earphone connectors, mount the knobs and tube sockets. I mounted my sockets by passing a 1¼-inch long wood screw through each of the socket's holes, and slipping a ¾-inch long spacer over each. Then I screwed the whole thing to the base about halfway between the front and the back, to allow room for wiring. At the back edge of the base, mount the binding posts or clips for the batteries, ground, and antenna. Once again, I mounted all the posts on a strip of plastic, and used the wood screw—spacer technique. Then wire according to the schematic. You probably won't need any tie points, because you can always solder an extra length of wire to a too-short lead, and slip spaghetti over the connection.

Do try to keep the wire between V1's grid and the C2, R1 combination very short. It tends to pick up noise. Finally, mark each binding post with its proper function.

Winding the Coil. As I said before, plug-in coil forms are becoming scarce, so if you can't get one (try to, because it makes the coil winding easier), you can substitute many things in its place. Tissue rollers, wood dowels, plastic tubing, or anything non-metallic will work, and it doesn't have to be exactly 1½-inch in diameter if you're willing to experiment some. If the form is too narrow, you'll have to wind more turns than I've indicated, and if it's wider, less wire will be needed. If you're not sure how much to wind onto L2 (L1 and L3 aren't too critical), wind on extra, because it's easier to remove turns than to add them.

Start by marking and drilling the form as I've indicated (see Fig. 7), and proceed by winding the required number of turns. Scrape (using fine sandpaper) the insulation off the end of your wire, run it through the bottommost hole you drilled on the form, and insert and solder it into pin. 4 Hint: if your form is plastic, hold the pin in the middle with a pair of pliers to prevent the heat from softening the plastic. Wind 11 turns, clip the wire (leaving enough to make the other connection) and insert it into pin 2, via the hole in the form's side. Don't solder it, but just cut off the wire, leaving about ¼

(Continued on page 75)

S&E LAB TESTS THE...

Sinclair ZX80 Computer

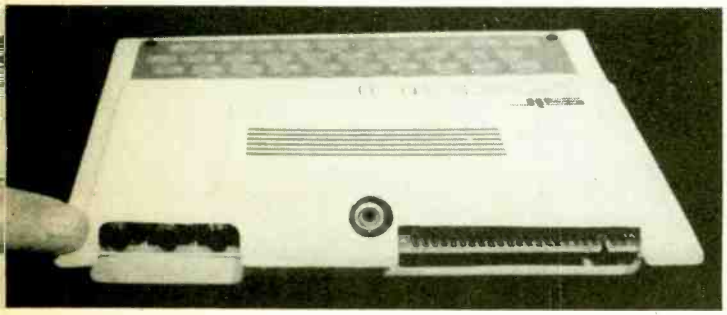
This mini-micro is a real computer for $200

CIRCLE 75 ON READER SERVICE COUPON

FROM ALMOST THE inception of solid-state technology, Sinclair Research Ltd. has been in the forefront of consumer electronics miniaturization. Their shirtpocket-sized FM radio and the first of the sub-mini pocket calculators are just two examples that come to mind. It is therefore not surprising to find that Sinclair has now come out with a sub-mini micro computer, the ZX80.

Sub-mini Micro. The ZX80, which is made in England, measures 6⅞ inches wide, by 8½ inches deep by 1 7/16 inches at its highest point. Weight is an almost unbelievable 12 ounces. The entire case and the keyboard are plastic. The keyboard is the "Lightouch" type such as used in electronic cash registers and scales. Sensitive switch contacts are sandwiched between two layers of flexible plastic, with the keyboard symbols printed on the top. When the plastic within a symbol's outline is pressed, the contacts under the symbol close to complete the circuit.

No display is provided because your own TV receiver becomes the CRT.



The plug in the middle of the ZX80's rear panel interfaces the computer with a TV set, which it uses as a CRT. The other three plugs are for power, a cassette recorder and for future peripherals.

Within the ZX80 computer is an RF modulator with an output on UHF channel 36. A standard phono jack on rear provides RF output to your TV.

Near the RF output are three other jacks, all of which are the miniature type. One is for the external 9-volt power supply, which is a plug-in AC adapter such as supplied with calculators and tape recorders. The remaining two jacks are input and output connections for a cassette recorder which serves as the data storage medium. Any program you develop can be recorded on standard audio cassettes for use at a later time.

Also, on the rear edge, is a connector for attaching optional peripherals as they become available. For example, the basic ZX80 computer comes with 4K of memory; and at present, an optional 16K of memory is available. Instead of reworking the computer's guts for installation, the 16K memory module is simply plugged into the connector.

The ZX80's language is a 4K integer BASIC in ROM. The term integer means there are no decimals: you cannot directly enter, say, 12.44 and 13.67 and perform any arithmetic operation; the computer will drop the decimal values. However, as with other integer BASICs, you can enter the values without the decimals—1244, 1367, etc.—and then use a subroutine in your program to calculate the "remainders." It's not the easiest of procedures, but it can be done. Also, not everyone uses decimals.

Sinclair BASIC. Unlike other 4K BASICs which were used in the early days of personal computing, Sinclair's BASIC is uncommonly extensive and flexible. Among the differences: many commonly used commands are "tokenized," meaning that you need enter a single key rather than the entire command; the computer makes the translation. For example, to enter INPUT the user simply touches the "I" key. For PRINT, the "P" key. For LIST, the "A" key is depressed.

Actually, you don't have to keep track of which key represents what "token." The key symbols imprinted on the keyboard contain the alphanumerics generated by the key and the shift. Also indicated are ten graphic characters, which we'll get to later. The "tokens" are fully spelled out above each key, and most are transmitted when the appropriate key is depressed.

Internal programming, within the computer, keeps track of whether a key should transmit the token or the character. For example, if you haven't yet started to enter a program, the Q/NEW key transmits the NEW command rather than a "Q" because no program starts out with "Q." If you're already into the program, pressing the "Q" enters a "Q" because you don't start a new program without clearing the old one. Get the idea? It's all handled automatically by the computer. A few tokens and editing commands (editing is built in) are obtained on a SHIFT.

The 4K BASIC contains the integral functions CHR$, STR$, TL$, PEEK, CODE, RND, USR and ABS. The graphics, which were briefly mentioned earlier, allow the screen to be utilized for non-alphanumeric display: a bar graph interpretation of numeric data, for example.

Like all BASICs, the ZX80's is too extensive to discuss in any detail here. It's the type of thing to try "hands on" in the dealer's showroom.

Programming Ease. There are a few features we should cover, however, because they are particularly attractive to the newcomer and beginning programmer. The ZX80's BASIC is loaded with helpful programming conveniences. For example, the cursor, the block or square that tells you where you are on the CRT, changes shape to indicate "condition." Normally the shape of a "block K," it changes to an "L" when you're running a program and the computer is waiting for you to do something. If the computer is waiting for you to input a number, the cursor indicates an "LS."

When entering a program the cursor

(Continued on page 76)

SEMICONDUCTOR SURVEY

THE EXAR XR-2207: A FOUR-FREQUENCY VCO

BY ED NOLL

THE EXAR XR-2207 is a voltage-controlled oscillator (VCO) that can provide simultaneous triangle and square wave outputs or simultaneous pulse and ramp outputs. Frequency range extends from 0.01 Hz to 1 MHz. Four separate output frequencies can be selected by a two-terminal binary logic input.

The internal arrangement, shown in Fig. 1, consists of the VCO and individual buffer amplifiers for both triangular and square wave outputs. There are four internal current switches to which four external timing resistors can be connected. These resistors, in conjunction with the timing capacitor connected between pins 2 and 3, determine the operating frequency. Four individual frequencies can be selected, as set by the logic levels applied to the binary keying input terminals 8 and 9.

A simplified schematic of the frequency control arrangement is given in Fig. 2. The frequency-determining capacitor is connected between pins 2 and 3, while the four frequency-determining resistors are connected to pins 4 through 7. It is these resistors that are keyed in and out of the circuit by the binary information applied to terminals 8 and 9.

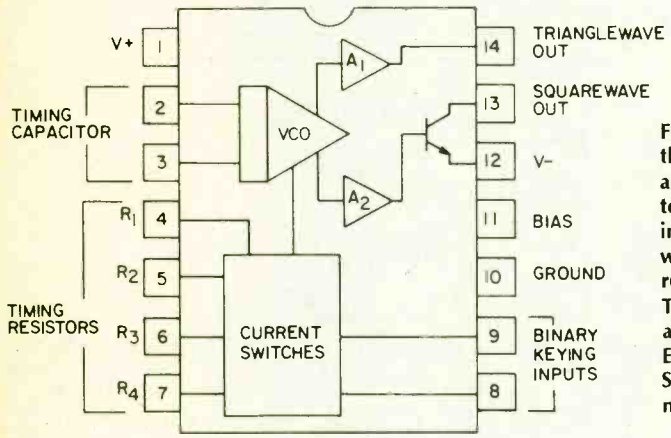


Figure 1. Block plan of the Exar XR-2207 voltage-controlled oscillator. Note the four internal switches to which external timing resistors can be added. The Exar XR-2207 is available from Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002.

Frequency of Operation. The frequency of operation is determined by the resistor-capacitor time constants as selected by the binary logic levels of A and B as applied to pins 8 and 9 respectively. These relations are shown in the table.

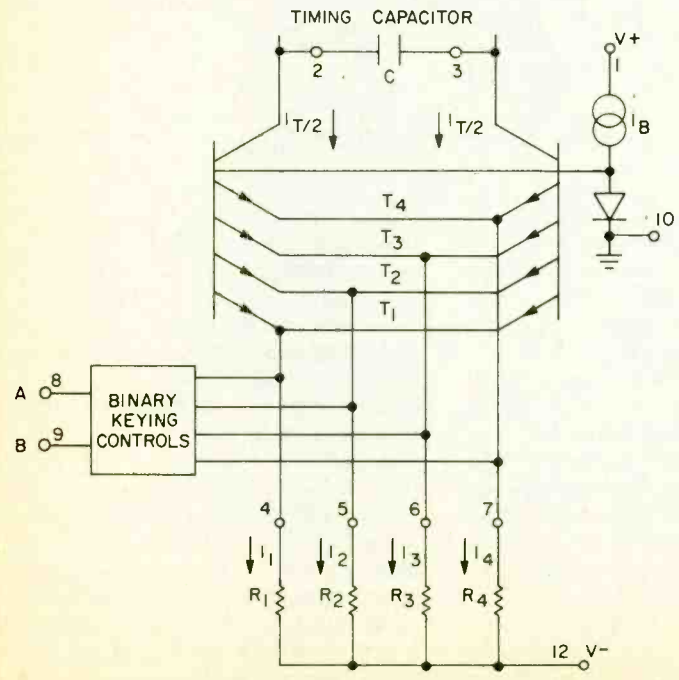
Individual equations for f_1, Δf_1, f_2 and Δf_2 are:

$f_1 = 1/R3C$ $\quad\quad$ $\Delta f_1 = 1/R4C$

$f_2 = 1/R2C$ $\quad\quad$ $\Delta f_2 = 1/R1C$

For example, when terminals 8 and 9 (A and B) are at logic 0, the resistor connected to pin 6 is selected. Thus the frequency of operation is 1/R3C. If the logic level at A is zero and at B is 1, both resistors R3 and R4 are selected. Therefore, the frequency of operation is 1/R3C + 1/R4C. If resistors R3 and R4 were of exactly the same value, the latter logic condition would produce an output frequency that is twice the frequency obtained with the first logic condition.

Four-Frequency Oscillator. The practical four-frequency oscillator circuit of Fig. 3 was set-up by the author on a solderless breadboard. The logic switching is shown at the lower right. When



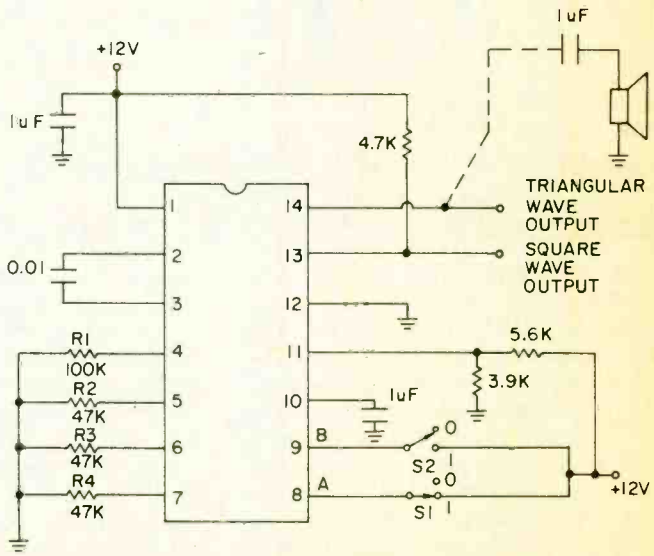


Figure 2. Schematic of frequency control arrangement is at left. The frequency-determining capacitor is connected as shown.

Figure 3. Above is a practical four-frequency oscillator circuit employing the XR-2207. Logic switching is shown at lower right.

switch S1 is connected to the supply voltage, point A is at logic 1. When switch S1 is open there is a logic 0 at point A. The same applies for the logics at input B using switch S2.

In the schematic diagram, switch S1 is set to logic 1 and switch S2 is set to logic 0. Therefore, A is logic 1 and B is logic 0. From the chart note that this pair of connections selects the resistor connected to timing pin 5. Thus, the frequency of operation is:

$$f_2 = 1/R2C = 1000 \text{ hertz}$$

If switches S1 and S2 are both set to logic 1, the resistors at both pins 4 and 5 are selected. The frequency of operation would be $f_2 + \Delta f_2$. Since resistors R1 and R2 are of the same value, the output frequency would now be 2000 Hz. The value of capacitor C1 and resistors R1 through R4 can be selected according to the desired frequencies of operation.

Precautions. Several precautions must be observed. Terminals 2, 3, 4, 5, 6 and 7 have very low internal impedance and should, under no circumstances be shorted to ground or connected to the supply voltage. In fact, the total current drawn from pins 4, 5, 6 and 7 should be limited to 6 milliamperes or less.

LOGIC A	LOGIC B	SELECETED PINS	FREQUENCY
1	1	4 & 5	$f_2 + \Delta f_2$
1	0	5	f_2
0	1	6 & 7	$f_1 + \Delta f_1$
0	0	6	f_1

This chart shows the pin connections of the various logic configurations possible with the XR-2207. Equations give the frequency.

Output Characteristics. The square wave output is an open-collector stage, and a pull-up load resistor is used. Recommended values range from 1K to 100K. The stage is capable of sinking as much as 20 mA of load current. The triangle wave output has a peak swing of about one-half of the supply voltage. It has a very low 10-ohm output impedance. Output can be monitored on a small loudspeaker using the optional circuit connected to pin 14, as shown in Fig. 3.

Applications. In addition to its operation as a voltage-controlled oscillator and waveform generator, the XR-2207 can be used in a phase-locked loop circuit, as an FM or sweep generator or as a frequency-shift keying generator. EXAR suggests several circuit arrangements. The circuit of Fig. 4A shows its application as a pulse and sawtooth generator. In this mode of operation the operating frequency is:

$$f = 2/C(R2 + R3)$$

$$\text{Duty Cycle} = R2(R2 + R3)$$

A split supply connection is used. Two 6-volt batteries or a +6V, −6V split-voltage power supply would do.

The second example shows how the chip can be used for frequency sweep operation. In this application, the square and triangular wave outputs vary in frequency in accordance with the DC voltage change or waveform change applied at the Vc input.

A versatile frequency-shift keying circuit is given in Fig. 5. The keying signal is applied to pin 9. When the keying signal is a 0 level, the output frequency is f_1; at the 3-volt level, the output frequency is f_2. Thus, as the input keying signal changes between space and mark, the appropriate space and mark audio output frequencies are made available. These frequencies can be set precisely with the potentiometers connected to timing pin connections 4, 5, 6 and 7.

In this versatile arrangement, two pairs of FSK frequencies can be chosen, using the channel select pin 8. For a logic 1 level at pin 8 the mark and space frequencies are determined by resistors R1 and R2. Conversely a logic 0 setting at pin 8 sets up mark and space frequencies determined by resistors R3 and R4. ■

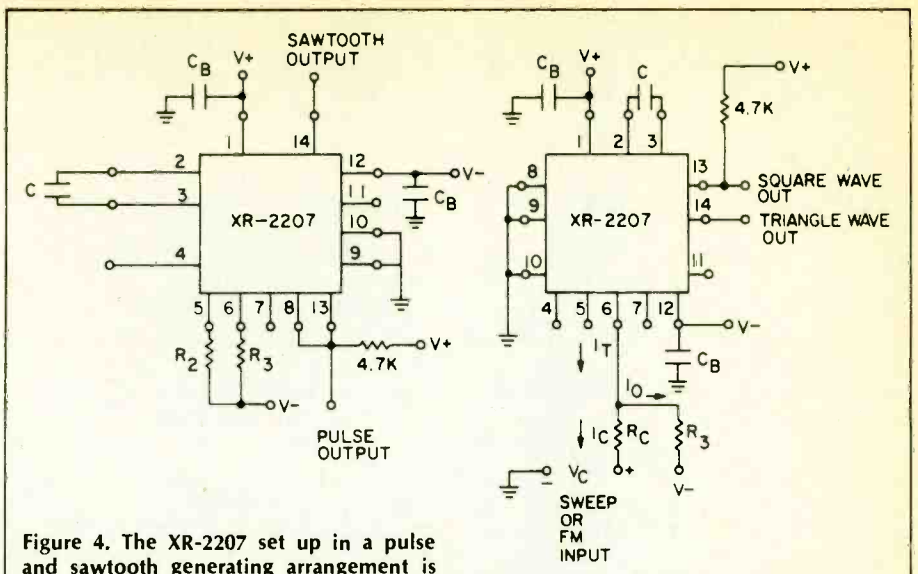


Figure 4. The XR-2207 set up in a pulse and sawtooth generating arrangement is shown in the schematic above. As the text describes, you'll need either a split-voltage 6-volt supply, or 2 6-volt batteries.

Figure 4b. The chip set up in a frequency sweep configuration is shown above. Outputs vary with changes in input voltage.

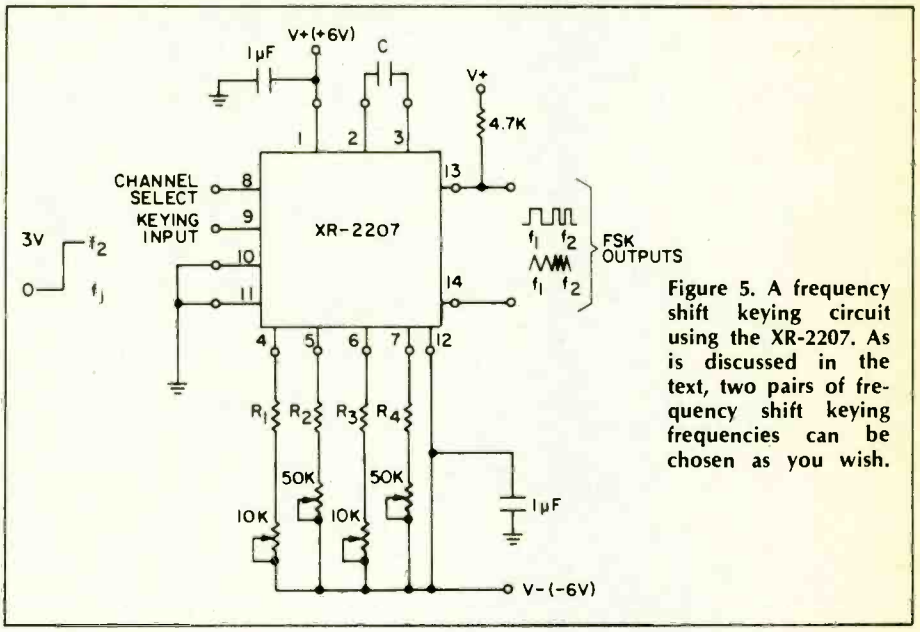
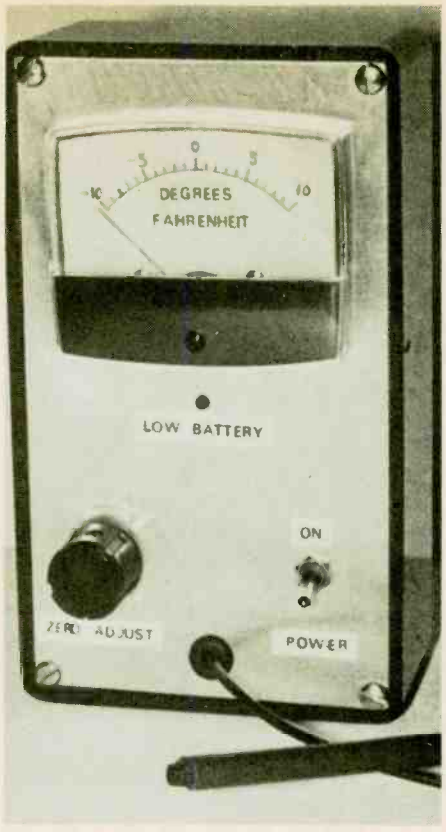


Figure 5. A frequency shift keying circuit using the XR-2207. As is discussed in the text, two pairs of frequency shift keying frequencies can be chosen as you wish.



Heat Loss Sentry

Locate home heating losses and reduce your energy costs

BY ANTHONY CARISTI

THE MONEY spent on heating and cooling your home represents your largest energy expenditure. As you are well aware, this cost can easily amount to over $1000 a year at today's prices for energy. With the dramatic increase in energy costs, it behooves everyone to do everything possible to reduce his energy consumption. This will help reduce oil imports, while keeping your personal expenses as low as possible.

Many of our utility companies are instituting a program of energy surveys for homeowners to pinpoint the various sources of energy loss in our homes. One way this is done is to pressurize the home under test with an air blower and use smoke generators to detect the passage of air from within the home to the outside. These passageways represent points of heat loss (or gain) in winter and summer.

With the help of Heat Loss Sentry you can perform the same tests for heat loss, using not smoke as the detecting mechanism but temperature change. These tests can be made in winter or summer. All that is required is a temperature difference between the inside and outside of your home.

Heat Loss Sentry is a low cost quality instrument, sensitive enough to detect changes in temperature as low as one degree Fahrenheit. It is self contained in a small cabinet and powered by a readily available 9 volt transistor radio battery which provides many hours of operation. An easy to construct, probe contains a temperature sensing device used to locate sources of air leaks throughout the home. A built-in battery monitor circuit in the instrument alerts the user when the battery is near the end of its useful life. Although Heat Loss Sentry has been designed as a heat loss detector, it is accurate enough for use as a thermometer over its range of 20 degrees Fahrenheit.

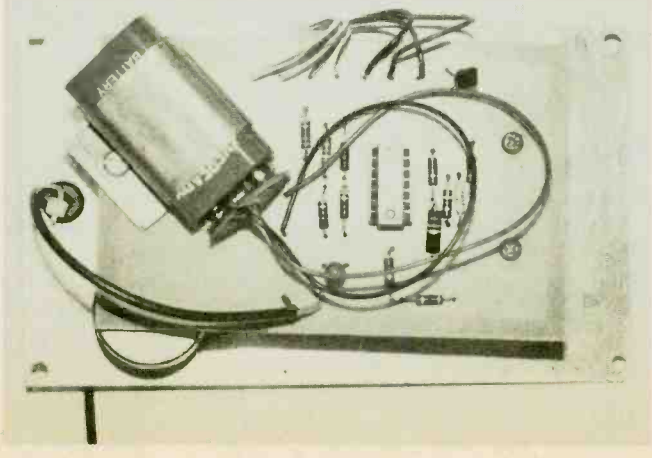
Circuit Theory. Heat Loss Sentry has been made possible by the development of an accurate low cost temperature sensor integrated circuit, LM335. This is a three terminal IC, designed to look like a 3 volt zener diode with an accurate temperature coefficient of 10 millivolts per degree Kelvin. (The Kelvin temperature scale is identical to the more familiar centigrade or Celsius scale with zero degrees Kelvin equal to −273° C, or absolute zero.) The IC can be accurately calibrated to any desired temperature. Typically, the LM335 will provide one degree C accuracy over its entire operating range when it's calibrated at any temperature.

Refer to the scematic diagram. U1 and U2 are each an LM 335 IC, connected in a differential amplifier circuit to detect a temperature difference between these two devices. U1 is mounted in a probe assembly, used to detect temperature changes, and U2 is contained in the instrument cabinet and acts as the reference. The adjustment lead of U2 is connected to a potentiometer (not panel mounted) so the meter reading can be set to center scale.

In energy leak detection, center scale becomes the nominal or average temperature being measured.

When Heat Loss Sentry is calibrated to center scale, the voltage across U2 is adjusted to be sufficiently below the voltage of U1 so that the output voltage of operational amplifier U3A drives the meter to center scale. Since U3A has an accurate gain of 18 determined by the ratio of resistors R6 and R5, the 10 millivolt per degree Kelvin sensitivity of U1 is amplified to 180 millivolts per degree Kelvin. This is equivalent to 100 millivolts per degree Fahrenheit. Resistors R7 and R8 are multiplier resistors which convert the one milliampere meter movement to a voltmeter of 2 volts full scale. This provides a total meter range of 20 degrees Fahrenheit, or a relative scale of ±10 degrees with zero at center scale. Once calibrated to center scale, placing the sensor probe in any environment with a different temperature, will produce an indication. A meter deflection downward occurs for colder temperatures, and an upward deflection occurs for warmer temperatures. If the total temperature change is 10 degrees or less, the actual differential can be read directly from the meter scale.

IC U3B is operated as a voltage comparator to constantly monitor battery voltage when the instrument is operating. This is accomplished by feeding a reference voltage across zener diode D1 to the positive input of U3B. A portion of the battery voltage is fed to the negative input of U3B. Voltage from a new battery is sufficient to develop a higher voltage at pin 9 of U3B than the D1 reference voltage. As a result, the U3B output is at zero potential and LED 1 is extinguished. As bat-



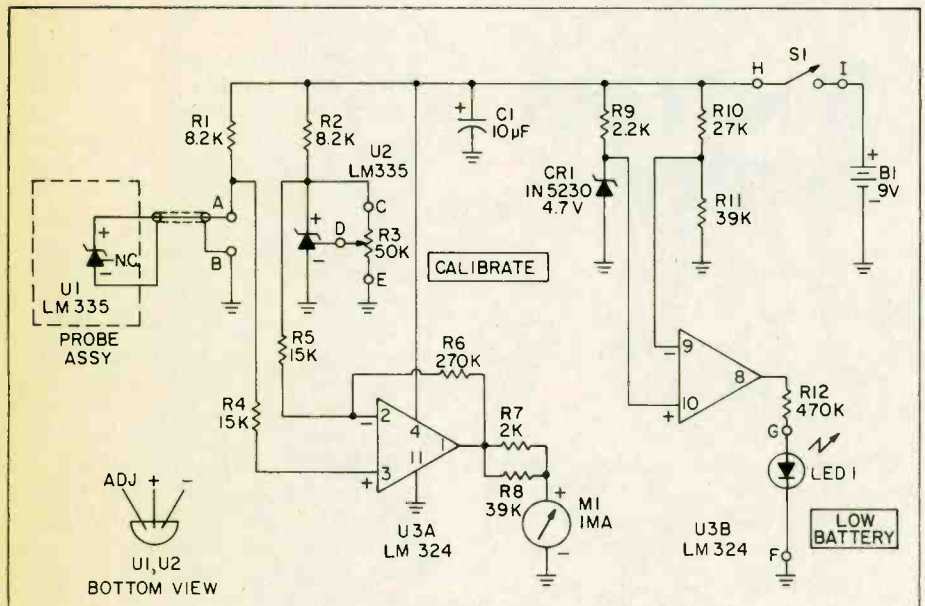
Looking inside a Heat Loss Sentry. There's plenty of room for the nine volt transistor battery, as well as for the components. Note series of wires coming from pads "A" to "I." The wiring is discussed in detail in the text.

tery voltage decreases a point is reached when voltage at pin 10 of U3B exceeds pin 9 voltage. This results in U3B output rising to battery potential, and illuminating LED 1. The user is thus alerted that the battery is near the end of its useful life and should be replaced.

Construction. The entire circuit, with the exception of the sensing probe and front panel components, is contained on a printed circuit board. On other page is a full size illustration of the foil layout as seen from the copper side of the board. On page also is the component side, showing the parts layout. The printed circuit board has been designed to mount directly on the back of the meter, using the meter screws for both mechanical and electrical assembly. Before constructing your printed circuit board, take into account the center to center distance of the studs of the meter, if you decide to use a different one milliampere movement than that specified in the parts list.

It is recommended that you use a socket for U3, rather than soldering it directly into the printed circuit board. This will permit ease of service should it ever be required. Be sure that the orientation of U3 is correct. Pin 1 of U3 is clearly marked on the parts layout and foil layout by a small dot. The same precautions hold for U2, the diodes, and electrolytic capacitor. These parts are polarized and must be placed into the circuit in the proper direction. A bottom view of U1 and U2 is seen on the schematic diagram.

Connections between the printed circuit board and external components are made through a series of pads marked with letters A through I. These connections are clearly shown on the schematic diagram. It is best to use wires of different colors to help prevent wrong connections. The sensing probe is connected to terminals A and B of the printed circuit board. Make this connection with a convenient length of flexible shielded wire. Maintain the correct polarity when connecting U1. The shield connection of the cable should be tied to the negative lead of U1, and to terminal B of the printed circuit board. Feed the probe cable through a front panel grommet.



PARTS LIST FOR HEAT LOSS SENTRY

B1—9-VDC transistor alkaline battery
C1—10-μF, 15-VDC electrolytic capacitor
D1—4.7-volt zener diode, 1N5230 or similar
LED1—red LED
M1—0-1-mA, DC meter
R1—8,200-ohm, ¼-watt resistor (all resistors 10% unless otherwise noted)
R2—8,200-ohm, ¼-watt resistor
R3—50,000-ohm potentiometer, panel mounted
R4—15,000-ohm, ¼-watt resistor
R5—15,000-ohm, ¼-watt resistor
R6—270,000-ohm, ¼-watt resistor
R7—2,000-ohm, ¼-wat resistor, 5%
R8—39,000-ohm, ¼-watt resistor
R9—2,200-ohm, ¼-watt resistor
R10—27,000-ohm, ¼-watt resistor
R11—39,000-ohm, ¼-watt resistor
R12—470-ohm, ¼-watt resistor
S1—SPST toggle switch
U1, 2—LM335 temperature sensor, National Semiconductor or equivalent
U3—LM324 operational amplifier, National Semiconductor or equivalent

Misc.—Cabinet, GC Electronics H4-726 or similar, wire, solder, battery clip, etc.

Power to operate the circuit is obtained from a 9 volt transistor radio battery, mounted directly to the printed circuit board. Connect the battery to the circuit with a battery clip made for this purpose. The layout easily provides room on the board for this. The battery can be secured to the board with a homemade clamp constructed from a piece of sheet copper, or by any other means you care to use. The parts list specifies a normally open, spring return, power switch. This was chosen to prevent the unit from being left on when not in use, and depleting the battery.

LED 1 is mounted on the front panel of the instrument using a small amount of epoxy. Use a pair of different colored wires to make the connections between the LED and printed circuit, and be careful not to bend the stiff leads of the LED where they enter the plastic body. This might render the LED defective.

Refer to the illustration of a typical probe assembly. If available, you may use a short piece of plastic or synthane tubing for the probe. You can even construct a probe from a piece of wood doweling. It is not recommended to use metal tubing for the probe, since the heat conduction from your hand may affect the temperature sensing performance of the sensor, U1.

Connect the shielded wire to U1, using the + and − terminals of the IC as shown on the schematic diagram. The adjustment terminal of U1 is not used. Insulate the connections carefully, and insert the IC and wire into the probe. Secure the IC and wire inside the probe with epoxy or silicon rubber compound. Allow part of the case of U1 to protrude outside the probe so that it is more sensitive to temperature change. Allow the assembly to harden before placing it in use.

For a professional looking instrument, you can use the meter scale shown which fits the meter specified in the parts list, as well as others. The existing meter scale can easily be removed by prying the plastic cover off the meter and removing two small screws. Be careful not to disturb the delicate needle. Paste the new scale on the back side of the meter scale, and reassemble it into the meter.

Checkout and Use. When the unit is

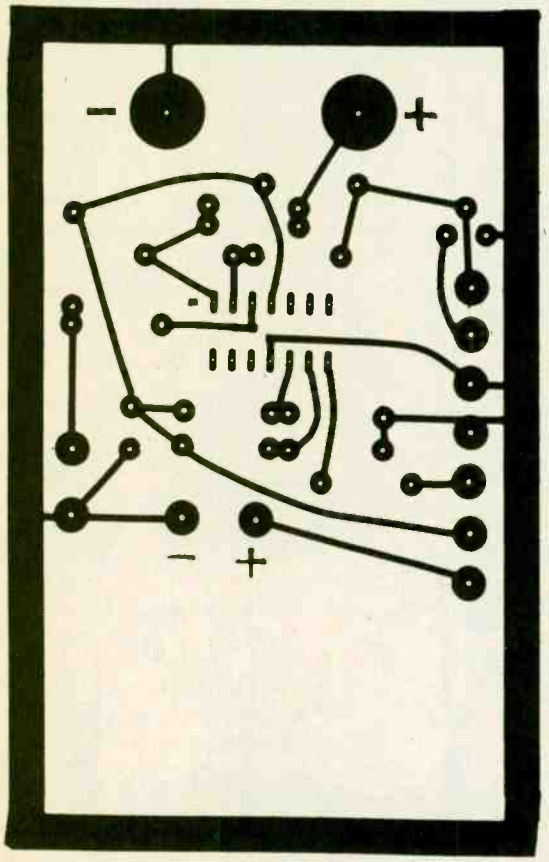
fully wired, check for wiring errors. Then, connect a 9 volt transistor battery to the power input terminals. Activate the power switch and rotate the zero adjust control over its full range. You should be able to adjust the meter reading from zero to full scale, with some extra range left in the potentiometer. Set the control so that the meter reads half scale. While holding the power control on, place your fingers over the sensing tip of the probe. The meter reading should increase to beyond full scale. If the unit performs as specified, it is operating properly.

You may wish to check the Low Battery indicator circuit to determine if it is operating properly. To do this, you must substitute a variable voltage DC supply for the battery. Set the supply to 9 volts and connect it to the power input terminals observing correct polarity. Turn the power switch of Heat Loss Sentry on, and observe the Low Battery indicator as the power supply voltage is reduced. The Low Battery indicator should become illuminated as the power supply voltage approaches approximately 6½ volts. Due to variations in zener diodes, you may wish to change the value of R11, if necessary, so that the LED lights at approximately 6.5 volts battery voltage. Once this is done, the checkout of the instrument is complete. Reconnect the battery to the instrument.

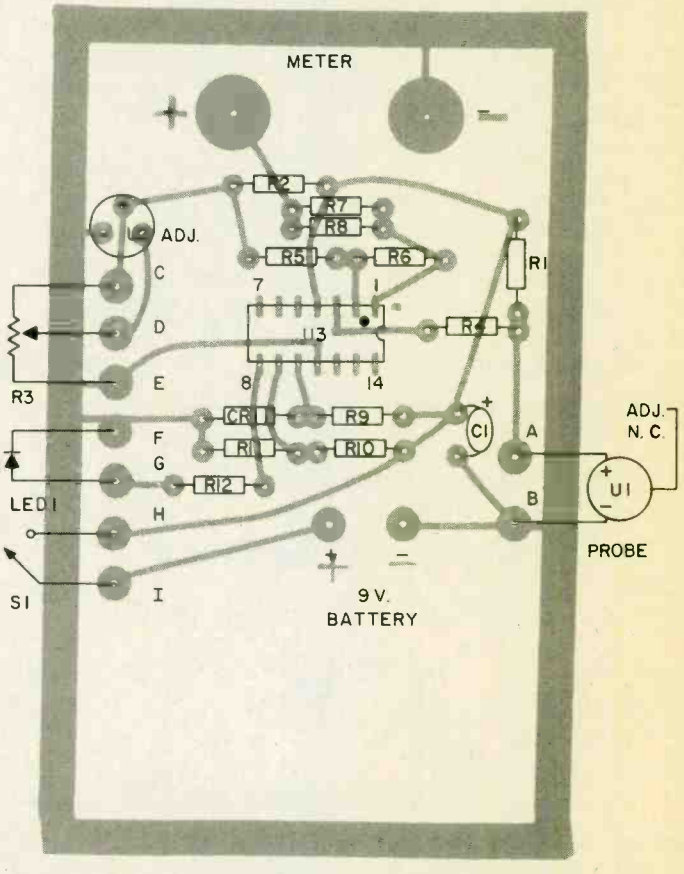
When Heat Loss Sentry is operated, you may notice that the Low Battery indicator blinks as the power is turned on and off. This is a normal reaction, which occurs as the circuit voltage passes from zero to battery voltage then back to zero.

To operate, hold the power switch on and adjust the meter to center scale. Holding the probe, search out any area where you suspect an air leak between inside and outside of your home. The meter will give an immediate indication if there is a change in temperature. In the case of very small leaks, allow sufficient time for the unit to react. This may take several seconds. Once a change of temperature has been detected, it is best to remove the probe from the leak and allow its temperature to stabilize to room temperature before searching out another leak. It takes a few minutes to familiarize yourself with this instrument.

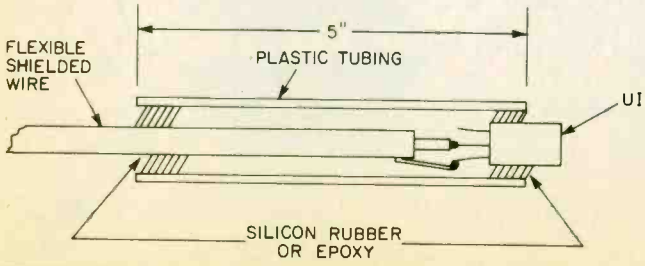
Another interesting use for this device is in troubleshooting defective electronic circuits. When the probe is held close to defective ICs, resistors, etc. a higher than normal temperature will be indicated. ■



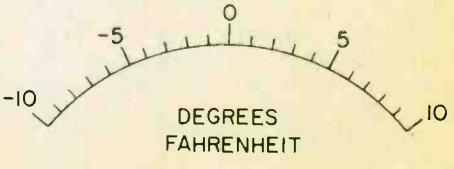
This is the foil side down view of Heat Loss Sentry's PC board. Care must be exercised in etching board.



The foil side up diagram illustrates parts placement on the top of the PC board. Heat Loss Sentry requires relatively few components.



To the left is a drawing of the heat sensing probe. Follow the set-up closely, and use the glue! At right is an exact size drawing of the meter face. Cut it out and paste it right on.



BLINKEY

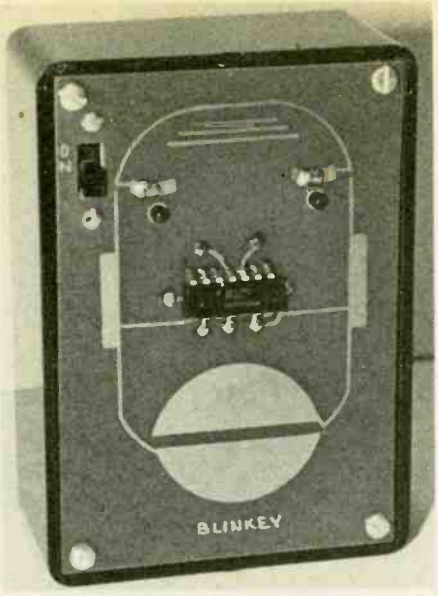
Electronic friend provides many hours of entertainment

BY JAMES BARBARELLO

BLINKEY IS AN ELECTRONIC "friend" from another galaxy. He is asleep as long as nobody disturbs him. However, press your finger to his lips and Blinkey becomes agitated. His eyes blink on and off. If you press your fingers more firmly, he becomes even more furious, blinking more rapidly. When you remove your fingers, Blinkey goes back to sleep again and his eyes stop blinking.

The simple circuit uses one integrated circuit and a few components. If you like, Blinkey can be built inside a doll or constructed on a PC board as the author has done. The remaining copper foil on the PC board resembles a mouth, ears and eye brows. The IC resembles a nose, and the two LEDs are Blinkey's eyes.

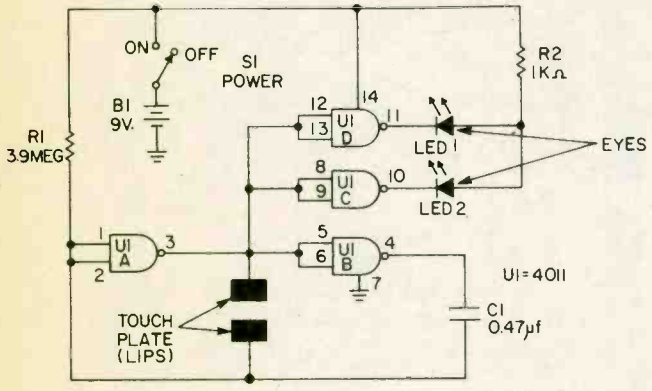
How He Blinks. BLINKEY's circuit is shown right below. Consider U1A and U1B alone (without R1 or UIC and D connected). If we replaced the Touch Place (lips) with a resistor, we would have an ordinary oscillator. The frequency of oscillation would be determined by the value of C1 and the resistor. Instead of using a resistor, you place your finger or hand across the touchplate, the resistance of your hand determines the frequency of oscillation. As you press harder, the resistance decreases and the frequency of oscillation increases. Now, if we connect U1C and D to the oscillator, LED (left) and LED (right) will simultaneously blink. U1C and D are buffers which provide enough current for the two LEDs to turn on.



If you removed your hand when the LEDs were on, they would remain on indefinitely. This would drain the battery. Since we often forget to turn off a toy, we provide an automatic shutoff of the LEDs. This automatic shutoff is R1. When your hand is removed from the Touchplates, R1 allows the voltage at pins 1 and 2 of U1A to rise towards 9 volts. Eventually (after a second or two) this will cause the output of UIA to go low, turning off the LEDs. In this state, the current draw by the circuit is very low, insuring a long battery life. R2 limits the current drawn by the LEDs and S1 provides the voltage from the battery for operation.

Construction. Any means of construction is suitable. An easy way of reproducing the circuit is to use the PC Board layout seen below. The overall size of the PC Board should be adjusted to allow it to substitute for the top plate of the box you are using. UIC is mounted on the FOIL side of the PC Board, while all other components are mounted on the reverse side. Mount the two LEDs through the "eye" holes and secure with epoxy. After R1 is installed, solder a short length of wire between it and S1 as shown in the detailed component placement. If a 0.47 uF non-polarized capacitor is not available, five 0.1 uF disk capacitors can be paralleled together and used instead. While R1 is stated as 10 megohms, any value greater than 3.9 meg-

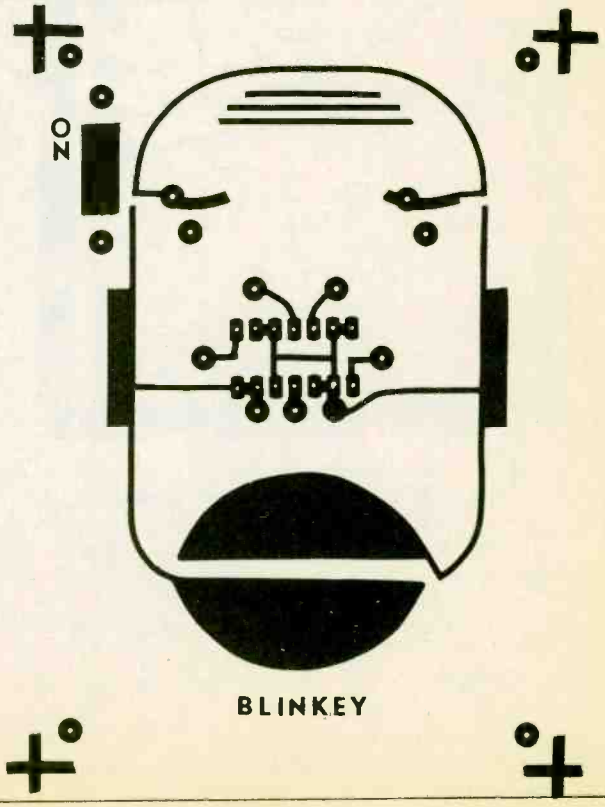
(Continued on page 77)



PARTS LIST FOR BLINKEY

B1—9-VDC transistor battery
C1—0.47-uF, non-polarized electrolytic capacitor
LED 1, 2—light emitting diode, ⅛-inch
R1—10,000,000-ohm, ¼-watt resistor, 10%
R2—1,000-ohm, ¼-watt resistor, 10%
S1—slide switch, SPST
U1—CD 4011 quad, 2 input NAND gate integrated circuit
Misc.—PC board, 9-volt battery clip, suitable case, wire, solder, etc.

At right is the Printed Circuit board template for Blinky. As you see, the switch is actually etched on the board. It uses a bit more copper than usual. Schematic, above, is simple and straightforward. The whole thing should take less than an hour.



WINCHESTER DISK DRIVES

This sealed disk drive may revolutionize microcomputer data storage

BY IRWIN SCHWARTZ

AS MICROCOMPUTERS get more powerful, many hobbyists and small business users are discovering that they don't have enough data storage capacity. On-board semiconductor memory just isn't capable of the storage required for increased program lengths and the high-level languages currently in use. Floppy disks, *de riguer* in the micro community, offer greater memory depth. But, even with them, today's double-density/double-sided floppy disks have a maximum unformatted capacity of no more than 1.6 Mbytes (One Mbyte is a million bytes; a byte is eight bits.)

Of course, you can keep adding disks to your memory bank as you need them. But the thin, flexible media have a finite lifetime, and it becomes annoying and expensive to dump data from one disk to another.

What's needed is a low-cost, reliable, high-capacity, and fast-access medium for quantity storage of data. Enter Winchester disk system.

What makes a Winchester a Winchester? Although the circumstances surrounding the birth of Winchester technology are well documented, the origin of the name remains somewhat obscure. The story goes that, following the development of the Model 3340 removable disk pack in 1973, IBM improved the technology with a dual 30 Mbyte drive. This "30-30" storage unit was code-named, in the best cloak-and-dagger tradition, "Winchester." And the name stuck.

Winchester Characteristics. Four major threads tie Winchester technology together: very lightly loaded read/write heads (typically 10 grams); well lubricated recording media (mylar-based ferric oxide deposited on an aluminum disk substrate); a head flying height of 20 microns over the medium surface, and the housing of the head-disk assembly in an antiseptic, hermetically sealed chamber. Each of these design elements contributes to the storage device's reliability. However, there is more.

Track density is dramatically increased over that of floppies. Up to 500 tracks per inch (tpi) have been achieved, with typical densities in excess of 400 tpi.

In comparison, double-density / double-sided floppy disks are rated at 48 tpi, with a couple of manufacturers offering 96 tpi. Recording densities of over 6000 bits per inch (bpi) are now a reality. This represents a significant improvement over the "primitive" 4000 bpi of IBM's pioneering Model 3330.

Greater recording densities are possible because the Winchester's disks are isolated from outside environments. In that regard, whenever a removable disk is handled, small changes in its geometry develop. Repeated insertion and removal of floppies cause an accumulation of dimensional changes (particularly in the alignment hole at the center of the disk) which eventually make the disk wobble on the spindle as it rotates. This wobble is a primary source of read/write errors caused by a building up of a loss of data integrity which ultimately renders the disk useless. Sealed, fixed-medium Winchester devices do not suffer from this.

What Makes The Winchester Tick? A complete Winchester unit is shown in Fig. 1. The hermetic seal wraps around the drive assembly (thus sealing the recording disk). The read/write head assembly also resides within the chamber. The drive motor and the head assembly stepping motor, however, lie outside the chamber. This design reduces the possibility of medium contamination.

The arm assembly is the linear positioning type; its movement is shown in Fig. 2. The stepper motor turns the capstan upon receiving instructions from the controller board, which may or may not be supplied with the drive. One end of a thin metal band is connected to the capstan; the other end of the band is tied to the arm assembly. When the capstan rotates, the arm is pulled to the desired position over the disk for read/write functions.

A radial arm positioning system is shown in Fig. 3. There is a division of opinion concerning which type of arm actuation is best.

Sealed Security. If the medium chamber were not protected against contaminants, small particles might jam between the recording heads and the media. The result could be scratching of the disk's surface.

In addition, a "head crash," the result of interruption of the air pressure differences which cause the head to fly over the disk, could be catastrophic. Low flying heights, which are imperative for data integrity and recording density, are practical only with sealed disk drive systems.

Also, because Winchester units are sealed, air circulation (part of the sanitation process) must originate and follow a closed-loop pattern within the chamber. Fig. 4 shows how air is circulated by the rapidly spinning disk.

The air is continuously cleaned by a 0.3 micron filter to 99.9% efficiency. The air pressure differences resulting from the rapid rotation of the disc (typically 3600 rpm) create the atmosphere in which the read/write head(s) fly over the disk. Average altitude is 20 microns. Flying heights of less than 0.4 micron have been achieved by IBM.

Why Winchester? The bottom line specifications users look for in storage units are (1) cost per unit storage, (2) overall storage capacity, (3) data reli-

ability, and (4) data retrieval time.

One of the most attractive reasons for upgrading to Winchester is that of dramatically increased storage capacity.

Whereas a typical double-density/double-sided floppy disk stores a maximum of 1.6 Mbytes of unformatted data, a mid-range Winchester unit can hold almost 18 Mbytes. Indeed, the lowest capacity Winchester, at "only" 5.33 Mbytes, has well over three times the data storage capacity of a double-sided/double-density floppy disk. The average Winchester can represent a ten-fold increase in storage over floppies.

Accessing data from an 8-inch Winchester disk is very short work. It takes an average of 48 microseconds (ms) to retrieve a byte of data from the medium's surface. On the other hand, a floppy requires about 100 ms, and sometimes as much as 300 ms, to access the same piece of data. Winchesters are, at worst, twice as fast.

Also, contamination is no longer a problem; dirt, fingerprints, scratches, and other medium surface interferences are no longer a concern. The business end of Winchester units is manufactured under clean-room conditions.

This is not the case with floppy disks. Floppies suffer degradation every time they are handled. Dirty fingers, cigarette smoke, dust particles and other glitch-makers cannot reach the insides of a Winchester. Hermetically-sealed, sanitary conditions result in error specs which exceed those of any other storage media in use.

Typically, the seek error rate is one per 10^6 seeks; the soft error rate is one per 10^{10} bits; and the hard error rate is 1 per 10^{12} bits. That's one bit in 1,000,000,000,000—comparable to an error in one letter in a 6,250,000,000-page book! All Winchester manufacturers subscribe to the same error rate claims.

Two major families of Winchester disk storage units have emerged: 8-inch and 14-inch, the size refers to the diameter of the recording disk.

The present trend in low-end minicomputer and, more recently, in microcomputer applications has resulted in even smaller sizes. One manufacturer has a 5¼-inch Winchester drive with a storage capacity of 6.38 Mbytes (unformatted). Another is whispered to be preparing a similar unit. These micro-Winchesters may eventually find their way into homes and small businesses, and become the standard for such systems.

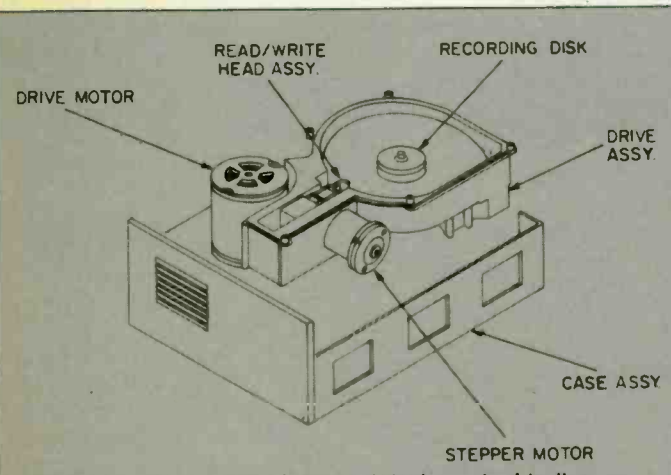


Fig. 1. The complete Winchester unit is shown in this diagram. Note how drive assembly and read/write heads are sealed in.

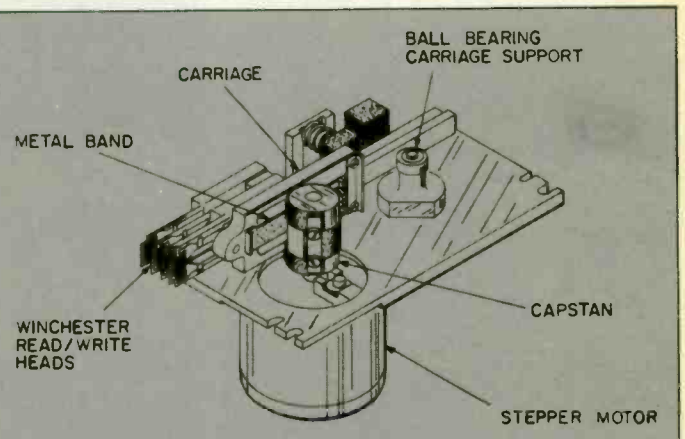


Fig. 2. The stepper motor turns the disk drive capstan; it receives its instructions from the controller board interface.

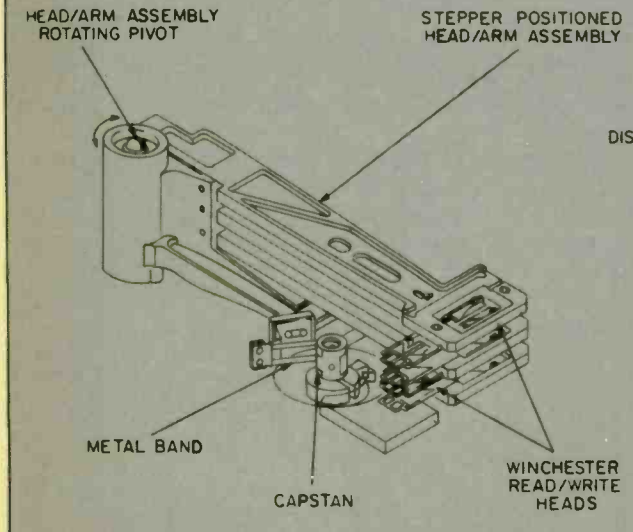


Fig. 3. Read/write functions are performed by the sensors at the end of the radial arm, a diagram of which is shown above.

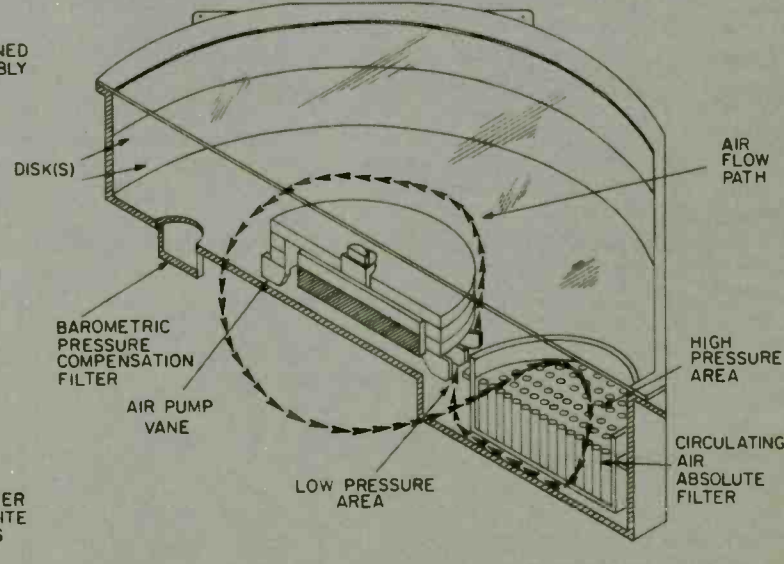


Fig. 4. Air circulation within the sealed disk drive is made possible by the rapidly spinning disk, which allows circulation.

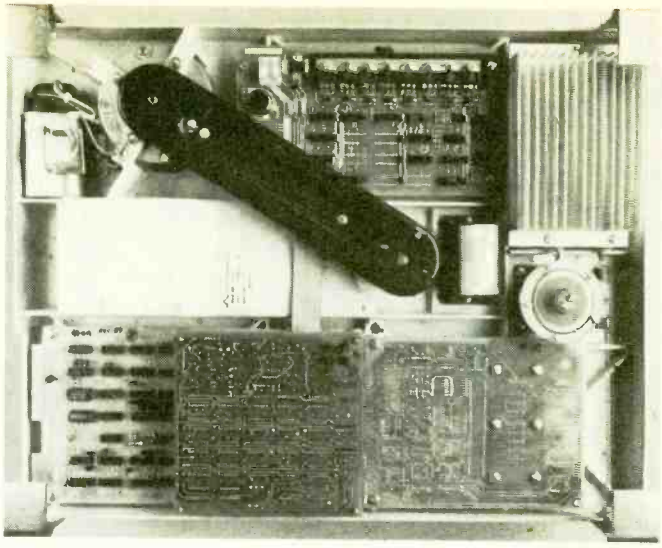
Although most manufacturers and users agree that Winchester-type storage requires the use of an auxiliary backup medium, there is no agreement on which method to use. The contention rests between tape backup and floppy disk backup. Some pundits have even suggested using a second Winchester as the fail-safe device.

Streaming Tape Backup. The literais full of arguments for and against backup alternatives. One of the frontrunners is digital streaming tape. A streaming tape is a ¼-inch or ½-inch recording tape system in which the transport continuously moves the recording medium past the heads at speeds up to 100 inches per second.

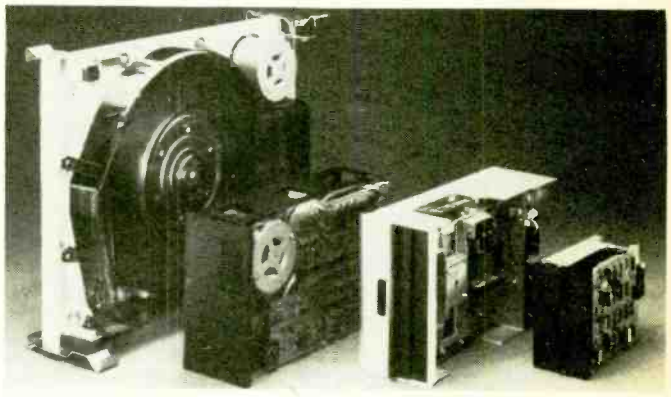
Formatting is achieved through "data blocks." The blocks are separated by "gaps" which are either physical (no data recorded) or electronic (the presence of an "instruction pulse") from a formatter/controller board. Streaming tapes are gaining in popularity because of their small size and their relatively high recording capacity.

A Winchester In Your Future? Industry observers feel that Winchesters will find a niche as a microcomputer peripheral. Floppy disks, it appears, are slated to be used as input/output devices in larger data-based microcomputer systems and, of course, as backup media for Winchesters. The high-capacity, sealed, fixed-disk, 8-inch Winchesters will more commonly be used for secure mass archival storage. Also, with the promise of personal 16-bit microcomputers, the burden of massive data holding will be delegated to the Winchester system.

For now, alas, most hobbyists will have to wait for the price of the units to drop. However, the short history of personal computers has taught us that sophisticated equipment quickly becomes accessible when it's in demand. ■



This bottom view of the Shugart SA4000 rigid disk drive shows the electronics controlling the drive, and the motor and pulley mechanism. A 14-inch unit, the SA4000 is an example of the current type of Winchester.



The complete line of Shugart Associates' fixed and floppy disk drives, from the big 14-inch SA4000 down to the SA400 Mini-floppy. The two drives in between are both 8-inch.

Pertec's Model D8000 offers 20 Mbyte capacity in a sealed disk unit. This Winchester drive uses the 8-inch format; the disk leaning against it is used in this type of unit.

IMI's Series 7700 of disk drives are compact, lightweight and have large capacities.

Manufacturers of Winchester Drives.

BASF
Crosby Drive
Bedford, MA 01730

IMI
10381 Bandley Drive
Cupertino, CA 95014

Kennedy Company
1600 Shamrock Avenue
Monrovia, CA 91016

Memorex
San Tomas at Central Expy.
Santa Clara, CA 95052

Micropolis
7959 Deering Avenue
Canoga Park, CA 91304

Pertec
12910 Culver Boulevard
Los Angeles, CA 90009

Priam
3096 Orchard Drive
San Jose, CA 95143

Shugart Associates
435 Oakmead Parkway
Sunnyvale, CA 94086

CB SPECTRUM

Transceiver test equipment

BY KATHI MARTIN KGK3916

OF ALL THE LETTERS I get, recently many of them have compained of poor performance from new mobile equipment. Now I'm certain that from time to time someone gets stuck with a CB "lemon," just as they do with all other types of equipment, but the number of complaints seemed way out of proportion with my usual experience. So I decided to look into the experiences of a few readers.

Sifting through a month's mail, I found four CBers in the area who had recently purchased mobile equipment and had problems getting out.

There's no need to go into the minute details of each problem, because the main reason they weren't getting out was essentially the same in each instance. The RF from the transceiver just wasn't getting *into* the antenna.

A few years ago, when just about everyone was heavily into CB for both hobby and personal communications, there were "experts" coming out of the woodwork. You couldn't go into a store to buy CB gear without someone offering advice on how to get the best performance from your particular rig. There always seemed to be a few well-informed technicians hanging around every CB shop.

Even if you didn't get expert advice at the time of purchase, there was usually a CBer within a block or two of your home who would somehow find you and give advice.

The Lone CBer. Today things are different. Non-technical CBers are usually left hanging by their fingernails, with no one to turn to for advice.

Consider the average store that sells CB. It's either a department store unloading CB equipment they found in a warehouse, or an auto parts store that handles anything to do with cars and trucks. Or perhaps the local CB dealer is a flea market merchant who sells job lots. Today it's four transceivers, eight antennas, toothpaste and bakery rolls. Again, there's no one to give the new CBer advice on how to get the most out of CB.

How does all this tie in with getting the juice to the antenna? Here's how: the most common CB antenna sold today is the short (loaded) whip ranging between 48 and 56 inches. Some are even shorter, others longer. Now it is a characteristic of virtually all loaded whips that they *must* be tuned for minimum SWR (Standing Wave Ratio) because the higher the SWR the lower the power accepted by the antenna, and the lower the RF energy put out.

The adjustment range on most loaded antennas is about ⅛-in., meaning a variation in overall length of as little as ⅛-in. can mean the difference between a high or low SWR.

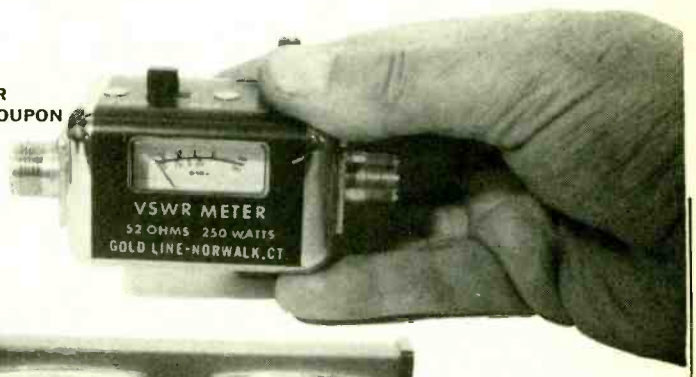
Back in the halcyon days of CB, virtually every CB dealer warned the purchaser that a loaded antenna required adjustment, and he often recommended purchase of an inexpensive SWR meter. This device indicates when the antenna is properly adjusted to the particular vehicle on which it's installed. In fact, many CB shops simply loaned the buyer a meter, or recommended a local CB'er who had an SWR meter and would perform the adjustment as a friendly service.

The four CBers I tracked down were never told the loaded antennas they purchased required tuning. They had simply installed the antenna on the car, connected it to the transceivers, and expected the whole thing to work. These who had noticed mention of SWR in the transceiver instruction manual simply assumed if they could hear a signal everything was A-OK.

The truth of the matter is that you must have phenomenal luck to have a mobile installation work at optimum efficiency without an antenna adjustment. Here's why. The antenna can put

(Continued on page 78)

CIRCLE 72 ON READER SERVICE COUPON



CIRCLE 71 ON READER SERVICE COUPON

CIRCLE 32 ON READER SERVICE COUPON

CB test equipment ranges from plain to fancy, as shown by these three units. Above is a unit that has everything, from the E.F. Johnson Company. Above right is a VSWR thru-line meter from Gold Line, a unit small enough to be carried in the tool box at all times. Below right is a power SWR meter made by Archer, sold by Radio Shack.

Getting the most from Hi-Fi Speakers

Speaker placement is the all important factor in maximum hi-fi satisfaction

BY HERB FRIEDMAN

FOR TRUE HIGH FIDELITY sound reproduction, the speaker must not add any coloration to the signal source. You have probably read words to this effect a hundred times, heard the statement in endless hi-fi showrooms.

Actually, all speaker systems have inherent coloration; there is no such thing as a coloration-free speaker. If there were, there would be no difference in the perceived sound quality between two or more speakers. Yet we know this is not the case. There are virtually no two different speaker systems of all that are available that sound identical to each other. In fact, if you were to place two *identical* speakers adjacent to each other in an average living room of approximately fifteen by twenty feet, they would probably not sound the same; each would give coloration.

There have been tests in large auditoriums, where an orchestra went through the motions of playing while the sound actually came out of speakers, and the audience could not discern any difference between live and reproduced sound. The key to this experiment is the large auditorium, where complex standing waves and high frequency diffusion can mask the differences. It is also quite possible that the auditorium is coloring the live musicians so they sound as if they are being reproduced by a speaker.

Naturally, someone can claim that the "live" sound source is the high fidelity reference. But who says it is? Auditoriums are warm, cold, neutral, dry, reverberant. The cello you hear in Symphony Hall will never sound the same as if you heard it in your living room. So which is the *natural* high fidelity sound? The average living room simply does not have the room loading to duplicate the bass of the auditorium sound equipment, nor does it have the throw and reverberation characteristics.

What High-Fidelity Is. Basically, it comes down to this: High fidelity is the best sound quality you can get in your own home by blending the inherent coloration of a speaker system to your personal preference.

How do you get that blend? As we have implied, the size of the room in large part determines the sound quality of a speaker system. In fact, more than just size affects the overall sound quality. Highs are accented or muted depending on wall and floor coverings.

Bass, that all important "full bodied quality," is extremely dependent on the position of the speaker, the position of the listener's ear and the distance from the speaker to the listener. Short of redecorating the listening environment, there is almost no way to modify a speaker system's high frequency performance other than by adjustment of *presence* and *brilliance* controls, if the speaker is so equipped.

Critical Bass. In home high fidelity systems it is the bass that's extremely critical. This is because of standing waves within the room that are determined by the size and shape of the room and the reflection coefficient of the walls, floor and ceiling. If these standing waves come together out of phase just where your head is located, you will hear a weak, thin sound lacking in bass. If the waves come together in-phase at your head, the sound will be rich, "full blown," possibly even "muddy." Yet a slight tilting of the head, or pushing a speaker a couple of inches, might be all that's required to clean up the sound.

The diagrams illustrate some of the things you'll run across when setting up your hi-fi system, and will give you an idea of what you can do to get the best possible sound. The graphs are the readout of a real-time, ⅓-octave spectrum analyzer. This is a device that measures the sound power in 1/3-oc-

tave bandwidths from approximately 20 to 20 kHz at the precise time the sound occurs. There is no delay as a "sweep" steps from one frequency to the next.

The analyzer's horizontal scale, at the bottom, is calibrated in center frequencies from 20 Hz to 20 kHz. The vertical calibration is 3 dB or 2 dB per step, indicated by one of the three LED lamps at the "0 dB" reference line located on the left of the instrument.

The signal source fed to the speakers is "pink noise," which is a random instantaneous noise spectrum of 20 Hz to 20 kHz with constant power per ⅓-octave bandwidth. Again, the amplifier and speakers reproduce 20 Hz to 20 kHz simultaneously, which the analyzer then measures in "real time." If everything was "ruler flat" the display would be straight across the top from 20 Hz to 20 kHz.

The speakers used are the OHM Model "L," which was selected because it is among the very finest in the price range indicated as "most desired" by the readers of the Hi-Fi/Stereo Buyers' Guide. The OHM Model "L" is a real bookshelf-sized speaker with individual *presence* and *high frequency* sensitivity controls. These speakers normally tend to be slightly bright, so it was easy to adjust them for optimum response at one meter (the standard test range) prior to making the series of measurements used for our illustrations.

Because the speaker response was optimized to the room, the variations in response shown in our diagrams are attributable to speaker positioning within the room and the relative position of the listener. In short, the results are typical of what might occur in your own listening environment.

The speakers were located in a moderately live room approximately twelve by twenty-five feet. The speakers were positioned 7 feet apart with their throw to the short dimension of 12 feet. The microphone was located on a line running through the midpoint between the speakers at a height of 3.5 feet, which is about the average height of an adult's ear when seated.

Speaker Phasing. First, let's look at speaker phasing, or why two speakers appear to deliver more bass in proportion to other frequencies than one speaker. Fig. 1 shows the response measured with only the left speaker being fed. The high frequency rolloff about 6.3 kHz is normal; it is caused by high frequency absorption of curtains, drapes, soft furniture, etc. Fig. 2 is the sound at the listening position when the right speaker is turned on. Logically, since the right speaker doubles the acoustical power, the level in the room should increase 3 dB (X2 power factor) at all frequencies, with only minor variations due to differences in speaker locations.

You will note from Fig. 2 that the general level is raised about 3 dB. (With 3 dB value per step there can be 2 dB error per total reading.) However, note that from about 31.5 to 125 Hz the level is raised some 9 dB. Allowing for the normal error which can range to 2 dB when using 3 dB per step increments; it creates the "extra" bass one hears when using two speaker systems.

The Response Variations. Figs. 3 through 8 illustrate the variation in frequency response due to speaker position and the listening location. In Figs. 3 and 4, the listener is 8 feet from a line drawn across the front of the speakers (listener's ear in constant position). In Fig. 3, however, the speakers are positioned on stands 3 feet high. In Fig. 4 speakers are on the floor. Sound pres-

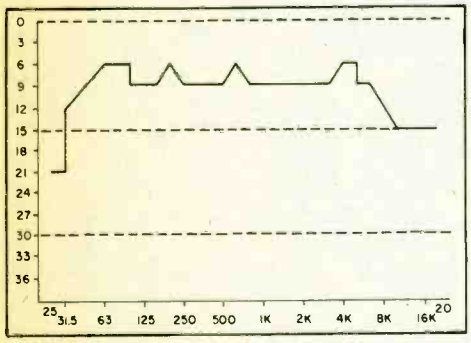


Fig. 1. This diagram and Fig. 2 show speaker phasing. Here is left speaker response.

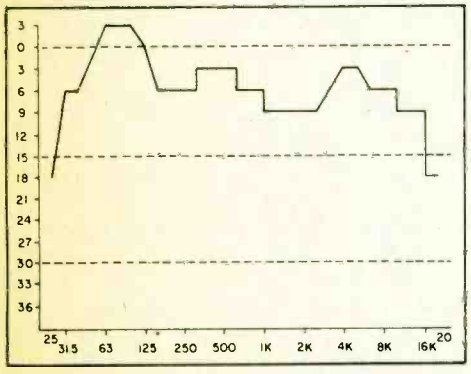


Fig. 2. The response level is raised by 3 dB when the right speaker is switched on.

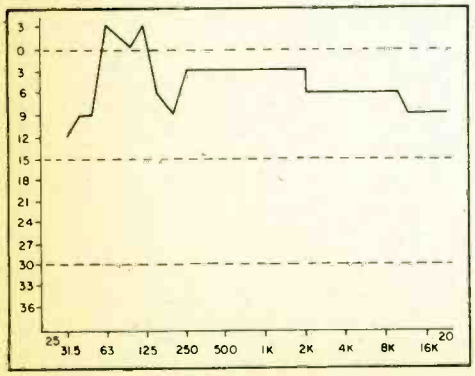


Fig. 3. In Fig. 3 the listener is 8 feet from speakers; speakers are 3 feet off floor.

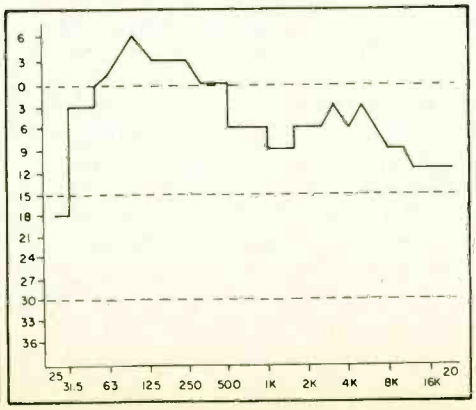


Fig. 4. This dramatic difference in speaker performance results from speakers on floor.

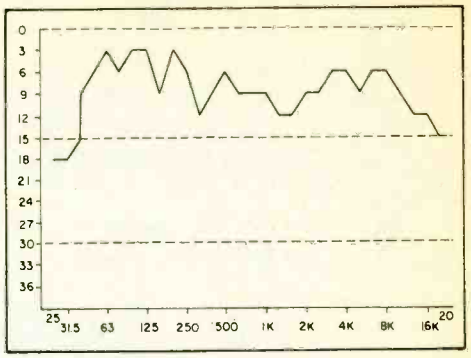


Fig. 5. A change of position makes a lot of difference; speakers are 10 feet away.

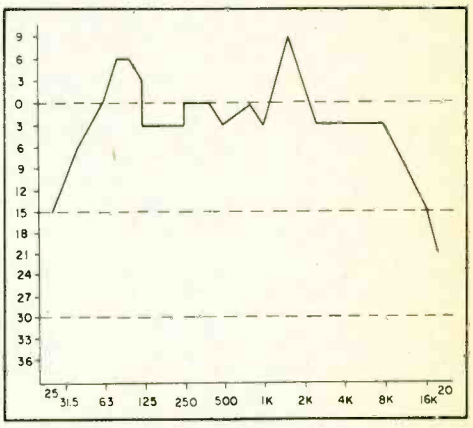


Fig. 6. In this case the "ear" has been moved out to 10 feet; speakers on floor.

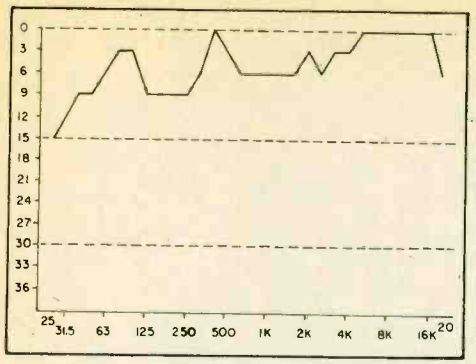


Fig. 7. Figs. 7-10 show speaker positioning in poor locations. On stands in Fig. 7.

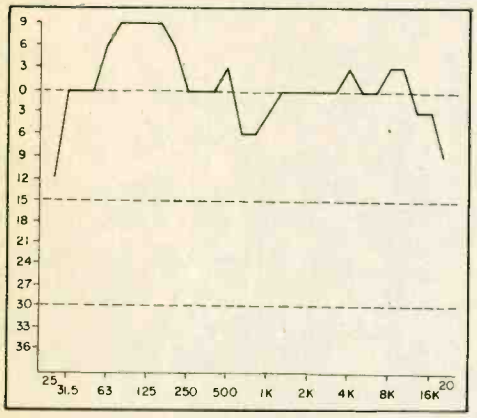


Fig. 8. Placing speakers on the floor is responsible for the dramatic bass response.

sure at the ear (microphone) is 60 dB.

The slight decrease in midband (1kHz) and boost in the upper highs with the speakers on the floor are most likely caused by reflections from the floor mixing with the direct wavefront. (This can be normal.) But look at the low frequency response with the floor speakers: there is a broad general boost of about 3 dB centered on 100 Hz.

If we move the listener (the microphone) two feet back, a total of 10 feet from the speaker, and within two feet of the rear wall, we get the response shown in Figs. 5 and 6. Figure 5 is the speaker on a 3 foot stand; in Fig. 6, the speaker is on the floor. (Levels are equalized to maintain 60 dB SPL at the ear.)

Compare Figs. 3 and 5, which show the stand mounted speakers. Note the dramatic attenuation of lows through midband relative to the highs when the microphone is moved out to 10 feet. Now compare this with the response shown in Figs. 4 and 6, when the speakers are on the floor.

In Fig. 6, moving the ear out to 10 feet with the speaker on the floor results in a dramatic peak at 1.6-2 kHz, producing a very bright sound. Nothing other than the listener's position has been changed, yet the well balanced

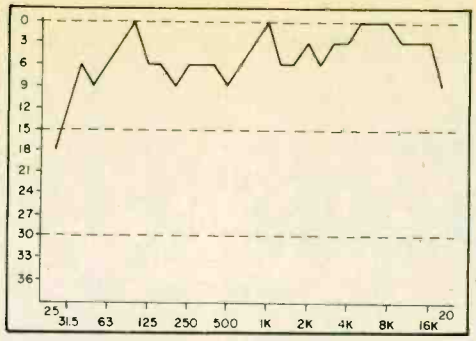


Fig. 9. In Figs. 9 and 10 the ear is at 10 feet. Fig. 9 speakers are on 3 foot stands.

sound of Fig. 4 is changed into the edgy, excessively bright sound of Fig. 6.

Location Affects Sound. In Figs. 7 through 10, we illustrate the most uncommon problem whereby the listener is not in an optimum location. Because of furniture position, the shape of the room or whatever, he or she is in line with and unnaturally close to one speaker, rather than being at what we consider the "short throw" listening position of 10 feet. Naturally, the response will vary from room to room; our illustrations only are meant to show one set of conditions particular to test room.

In Figs. 7 and 8, the ear is three feet from the right speaker. In Fig. 7 the speakers are on 3 foot high stands. In Fig. 8 they are on the floor. Look at the dramatic increase in bass response with the floor mounted speakers. In Figs. 9 and 10 the ear is at 10 feet. In Fig. 9 the speakers are on 3 foot high stands. In Fig. 10 they are floor mounted. Again, the floor mounting provides a better, though not as dramatic bass "boost," along with a moderate boost in the lower midband. While this bass boost might appear attractive on the surface, the overall music quality of Fig. 8 is best described as "muddy" —too much bass is not necessarily a good thing.

Summing Up. Once a speaker gets out into the real world, away from anechoic test chambers, its sound coloration is more often than not determined by the speaker positioning, the position of the listener and the room's dimensions, ratios and furnishings. Often the sound quality at the amplifier is not what's heard when the listener sits down, as shown in Figs. 11 and 12. Figure 11 is the sound heard by a listener as he bends over a receiver and adjusts the tone control for a "solid bass." Figure 12 is the response he hears when he sits down. The midband is up slightly, the bass is down slightly, and the two combine to produce a bass that isn't all that solid. At the very least, it doesn't sound as it did when our stereophile set the tone equalization adjustments at the amplifier.

Basically, it all comes down to this: Just about everything colors the sound of a speaker system. So if you're not happy with the sound from your speakers, push them around. Move them right or left. Try stands if you feel there's too much bass. Get them off stands if you believe they lack bass. Change your listening location. Close or open the curtains or drapes. Every one of these things will change a speaker's tonal coloration. Just keep trying until you get the sound quality you like. That will be *your* high fidelity sound. ■

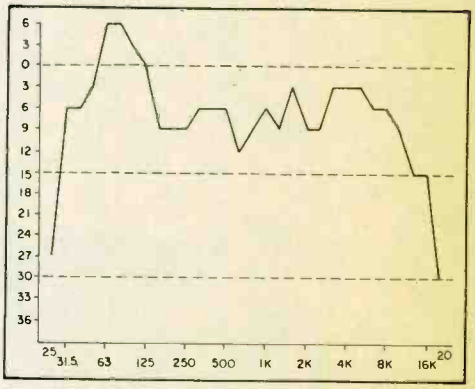


Fig. 11. This diagram shows the sound that a listener hears as he adjusts for best bass.

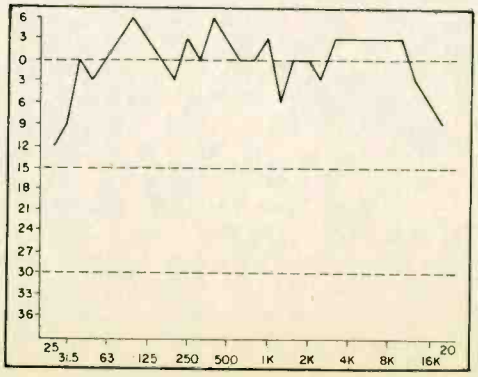


Fig. 10. Floor mounting improves the bass portion, with a moderate boost at mid band.

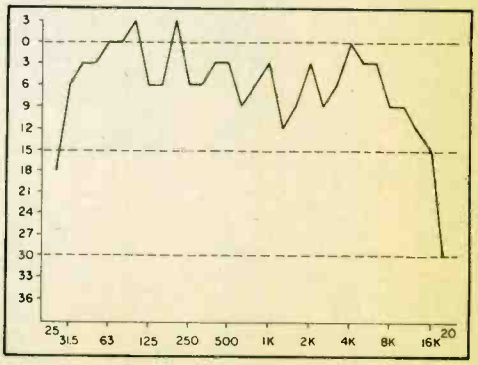


Fig. 12. But when the listener moves away from the set, this is the pattern of sound.

S&E LAB TESTS THE...

Avanti AV 801 Scanner Antenna

This tri-band antenna covers from 25 to 512 MHz

YOU READ CORRECTLY! This article is an installation and use report on the Avanti Astro Scan AV-801 triband monitor Antenna by this anonymous reviewer who, alas, learned he was not so hot. You see, the story starts with a 1½-foot length of fine stainless steel mounted on a piece of plexiglass and loaded directly into a coaxial cable of unknown impedance, but inexpensive brand. While connected to a half dozen different monitors and scanners during the past few years, this inexpensive and simple antenna pulled in the cops, fire, ambulance, commuter railroad, etc., with no difficulty. The police precinct was only five city blocks away, the thoroughfare used by the fire department was only one city block away, and everything else was less than one quarter of a mile away. With signal strengths at a maximum, it was a wonder that the antenna itself did not glow red.

The awakening came when a friend told me of a police stake-out frequency that worked night-time only just above 450 MHZ. Try as I may, I could not hear them even when my buddy confirmed their existence by placing his telephone mike next to his scanner's loudspeaker. He was pulling it in and I wasn't. Goodbye to that simple stainless steel thing-a-ma-jib.

Up went the Avanti Tri-band monitor antenna AV-801 which can pull in 25-50 MHZ, 140-174 MHZ, and 450-512 MHZ (includes the new "T" band).

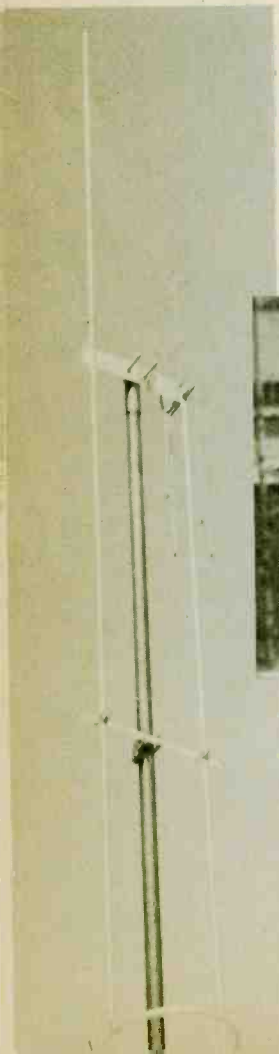
If you had watched me doing it and blinked twice—you would have missed the whole installation. Assembly was done at street level. All parts were bolted together with mast mounts attached. I was using an old TV mast which was secured on the roof to the chimney by the usual brackets.

I went up to the roof with a bucket of tools, tape, RG-58/U cable, and the AV-801. In all honesty, if it were not for picture-taking time, the AV-801 would have been up in 15 minutes including cleanup. I did the whole installation myself mainly because the total weight of the antenna is only 2¼-pounds. All tubes and plates are aluminum. Only the small solid rods are stainless steel.

But watch out, haste can make trouble. Check that there are no overhead high voltage wires, or, should the antenna mast topple be sure it would not fall on high voltage lines near the house. I sprayed some clear lacquer on the coaxial connector, hopefully sealing out moisture. The same spray was used on the hardware threads as a safety lock and also to retard corrosion. The antenna site is near the sea, and salt air does pit alumminum, I couldn't wait to tie the Avanti AV-801 into my Bearcat. I didn't even cut back the excess footage on the 50-ft long RG-58/U, for I wanted to get the rig on the antenna at once.

CIRCLE 36 ON READER SERVICE COUPON

Whamo, I heard stations, base and mobile alike I never suspected existed. Surprise No. 1 was that amateur 6-meter reception was good. And no wonder, the high-frequency section of the antenna is a co-inductive 5/8 wave Astro plane with 4.4—dBi gain. The VHF section is effectively a half-wave dipole with 2.1-dBi gain. Up in UHF country an 1¼-wave collinear provides 3.3-dBi gain. Antenna matching to the line indicated more signal was lost in the cable than to any mismatch. That's good for the antenna, but bad for the line. So I cut 22 feet of coax out to reduce HF losses. At the low end using 27-MHz, the SWR was 1.13 and that's darn good. There's no reason for you, as it was for me, not to expect an exceptional increase in monitor/scanner performance with the addition of the Avanti AV-801. It's reasonably priced at $34.95, and with the added cost of a new mast, coax cable and 2 standoffs, the total cost was a bargain that fit hobby budget. For more information, circle No. 36 on the Reader Service pre-paid post card. ■



At left is the Avanti 801 antenna installed, with all its elements for multi-band reception in view. Longer elements low frequency, short for high.

The warning means exactly what it says! Contact with voltage carrying wires can result in electrocution. Check for wires in the vicinity beforehand.

Computing Car Costs

This program calculates automobile cost-efficiency

BY MICHAEL KAYE

AUTOMOBILE ECONOMY is the one topic that can be counted upon to be on everyone's mind. Is it cost-effective to buy a new, high-mileage compact car; is it cheaper to keep your old clunker for another two years; or would it really break you to operate one of the luxury models? It all depends upon your particular circumstances of car use—and no two people use their cars exactly alike.

Luckily, however, there are a number of parameters around which we can calculate car costs, and these parameters are more or less common to everyone. This car cost program, which is being published here for the first time, can tell you virtually everything you need to know regarding the operating costs of your car—or any model you may be contemplating buying. It would take you hours to get these figures using a hand calculator, but your personal computer can come up with them in seconds.

This program has been set up to run on a Radio Shack TRS-80, Model I, Level II, 16K or greater, computer. It will need modification before it can be used on another model of computer. However, it is written in BASIC, so such a conversion is not impossible. The following will give you some idea of how the program runs.

Lines 100–120 dimension the variables. There are 20 in this program, but I have included space for 50 in Line 110. Fifty (cents) may seem ridiculous; but remember when gas used to be 35 cents a gallon?

Lines 130–140 read in string variables used in the PRINT USING statements. PRINT USING allows you to plug everything in nice and neatly (see Line 1000). The GOSUB 1190 calls up a simple graphics routine that starts the program off (see Line 1200). This routine can be deleted if you want to conserve space (Line 1200-1440), but make sure to delete the GOSUB 1190 in Line 130. Line 140 reads in the strings that name the variables (see Lines 770-980). These strings are stored in the program as data statements and can be added to or changed if you want to embellish upon the calculations.

Line 150 is a part of an error-trapping routine that checks for a division by zero; this happens if you forget to enter certain values when asked to do so by the computer. The program will not let you get away with that and will keep asking for what it wants until it gets it. ON ERROR GOTO statements have to appear before the error occurs, otherwise the error trapping routine won't work.

Lines 160-190 inquire as to whether you need your hand held. Remember, when all else fails, read the instructions.

Line 200 begins the interrogation. The computer will ask for the year and model of the car. The model year is the variable labeled "MO" and the model is the variable CA$. These are left alone once entered, as you may want to use different sets of figures for the same car. If you want to change the model and year the program will ask when you wish to do so.

Line 280 uses a FOR / NEXT loop which asks for eight variables to be entered by you. Check the DATA statements starting at line 770 to see what variables are associated with each other in this section.

Lines 350–580 figure it all out. There are no tricks in these calculations with the exception of some slight of hand in Line 380 which tests for daily or yearly mileage. I figure that anyone who owns a car must drive it at least 1000 miles a year. (I have written a "little old lady" subroutine which uses different values and can be obtained from me on any Sunday.) Moreover, very few drive a 1000 miles a day, so the computer assumes that if you enter anything less than 100 it is a daily figure and multiplies it by 365; anything over 1000 is a yearly figure.

Lines 600–750 print out the results. The use of PRINT USING statements is straightforward. One of the nice things about using PRINT USING is that the figures are rounded off when this statement is used. I suggest that you read up on PRINT USING in the Level II manual.

Line 700 does all the work so I'll describe it in greater detail. The print statement is encased in a FOR / NEXT loop which prints out A$(9) through

A$(18); look at Lines 870 through 960 to see what the variables are. The using $$#####.## is hung on to the string variable by virtue of the use of semicolons. The numeric variable c(x) is then plugged into that $$#####.-##, being neatly rounded off in the process. The last part of Line 700 (the part about the total cost per mile) was added after the majority of the program had been written and debugged. Rather than rip the program open to add it in, I decided to insert the calculation at the point of printing. You can add additional calculations of this sort if you want to customize the program. This is the kind of thing that happens quite often when you are writing programs and its nice to know that you can add on a frill or two without major surgery.

Lines 770–1040 are self-explanatory. They contain program data; the strings used in printing out the results of the calculations and the instructions for using the program.

Lines 1200–1440 contain the simple graphics routine that runs at the beginning of the program. Line 1280 looks formidable but all it does is center a given string in the middle of a line. It calculates how far to tab over to center the statement based on the length of the string it is printing. I like this one because it makes things look neat. You can use variations of this theme when you want to center statements in the middle of the screen.

If you want to conserve memory space you can delete all the remark statements as well as the graphics routine. I try to stick in as many remarks as possible to remind myself of what I was doing when I wrote the program.

You may be in for some surprises when you run figures for your car or on one you want to buy. That 1964 Plymouth you've been tooling around in may be cheaper to run than the Diesel Rabbit that's been hopping through your mind. ■

```
50 REM -- 'CAR' BY MICHAEL KAYE 03/06/80
100 CLEAR 1000
110 DIM A$(50),C(50)
120 Q=20
130 GOSUB 1020:GOSUB 1190
140 FOR X=1 TO Q:READ A$(X):NEXT
150 ON ERROR GOTO 330
160 CLS
170 PRINT@460,'DO YOU WANT INSTRUCTIONS (Y/N) ? '
180 QQ$=INKEY$:IF QQ$=''THEN 180 ELSE IF QQ$='Y' THEN 1050 ELSE 190
190 CLS:PRINT'PLEASE ANSWER THE FOLLOWING QUESTIONS !'
200 IF MO <>0 THEN 290
210 REM - THIS ASKS FOR NAME OF CAR & MODEL YEAR
220 PRINT A$(19);:INPUT MO:PRINT A$(20);:INPUT CA$
230 GOTO 280
240 REM ------------------------------------------
250 REM - INPUT OF VARIABLES
260 REM ------------------------------------------
270 IF MO<>0 THEN 290 ELSE 280
280 FOR X=1 TO 8:PRINTA$(X);:INPUT C(X):NEXT:GOTO 310
290 PRINTA$(19);MO:PRINTA$(20);CA$
300 FOR X=1 TO 8:PRINTA$(X);C(X);:INPUT C(X):NEXT
310 PRINT'
    IF YOU WISH TO CHANGE ANY OF THESE FIGURES TYPE <C>
    AND THE COMPUTER WILL ASK FOR A NEW SET OF FIGURES ,
    IF YOU WISH TO EXIT THE PROGRAM TYPE <E> OTHERWISE
    HIT <ENTER>.'
320 QQ$=INKEY$:IF QQ$='' THEN 320 ELSE IF QQ$='C' THEN 190
    ELSE IF QQ$='E' THEN 1170 ELSE 340
330 CLS:RESUME 1150:REM -- ERROR RECOVERY
340 REM ------------------------------------------
350 REM -- COST CALCULATIONS
360 REM ------------------------------------------
370 REM - DAILY OR YEARLY MILEAGE
380 IF C(3)<1000 THEN C(3)=C(3)*365
390 REM - FUEL COST PER MILE
400 C(9)=C(1)/C(2)
410 REM - FUEL COST PER YEAR
420 C(10)=C(9)*C(3)
430 REM - DAILY INSURANCE COST
440 C(11)=C(4)/365
450 REM - DAILY PARKING COST
460 C(12)=(C(5)*12)/365
470 REM - DAILY MAINTENANCE
480 C(13)=C(7)/365
490 REM - DAILY FUEL COST
500 C(14)=(C(3)*C(9))/365
510 REM - DAILY MISC. COSTS
520 C(15)=C(6)/365
530 REM - DAILY COST OF MONTHLY PAYMENTS
540 C(16)=(C(8)*12)/365
550 REM - TOTAL DAILY COSTS
560 C(17)=C(16)+C(15)+C(14)+C(13)+C(12)+C(11)
570 REM - TOTAL YEARLY COSTS
580 C(18)=C(17)*365
590 REM ------------------------------------------
600 REM     THIS PRINTS OUT THE DATA
610 REM ------------------------------------------
620 CLS
630 PRINTUSING R5$;MO,CA$,C(17)
640 PRINTUSING R6$;C(3),C(1),C(2),C(9),C(14)
650 PRINT@832,'TO SEE A COMPLETE BREAKDOWN OF FIGURES TYPE <B>'
660 PRINT@896,'TO ENTER FIGURES FOR A DIFFERENT CAR TYPE <N>
670 PRINT@960,'TO ENTER ANOTHER SET OF FIGURES HIT ANY KEY';
680 QQ$=INKEY$
690 IF QQ$=''THEN 680 ELSE IF QQ$='B' THEN 700 ELSE IF QQ$='N'
    THEN 740 ELSE 190
700 CLS:FOR X=9 TO 18:PRINT A$(X);'--';USING'$$#####.##';C(X):NEXT:PRINT:PRINT'TO
TAL COST PER MILE';'--';USING'$.##';(C(18)/C(3))
710 PRINT'
TO ENTER NEW FIGURES FOR THE SAME CAR HIT <ENTER>
FOR A DIFFERENT CAR TYPE <N> ; TO EXIT PROGRAM TYPE <E>.'
720 PRINT@305,MO;:PRINT@305+63,CA$;
730 QQ$=INKEY$:IF QQ$='' THEN 730 ELSE IF QQ$='E' THEN 1170 ELSE    IF QQ$='N' T
HEN 740 ELSE 190
740 FOR X=1 TO 8:C(X)=0:NEXT:MO=0:CA$='':GOTO 190:
    REM -- ABOVE ZEROS ALL VARIABLES.
750 END
760 REM ------------------------------------------
770 REM          DATA STATEMENTS
780 REM ------------------------------------------
790 DATA COST PER GALLON OF FUEL-------:'A$(1),C(1)
800 DATA ESTIMATED MILES PER GALLON----:'A$(2),C(2)
810 DATA DAILY OR YEARLY MILEAGE-------:'A$(3),C(3)
820 DATA YEARLY COST OF INSURANCE------:'A$(4),C(4)
830 DATA MONTHLY PARKING COSTS---------:'A$(5),C(5)
840 DATA MISC YEARLY COSTS ------------:'A$(6),C(6)
850 DATA ESTIMATED YEARLY MAINTENANCE--:'A$(7),C(7)
860 DATA MONTHLY PAYMENTS--------------:'A$(8),C(8)
870 DATA FUEL COST PER MILE------------:'A$(9),C(9)
880 DATA FUEL COST PER YEAR------------:'A$(10),C(10)
890 DATA DAILY INSURANCE COST----------:'A$(11),C(11)
900 DATA DAILY PARKING COST------------:'A$(12),C(12)
910 DATA DAILY MAINTENANCE COST--------:'A$(13),C(13)
920 DATA DAILY MILEAGE COST------------:'A$(14),C(14)
930 DATA DAILY MISC.COSTS--------------:'A$(15),C(15)
940 DATA DAILY PAYMENT COSTS-----------:'A$(16),C(16)
950 DATA TOTAL DAILY COSTS-------------:'A$(17),C(17)
960 DATA TOTAL YEARLY COSTS------------:'A$(18),C(18)
970 DATA MODEL YEAR--------------------:'A$(19),MO
980 DATA NAME OF CAR-------------------:'A$(20),CA$
990 REM ------------------------------------------
1000 REM     FORMATTED STRINGS FOR 'PRINT USING'
1010 REM ------------------------------------------
1020 R5$='
BASED ON THE FIGURES YOU SUBMITTED YOUR #### X                    X
COSTS YOU $$#.## A DAY TO OPERATE.'
1030 R6$='
THE FUEL FIGURES ARE AS FOLLOWS:
DRIVING #####  MILES A YEAR AT A FUEL COST OF $#.## PER GALLON
AND A MILEAGE OF ##  MILES PER GALLON COSTS YOU $.## PER MILE ;
AND $$#.## PER DAY.'
1040 RETURN
1050 REM ------------------------------------------
1060 REM          THESE ARE THE INSTRUCTIONS
1070 REM ------------------------------------------
1080 CLS:PRINT'
    THIS PROGRAM WILL HELP YOU FIND OUT WHAT YOUR CAR COSTS
    TO OPERATE.THE COMPUTER WILL ASK YOU A SERIES OF QUESTIONS
    ABOUT YOUR CAR.';
1090 PRINT'
    THE MOST IMPORTANT QUESTIONS ARE ABOUT FUEL COST AND
    THE NUMBER OF MILES DRIVEN ON A DAILY OR YEARLY BASIS.';
1100 PRINT'
    FUEL COST SHOULD BE ENTERED AS A DECIMAL FIGURE ,
    FOR INSTANCE A DOLLAR THIRTY PER GALLON WOULD BE
    ENTERED AS 1.30 , NINETY CENTS PER GALLON (REMEMBER
    THE GOOD OLD DAYS) WOULD BE ENTERED AS .90 .';
1110 PRINT'
    DAILY OR YEARLY MILEAGE REPRESENTS THE NUMBER OF MILES
    THAT YOU ESTIMATE ARE DRIVEN FOR THOSE PERIODS.IF YOU
    ENTER A DAILY ESTIMATE THE COMPUTER WILL FIGURE OUT THE
    YEARLY FIGURE.';
1120 PRINT:PRINT'
    TO CONTINUE HIT <ENTER>';:INPUT QQ$
1130 CLS:PRINT'
    IF YOU WISH TO ENTER ANOTHER SET OF FIGURES FOR THE
    SAME CAR WHEN PROMPTED TO DO SO BY THE COMPUTER ,
    THE COMPUTER WILL PRINT THE OLD FIGURE WITH A <?>
    BESIDE IT.ENTER ONLY THE FIGURES YOU WISH TO CHANGE.';
1140 PRINT'
    WHEN THE COMPUTER ASKS FOR FIGURES THAT YOU DONT WANT
    TO CHANGE , JUST HIT <ENTER> AND GO ON TO THE NEXT
    QUESTION.';
1150 PRINT'
    YOU MUST ANSWER THE QUESTIONS INVOLVING THE PRICE
    OF FUEL , MILES PER GALLON , AND MILEAGE DRIVEN OR
    AN ERROR WILL RESULT.
    TO CONTINUE HIT <ENTER>';:INPUT QQ$
1160 GOTO 190
1170 CLS:PRINTCHR$(23):PRINT@462,'HAPPY MOTORING'
1180 GOTO 1180
1190 REM ------------------------------------------
1200 REM          THIS IS THE OVERTURE
1210 REM ------------------------------------------
1220 A$=CHR$(152)+CHR$(140)+CHR$(164)+CHR$(144)
1230 F$=STRING$(64,191)
1240 F1$='C A R -- COMPUTERIZED AUTOMOTIVE RECKONING
1250 F2$='BY MICHAEL KAYE 03/06/80
1260 F3$=' TO CONTINUE HIT ANY KEY '
1270 CLS:PRINT@0,F$
1280 PRINTTAB(INT((64-LEN(F1$))/2))F1$
1290 PRINTTAB(INT((64-LEN(F2$))/2))F2$
1300 PRINT:PRINTF$
1310 X=448
1320 FOR Z=1 TO 35
1330 PRINT@448,CHR$(31):PRINT@X,A$:PRINT@X+30,A$:PRINT@X+60,A$
1340 FOR Y=1 TO 35:NEXT:X=X+64:NEXT Z
1350 PRINT@896,F$;
1360 PRINT@896+(INT((64-LEN(F3$))/2)),F3$
1370 QQ$=INKEY$:IF QQ$=''THEN 1370 ELSE RETURN
1380 REM ------------------------------------------
1390 REM     THIS ROUTINE CAN BE DELETED IF YOU
1400 REM     DONT WANT THIS MODEST TRIBUTE TO THE
1410 REM     GENIUS OF THE PROGRAMMER INCLUDED ,
1420 REM     HOWEVER , HIS SPIRIT MAY BE OFFENDED
1430 REM     AND YOU MAY BE THE RECIPIENT OF BAD KARMA.
1440 REM ----------)iiiiiiiiiiiiiiiiiiii
```

Antique Radio Corner

Homemade Replacements for Unavailable Parts

BY JAMES A. FRED

GENERALLY SPEAKING, the vacuum tubes made in the 1930s are in good supply; however, there are shortages of certain types. I don't know whether they were overworked in the circuits and expired early, or if a much smaller number than usual were made.

One tube falling into this category is the 6N6G. This tube is a direct coupled power amplifier dual triode, and I suspect that it was used in very few radio receivers.

It was an octal based glass tube with two triodes in one glass envelope. One triode has its cathode directly connected to the other triode grid. Thus one triode amplifies the signal and then sends it to the grid of the other triode where it is amplified even more. This tube never became popular, even though it was manufactured in both the older 6 pin type and in the 8 pin octal base.

Recently I made two adapters to allow a 6B5, (which is the electrical equivalent, and still available) to replace a 6N6G which isn't available. A collector is happily listening to his radio thanks to this adapter.

I recently completed a Wurlitzer Jukebox volume control box. The assembly consisted of a metal box that housed a dual volume control, several resistors, capacitors and two inductors. There were two shielded leads, one input lead with a 2-prong polarized socket and the other lead with a small 4-pin plug. One inductor had a value of 290 mH and the other was 400 mH.

Homemade Inductors. I purchased nylon bobbins with a ½-inch hole, ¾-inch wide, and with 1-inch square flanges. The inductor needed between 4000 and 5000 turns of number 39 enameled wire to reach the desired inductance. Fortunately, several months before, I had purchased a Stevens bobbin winder, that with the proper shape cam would wind a coil I could use. After winding a few experimental coils it became necessary to measure the inductance to see whether I needed more or less turns. I had no inductance bridge, so I used an alternate method of finding the inductance of a coil that used an AC VTVM, an audio oscillator and a capacitor.

I have shown the circuit for those antique radio restorers who might need to wind inductors for a restoration project. It would be best to accurately measure the capacitor if you can; otherwise buy one with an accuracy of 5 percent. The formula for finding inductance when you have frequency and capacity is:

Inductance in millihenries equals:

$$\frac{25{,}360{,}000}{f^2C}$$

where "f" is in Hertz and "C" is in microfarads.

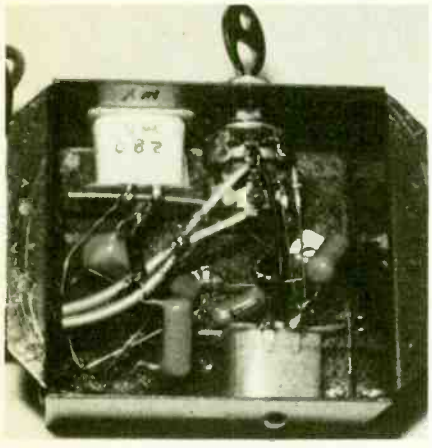
I used a .02 uF capacitor, but any similar value may be used. A much easier method, using an inductance slide rule made and distributed by Shure Brothers, 225 West Huron St., Chicago, IL, will allow you to make one-minute calculations of inductance.

To use the circuit setup shown proceed as wollows. Connect the inductor and capacitor in series as shown, and then tune the audio generator until you get a peak reading on the VTVM. The generator frequency becomes "f" in the formula; "C" is .02 uF.

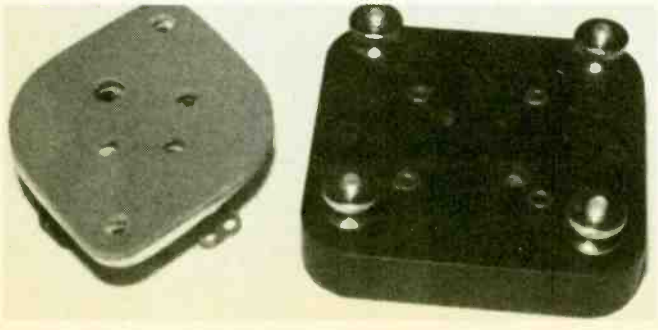
CAUTION: Some inexpensive audio generators have an unregulated output and will give false peaks on the VTVM. If there is any doubt that you have a true inductance peak, disconnect the coil and capacitor and check the generator output for flat response.

Most audio generators currently on the market have an AGC circuit that will hold the output constant over the complete frequency range. If your measured inductance is low, estimate how many more turns of wire you will need and wind a new coil. If you have too much inductance, you can remove turns until you reach the value you have determined that you need.

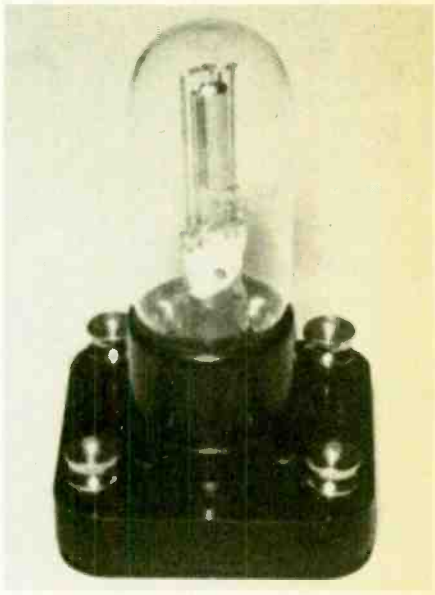
If you don't have a coil winder you can improvise a suitable one by using either an electric or hand operated drill. You can hand guide the wire into a



Two homemade inductors are used in this volume control; a 280 mH and a 400 mH.



These are two examples of WD-11 tube sockets made by the author. They were made up from parts of World War II vintage tube sockets, and then customized to fit.



This WD-11 is mounted in a socket made by the author. It complements the vintage tube.

Antique Radio Corner

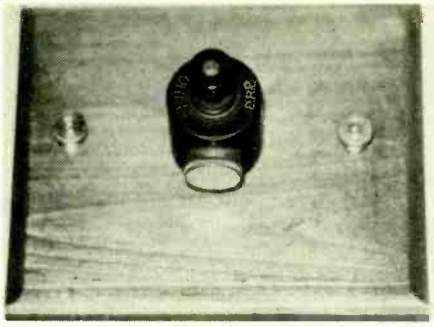
reasonably level winding. There's no need for insulation between turns of wire because the phono pickup will not put out more than 3 volts.

VARIAC. How many experimenters or antique radio restorers have a variable voltage transformer? You may have heard the word VARIAC, a trademark owned by General Radio Company. Variac is a contraction of the words Variable Alternating Current, and is the first variable voltage transformer I ever saw. Now there are several similar devices manufactured in the United States and overseas.

From the diagram shown, you can see that there is only one winding, which classes it as an autotransformer. Each turn of the winding, wound around a circular core, can be contacted by a wiper arm. As the arm is rotated it picks the voltage off each turn and provides a very linear output voltage.

In addition, there are a few more turns beyond the input line connection, which will boost the line voltage by about 15 volts. On the circuit diagram you will note the points labeled A thru E. If we apply the line voltage to points A and E, we can get a variable AC voltage from zero to the full line voltage. But if we apply the line voltage to A and D, we get the line voltage plus an induced 15 volts.

Variable voltage transformers come in a variety of sizes and wattage ratings. You will usually find them reasonably priced in surplus catalogs and at hamfest flea markets. They are used extensively in factory, college and experimental laboratories. Where do they fit into an antique radio collector's shop, you might ask? I have a half dozen built into various gadgets that I use regularly.



Can anyone identify this crystal detector? This photo was sent in by a curious reader.

Useful Variable Transformers. Antique radio restorers can put them to many uses. First, they can be used to prevent transformer burnouts in old AC radio sets. I recommend that you use a circuit like that shown with a voltmeter and an ammeter every time you plug a new or unknown radio in for the first time. Start the AC voltage at zero and turn the output voltage knob slowly as you watch the ammeter.

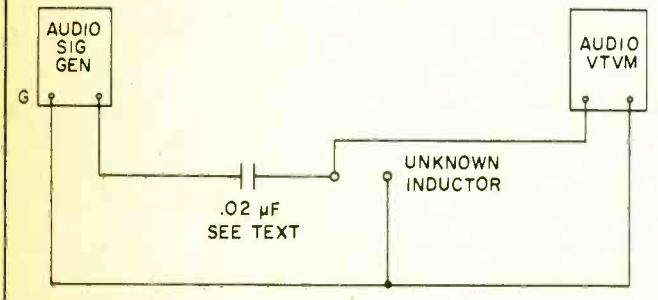
A quick application of the power equation, e.g., Power = volts times amperes, will give you an early indication of trouble. For instance, say you have an old radio with a power transformer whose rating is 1.2 amperes at 120 volts, or is rated at 145 watts; as you increase the voltage, you see that with only 50 volts on the voltmeter the ammeter is already reading 3 amperes. A quick calculation shows you that you have 150 watts, which indicates a short somewhere in the circuit.

Next, pull out the rectifier tube and if the current drops to half an ampere or less you can guess that the problem is in the B+ voltage circuit. If pulling the rectifier tube doesn't lower the current, you most likely have shorted turns in the power transformer. This means you will need a new power transformer.

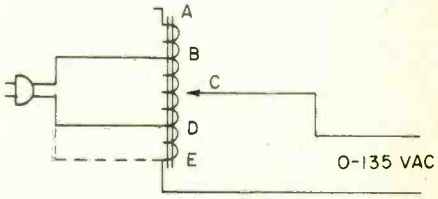
Another use for a variable voltage transformer is in a variable output power supply. The circuit diagram shows how simply this can be done. You don't need any transistors, rheostats or fancy semiconductors. The efficiency is quite good because you are supplying just enough power to take care of your load plus a few percent to cover core losses.

Still another use is to supply a lower or higher line voltage than normal. This is especially valuable when troubleshooting intermittent sets. Resistors, capacitors and sometimes inductors will break down with voltage surges. One way to simulate this condition is to increase the line voltage above its normal value.

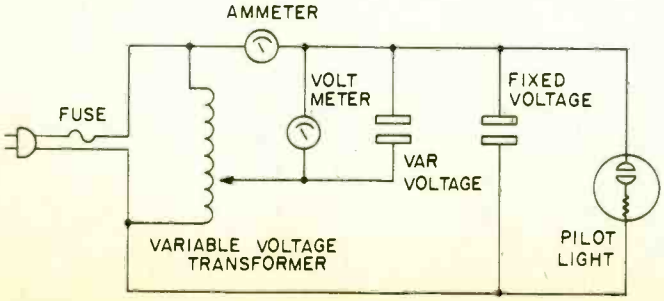
(Continued on page 79)



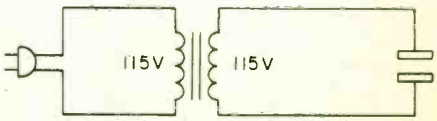
When you wind your own coils, you will need some way of checking the inductance, to determine if you need more or less turns. The setup shown at left is ideal here.



This circuit diagram describes elements of a 0-135 volt variable output transformer. Variable transformers such as this are very useful for powering all sorts of antiques.



Author recommends this circuit configuration to anyone interested in building a variable voltage transformer for the shop or the repair bench. As a troubleshooting tool, it is ideal.

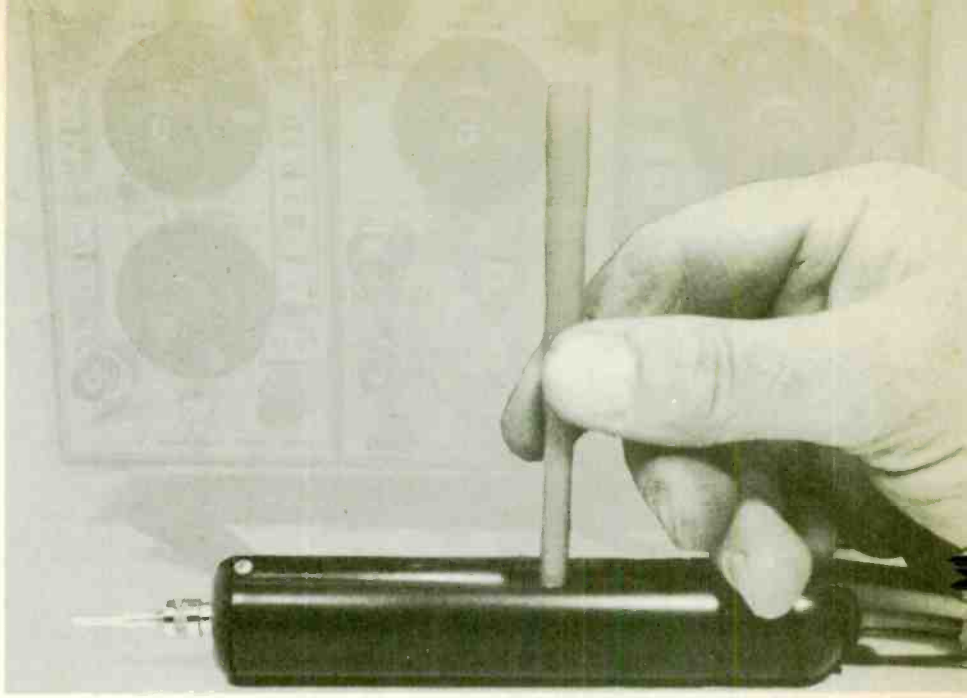


Isolation transformers like this one pictured above are good safety devices when working on older radios with one side of the power line connected to the chassis. A transformer can prevent nasty shocks.

LO CAP PROBE

Simple probe helps your oscilloscope perform at high frequencies

BY HERB FRIEDMAN



"WHAT YOU SEE is what you get" might be A-okay for a television comic, but it's not necessarily true when you use an oscilloscope.

It is unfortunate, but true, that a scope's performance is specified from the input terminals to the scope itself, but does not include the test probe or connecting wires. For this reason a service-grade scope rated out to 4 MHz, or 7 MHz, or even a laboratory scope rated out to 20, 50, or 100 MHz, might poop out on something as mundane as a 60 Hz square wave, delivering a CRT display with rounded leading edge while the real waveform is truly square. Worse than that, connecting your scope into an RF circuit may completely change the loading, or tuning of the circuit which is under test.

Here's Why. Forget for a moment that the scope has a frequency-compensated input. That has no bearing on your measurements, which is affected by the cable between the circuit being tested and the scope input. An ordinary shielded test lead approximately 3 feet long has a capacity of about 100-300 pF, depending on the type of shielding. If a "bare" test lead is connected into a circuit it is effectively loading the circuit with 100-300 pF: just imagine what this will do to an RF circuit, or any high frequency circuit from about 10k Hz up. "What you see *isn't* what you get in this case."

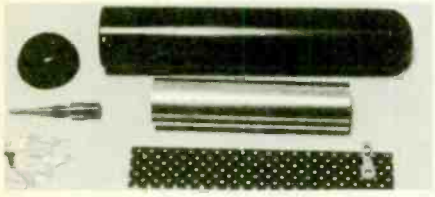
Also, consider the average scope's 1-megohm "high impedance" input. "High impedance" is a relative term: one equipment's "high impedance" is another's "low impedance." For example, imagine a transistor or integrated-circuit amplifier with a 500k or 1-megohm bias or feedback resistor. Connecting a scope's input across either value will completely change the operating parameters of the circuit. Or imagine what a 1-megohm "load" across a tuned RF input circuit will do: the "Q" might drop like a rock, not to forget the detuning effect of the test lead capacitance of the lead itself.

Follow the Labs. Commercial labs get around both the capacity loading and 1-megohm impedance by using a "10X low-capacity" test probe for the scope input. This device does two things: It makes the input capacity to the scope's test lead appear to be about 5-10 pF; and it raises the input impedance into the test cable—the impedance seen by the circuit being tested—to nominally 10 megohms (a value that won't affect any circuit the hobbyist will use or test).

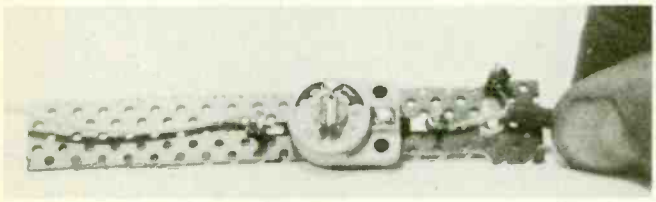
Easy to Build. A 10X Low Capacity Test Probe circuit is shown in Fig. 1. Basically, it consists of two components: trimmer capacitor C1 and resistor R1. C1 is generally any small trimmer wtih a maximum capacity in the range of 25-50 pF. R1 should be 9 megohms for a precise 10:1 voltage division: ie: the scope will indicate 1 volt P-P if the input to the cable is 10 volts P-P. However, 9 megohms, or anything close, is usually unattainable by the hobbyist. If you substitute a 10 megohm 5% resistor for R1 the accuracy will be sufficient for almost all applications (nominal voltage readout error will be about 10%).

In A Shielded Probe. The 10X probe must be assembled in a shielded test probe; if not shielded, hand capacity will induce "hum" into the signal, and add capacity loading to the circuit.

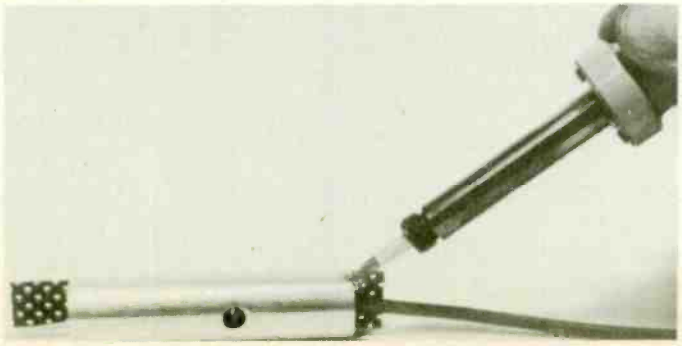
A shielded probe kit, the Keystone 1810, was used for the 10X probe assembly. The Keystone probe kit contains an insulated probe shell, a shielding sleeve, perforated wiring board (sized to fit inside the shield), probe



The Keystone 1810 shielded test probe kit before assembly. These are hard to get parts.



Trimmer capacitor wired onto strip of perf board. Be careful of parts shorting out in close spaces in which you'll be working.



As the text discusses, tack solder the test probe shield to the solder lug you've installed on the perf board. Do not fold the lug over the shield.

tip, and "flea" clips (soldering terminals). That's all you need.

Temporarily mount C1 to the perf-board and see if you can slide the shield over the assembly without having the shield short the trimmer capacitor. If it touches a metal part of C1, file the edges of the perf-board so it will sit lower in the sleeve and not short C1. When the shield can slide over the assembly secure C1 to the board with flea clips, as shown in the photographs. Install R1 across the C1 flea clips on the opposite side of the board (there isn't room for C1 and R1 on the same side) of the board.

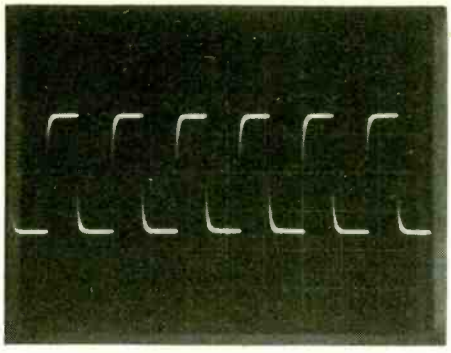
Solder about 3-inches of solid No. 20 or No. 22 wire to the front flea clip, the one on the opposite end from the solder lug which is factory installed on the perf board. This wire will eventually connect to the test probe tip.

Cut a piece of shielded wire to about 3-feet. You can use an ordinary audio patch cable with the phono plugs cut off the ends. Solder the center conductor to the rear flea clip; solder the shield to the solder lug and bend the solder lug at right angle to the perf-board. Make certain when you solder wires to the flea clips that C1 and R1 are also soldered to the clips.

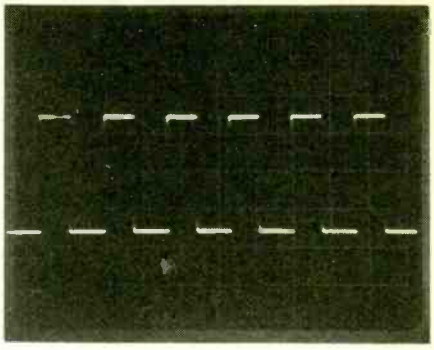
Slide the probe shield over the perf-board from the front until it touches the solder lug. Carefully mark the sleeve directly over the trimmer capacitor's adjusting screw. Remove the sleeve and drill a ¼-inch hole at the mark (careful, the sleeve is very thin). Solder an insulated stranded wire approximately 8-inches long to the solder lug's grommet–where it's secured to the perf-board. (This wire will pass out the hole in the rear of the probe cover and will connect to an alligator ground clip) that you use.

Now slide the shield over the perf-board, press it against the solder lug, and tack solder the shield to the solder lug. Do not fold the lug over the shield as it might prevent the cover from being slipped into place. Screw the probe tip into the probe's front cap, and then thread the solid wire from the perf-board through the probe, pulling on the wire so the perf-board is tight against the cap. Secure the wire to the probe tip. Measure the distance from the cap to the hole in the shield and transfer this measurement to the probe cover. Drill a ¼-inch hole in the cover at the mark. This will be the access hole for the capacitor C1.

Next, assemble the probe and install the required connector (to match your scope's input) at the free end of the shielded cable coming out the back.



Too much capacity shows up in a rounded leading edge, as shown here in Figure 2A.



Here, C1 has been adjusted correctly. Leading edge is perfectly square, here in Fig. 2B.

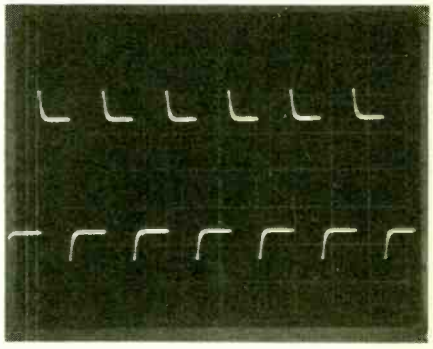
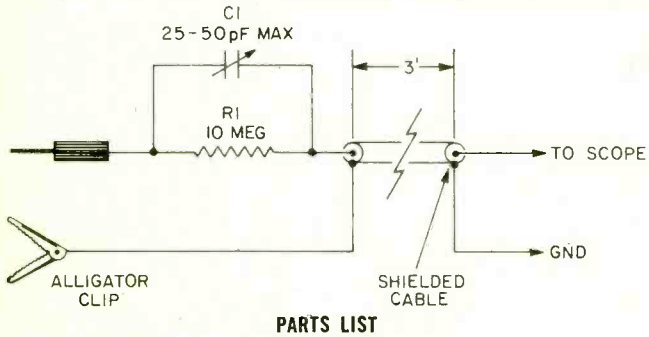


Fig. 2C. Peaked leading edge, shown, results from too little capacity in C1 adjustment.

Alignment. You must align the low capacity probe using some form of square waveform in the range of 60-1000 Hz. This can come either from the calibration voltage built into your scope or the square wave output of a sine-square signal generator. You can even use a broad pulse from a pulse generator if you have such an instrument in your workshop.

Touch the low capacity probe to the square waveform output, adjust your scope for a convenient CRT display, and then using an insulated alignment screwdriver, adjust C1 for a perfectly square *leading edge*, as shown in Fig. 2B. If you have too much capacity the leading edge will be rounded, as in Fig. 2A. If you have too little capacity the leading edge will peak, as shown in Fig. 2C. Perfect adjustment is a *perfectly square leading edge*. Once C1 is adjusted it need never be changed as long as the same scope is used.

Using the probe. Remember to multiply the CRT voltage indication by 10 to obtain the correct voltage at the test probe. For example, if the scope is set for 1 volt per division, and the peak-to-peak waveform is 1.5 divisions, the actual voltage at the test probe is 1.5 volts p-p x 10, or 15 volts p-p. ■



PARTS LIST

C1—Trimmer capacitors 25 or 5 0pF max., see text
R1—10,000,000 ohm, ¼ or ½ watt resistor, 5%, see text

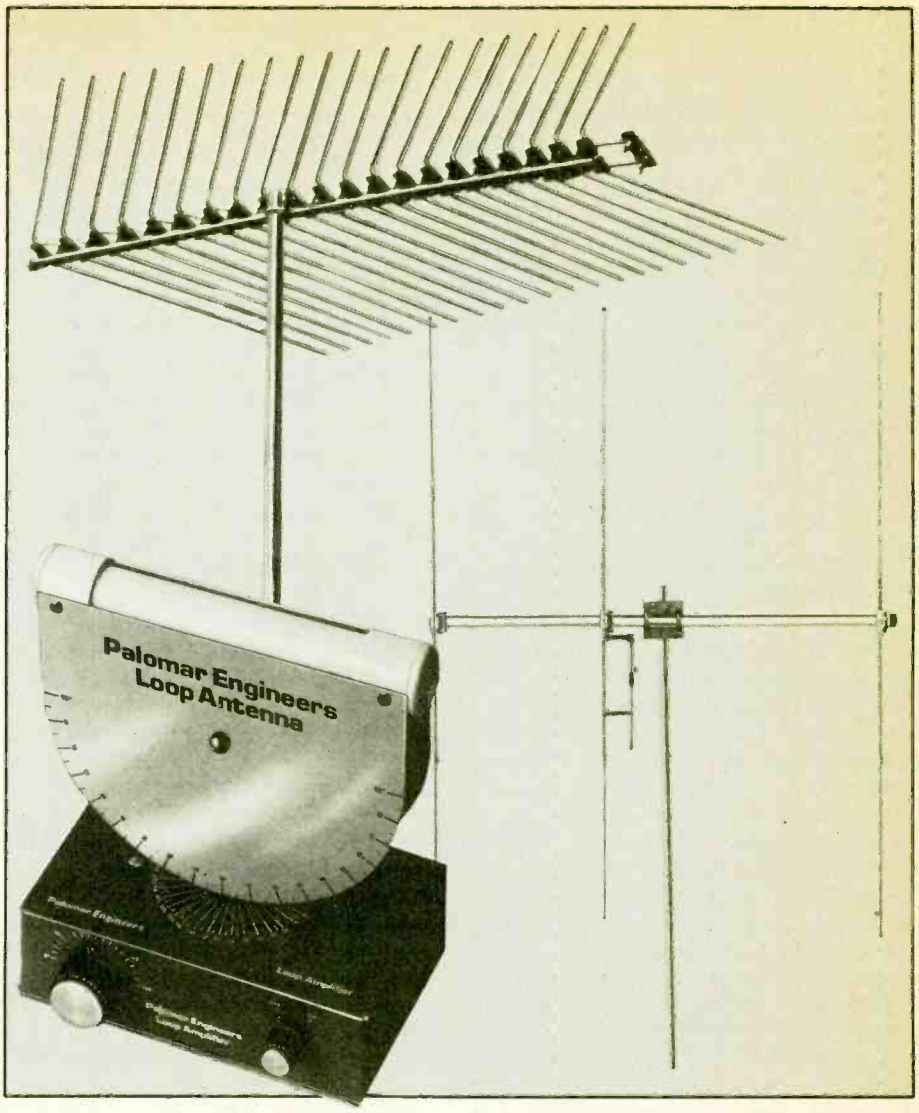
Misc.
Alligator grounding clip
Scope input connector
Keystone 1810 test probe

The Keystone 1810 test probe kit is available from Custom Components, Box 153, Malverne, N.Y. 11565. Price is $4 plus $2 postage and handling per total order: Canada add $1 additional. No foreign orders. N.Y. State residents must add sales tax.

Directional Antennas for the Shortwave Listener

Pinpoint signals with these professional techniques and equipment

BY ROBERT GROVE



MOST OF US APPROACH THE JOB of shortwave antenna installation in a casual manner; a long piece of wire is run away from obstructions and power lines and as high as possible. Hams are frequently guilty of the same sort of cavalier attitude toward antennas: "If it works, leave it up; if it doesn't, put up something else."

The fact of the matter is that shortwave receiving antennas, like other kinds of antennas, must be properly designed for optimum performance, and the job is not all that difficult once we understand a few of the underlying principles. Fortunately, shortwave receiving antennas are far more forgiving of sloppy design than are their transmitting counterparts. They don't balk at high SWR, they don't require special insulation considerations, and they needn't be concerned with large diameter conductors to accommodate radio frequency power. A receiving antenna is merely a conductor in the path of an arriving field of weak electromagnetic energy, and nothing more.

Back To Basics. In order to intercept the RF energy efficiently, a number of considerations are necessary. Like transmitting antennas, some lengths of antenna are more suited to certain radio frequencies than others. That is to say, certain lengths "resonate," or reinforce, radio signals whose wavelengths are mathematically related to the electrical length of the antenna wire or conductor. This is why CB antennas are all carefully adjusted to optimize their performance in the 27 MHz band.

Unlike CB, shortwave reception is very much broadband, typically from 3 to 30 MHz. This ten-to-one frequency range means that a resonant antenna is out of the question. This is where antenna "tuners" or "matchboxes" often enter the picture, especially for transmitting. From a practical standpoint, however, tuning devices are rarely necessary for receiving installations. A properly designed receiving antenna will work quite well over a wide frequency range, as evidenced by the reasonably good performance of that random length of wire discussed earlier.

Omnidirectionals. For the casual shortwave listener, desirable signals arrive from all points of the compass. He or she is unconcerned with the prospect that two signals arriving simultaneously on the same frequency make listening rather difficult. If one can't hear the station, it's merely a move up or down the dial for a new quarry.

In most cases, a random wire antenna, no more than 20 to 30 feet in length, will provide excellent worldwide reception. As with any antenna design, it should be as high as possible, and far away from physical obstructions—especially those which are metallic—and clear of power lines. Such random antennas may even be run at angles, following the contours of a roof line or building eave.

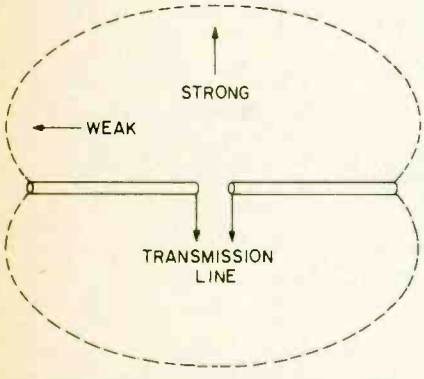
As an alternate solution, a very useful receiving antenna may be made from twenty feet of inexpensive mast pipe or conduit. It is mounted vertically, right on a ground pipe, and insulated from it by a sleeve of PVC pipe. A length of coax cable (any standard type)is run from the antenna to the receiver. Single vertical elements are always omnidirectional. Such an antenna configuration will give an excellent accounting of itself throughout the shortwave spectrum.

Directionals. A trip to an FCC monitoring station or to an intelligence gathering electronic surveillance installation will awe any but the most jaded listener. The Wullenweber antenna arrays they use look like elephant compounds. Is it really necessary to take such elaborate measures to improve shortwave reception? Certainly not. These electronic behemoths are designed with a very special purpose in mind: to measure exact bearings on incoming signals over wide ranges of frequencies.

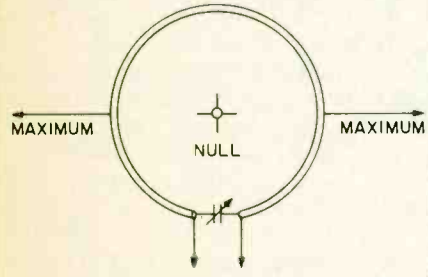
However, we can learn a lesson from these sophisticated installations. With proper design, an antenna can be made directional, and some of these designs

may be simpler than you ever dreamed.

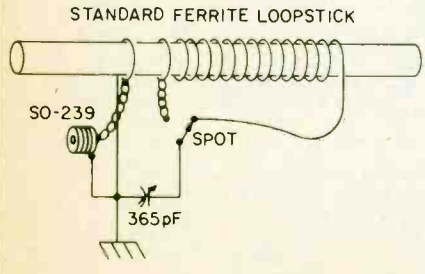
The Dipole. The simplest of all directional antennas is the dipole. Usually center-fed by a length of coaxial cable, the radiation (and reception) pattern of a dipole is that of a doughnut. Major receiving strength extends broadside to the antenna, which is relatively insensitive to signals arriving off the ends. In fact, deep nulls reject signals exactly off the ends of the dipole, making it very useful for interference cancellation from power lines or local transmitters. Since the reception lobes are very board and the nulls are very sharp, it is better to point the axis of the antenna at the source of interference in order to reduce it, instead of worrying about the broadside of the antenna facing a particular geographical location to favor reception.



The dipole makes simplest shortwave receiving antenna. Note directivity patterns.



Standard loop antenna is simple and easy to build. Sometimes used in mobile DFing.



Schematic for simple loopstick antenna. See text and box for further instructions.

Arriving radio signals are rarely stable targets. Only when the transmitter is relatively close to the receiver can the listener be assured of constant directional reception. The reason for this is the characteristic differences between ground waves and sky waves. Ground waves tend to travel in a straight path close to the surface of the earth, while sky waves are warped by the jonosphere, an electrically-charged layer of our atmosphere hundreds of miles above us. When these waves return to Earth, they are grossly altered from their original symetrical pattern and arrive at various angles.

A true directional antenna, such as that used for radio direction finding purposes and radio navigation, is carefully constructed to reject sky waves and concentrate on ground waves. Still, we can suppose generally that since the waves all started from one location, we can expect that *most* of the arriving signal will come from that direction, broad as it may be.

Beams. Commonly called the "beam" antenna, the Yagi-Uda array is the most common directional antenna encountered in ham radio installations, and it works well. Unfortunately, the Yagi has a very narrow bandwidth of operation, and the lower the frequency, the larger the array necessary. For this the larger the array necessary. For this reason, Yagis are rarely used solely countered below 14 MHz in hobby radio installations.

Quads. Large and ungainly, the cubical quad is popular among hams and CBers. The basic rules of Yagi element spacing apply to the quad. Like the Yagi, it is not practical as a shortwave receiving-only antenna, due to its size, complexity and fragility. It does, however, offer excellent directivity and gain factors, especially in two-way usage.

Log Periodics. The log periodic dipole array is used extensively for worldwide communications by military and government installations.

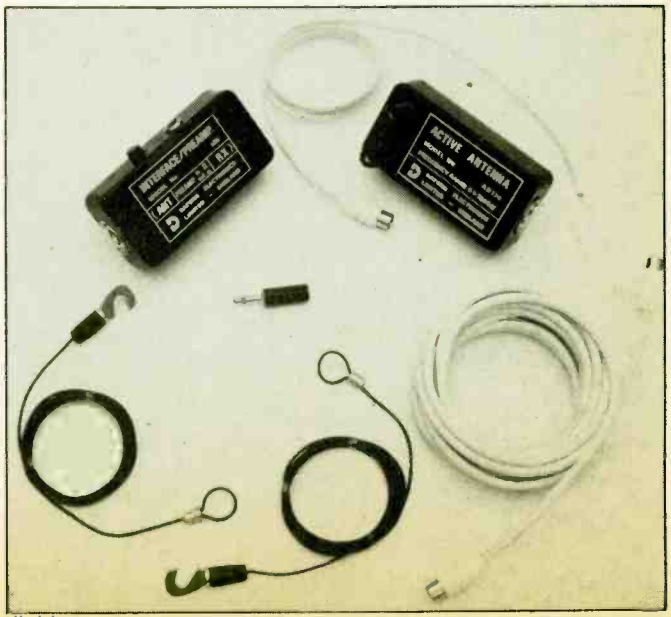
While useful over a 3:1 or even 4:1 frequency range, the elements of these broadband antennas are extremely large at the lower shortwave frequencies. Some of these antennas are hundreds of feet in length at major shortwave communications installations! Obviously, the most common and practical use of the LPDA is on VHF and UHF.

But the picture is not as bleak as it appears. There are some tricks the SWL can use which provide excellent antenna directivity, while utilizing small size and inexpensive construction methods and materials.

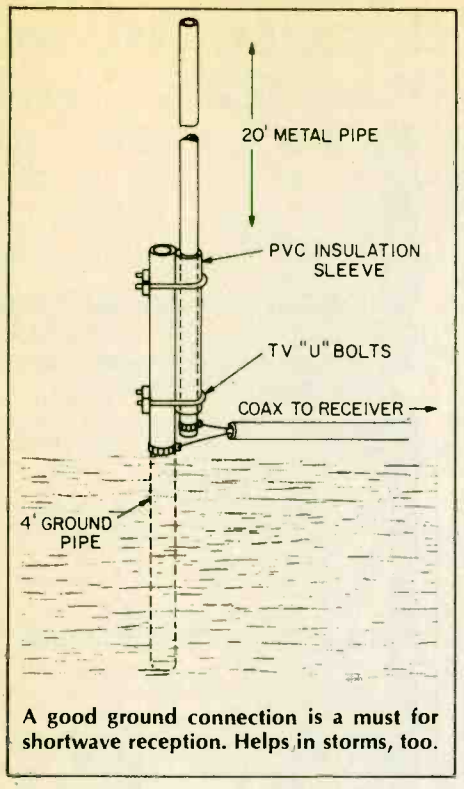
The Loop. Probably the most common directional low frequency antenna is the loop. Originally developed for direction finding service in the maritime industry, a loop antenna has a figure 8 pattern. Its null is at right angles to the plane of the loop, and its maximum signal pickup is off the ends.

A more recent variation on the receiving loop is the ferrite rod loop. One commercial unit is manufactured by Palomar Engineers (Box 455, Escondido, CA 92025). The Palomar unit is available with plug-in ferrite loops to cover 10 kHz through 5.5 MHz. Because the loop is tiltable, skywave anomalies may be greatly reduced, improving the directivity of the device.

The Palomar loop antenna also has a built-in amplifier. This is important for two reasons: the short antenna doesn't capture much signal, and the impedance of a loop is very low, making a poor match when connected di-



Active antennas have a certain appeal. They have a built-in preamp arrangement that amplifies the signal in the line. They do a good job in rejecting electrical interference.



A good ground connection is a must for shortwave reception. Helps in storms, too.

Antenna rotators are the deluxe way to solve the directional issue. Mount a yagi or quad on one; and your problems are over.

rectly to a receiver.

A Homebrew Loop. For the home experimenter, a ferrite rod loop antenna may be easily constructed once the materials are located. The experimenter will need a standard ferrite rod about seven-inches long, two rubber grommets to fit over the rod, a small aluminum utility box, an SPDT switch, a miniature 365-pF variable capacitor, a few feet of insulated hookup wire, and an SO-239 female coax connector.

The ferrite rod is wound tightly at its center with a single layer of cotton-covered hookup wire. Start by leaving about four-inches of wire as a beginning pigtail (this will be the ground lead). After one turn, twist tightly together another four inches of wire; this will be the output link. Resume winding another single turn and twist tightly together another four inches of wire; this lead will go to one side of the frequency range switch. Resume winding again until another 13 turns have been completed bringing the total to 15 turns. Leave about four-inches of pigtail to be connected to the other side of the frequency range switch.

Tape the coil down firmly against the rod to hold it in place. Slip a rubber grommet over each end of the rod to act as a cushion when it is fitted in place in the aluminum box.

Drill two holes through opposite sides of the utility box to accommodate the rubber grommets. With a hacksaw, cut a slot the width of the grommet holes from the top of the box all the way down to the holes. This will provide a Faraday shield to reduce the capacitive effects of nearby objects on the pattern of the loop, as well as serve as a mounting area for the ferrite rod. Be sure to leave room for the switch, jack, and tuning capacitor.

Cut and drill additional holes to allow for mounting of the variable tuning capacitor, SO-239 chassis connector, range switch, and any mounting bracket for a handle or brace.

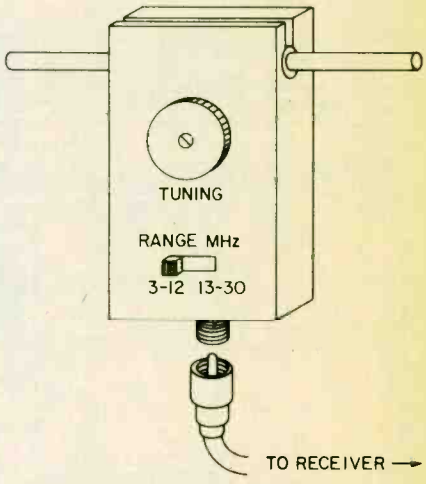
In actual operation, the range switch selects the tuning range of the antenna, and the 365-pF tuning capacitor peaks the incoming signal. When properly adjusted, the ferrite loop directional antenna will exhibit a very sharp null when pointed like a gun barrel at the source of the signal. It makes a good direction finding antenna for locating hidden transmitters anywhere in the shortwave spectrum.

The same hazards associated with unpredictable readings from skywaves, as mentioned earlier, still apply. Readings are best when sources are close, and when operating frequencies are low. Tilting the antenna up or down will frequently enhance the sharp directivity of the loop and increase accuracy on bearings. This is the same technique used with the Palomar unit.

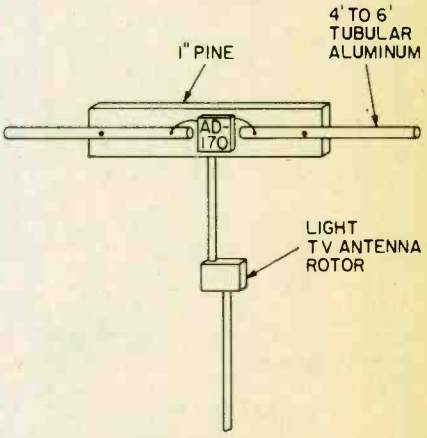
Active Antennas. In an effort to overcome the lack of appeal of large antennas for maximum signal pickup, the idea of a built-in preamplifier sounds attractive. In fact, several manufacturers now offer short receiving antennas which detect only a small amount of energy and amplify it, sending a husky signal to the receiver. Often, these antennas may be mounted in such a way as to null out electrical interference, favoring the desirable signals.

Among the more prominent manufacturers of active (or voltage probe) antennas are: MFJ Enterprises, P.O. Box 494, Mississippi State, MS 39762; Datong, available from Gilfer Associates, P.O. Box 239, Park Ridge, NJ 07656; and McKay Dymek Co., 111 S. College Ave., P.O. Box 5000, Claremont, CA 91711.

(Continued on page 78)



This is the way a completed loopstick antenna should look. It's a good little unit.



The Datong Active Antenna, Model AD-170 fits within dipole antenna elements!

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One-Tube Receiver

(*Continued from page 47*)

inch protruding from the pin. Pull that same end back out of the form so you can scrape ½-inch of insulation off, and re-insert it into pin 2, Still don't solder, but just fold that extra wire over the edge of the pin, to keep the coil from unwinding. Repeat this process for the remaining coils and pins, soldering in pins three and one, and folding two more wires over the edge of pin two. Evenutally, you will have three bare wires sitcking out of pin two. That's when you can solder them all in place, at once. Finally, add a bit of coil dope to the whole thing to keep it from loosening up and unwinding (clear nail polish works well). Plug the coil into place, and the tube, too, while you're at it.

For those of you who are using a substitute coil form, just run the ends of the windings out of one end of the coil, and secure the coil to the base using L brackets or spacers.

Operation. Check the wiring against the schematic for errors. If all looks okay, attach only the filament battery. If you can see it, the tube's filament will glow orange red. If not, re-check the wiring. Don't connect the B battery if there's any chance that 90 volts will wind up across the filament—some of these battery tubes like the 99 are very fragile in this respect. Assuming all looks well, connect earphones, an antenna, and a ground. Finally, connect the B battery; doing this should cause a decided click in the earphones.

Turn the regeneration control (R2) clockwise until you hear a pop or click in the phones, and beyond that point will be a soft hissing or squealing. That means the set is oscillating. Back off on the regeneration control until the set pops back out of oscillation, and tune around until you hear a station. Alternately adjust C1 (for loudest volume) and R2 (for most regeneration without allowing oscillation). This is where a steady hand helps. If, for some reason, you can hear stations, but can't seem to get any regeneration, by turning R2 back and forth. If the signals are *loudest* when R2 is counter-clockwise, you may have accidentally reversed the leads to L3, producing negative feedback, instead of positive. Try

(*Continued on page 76*)

Input/Output

(*Continued from page 30*)

July-August issue of ELEMENTARY ELECTRONICS. *Is your mind operating gigo, or what? The boy didn't ask for your opinion on what the use of home computers should be, he asked if you knew how to interface one to a BSR X-10 remote control! I am not usually one to criticize the opinions of others, but I had to speak up about your reply to his letter. If you can't, or won't, answer his question, then give him my name and address, and I'll be glad to help him. A computer isn't "too valuable for anything. In any application where they can help people, that is where they belong. I hope you have enough intestinal fortitude to publish this letter, and send my name and address to the boy who wrote you, so I can give him some help. By the way, this letter was written on my TRS-80 using a text-editing system I wrote, called "MAX"!*

—W.M., No. Platte, NE

Yep, we have "guts," so we printed your letter. In fact, although you disagree with us, your views are worthy of consideration. You'll note that we dropped your middle paragraph where you qualify your background to justify your position. I'm impressed, but I'll stick to my guns. Please write to us again, and everyone else who disagrees with me. I'm not too old to learn, or so they tell me.

Spend to Save

I like to build the projects in ELEMENTARY ELECTRONICS, *but the prices charged for parts are just too much! How can I break the price barrier?*

—B.F., Ellwood, PA

Buy in quantity and reuse parts. For example, never buy a resistor off the peg board rack, buy a large assortment of resistors that include the resistor you need. This way you will build up your parts supply, and somewhere down the road you may build a project with all resistors coming from spare parts. Also, the unit costs for bulk resistors are anywheres from one-quarter to one-tenth the peg board price. Do the same with other parts. Next, a switch to solderless breadboards. They may seem costly, but you will be able to salvage 100 percent of the parts used. Think of the many 741s and 555s you can use over and over.

Draw!

Hank, how good are you at computer language?

—D.R., Grafton, VT

At BASIC I'm about as good as Larry Friedman, our young editor of the Simply BASIC column. However, he's much faster than me. That's what youth and practice has over us old timers.

An Upsidedown World

What is meant by "susceptance"?

—W.Y., Redmond, WA

Impedance (Z) consists of a real part called resistance (R) and an imaginary part called reactance (X). Admittance (Y) is the reciprocal of impedance. Conductance (G) is the real part of admittance and is the reciprocal of resistance. Susceptance is the imaginary part of Admittance (B) and is the reciprocal of reactance. This detailed terminology is seldom used. We usually talk about impedance and its two parts, and the reciprocals of all three. (Now I know some high school science teacher will write saying that I'm working against him.)

Nice Note

I am a new subscriber to ELEMENTARY ELECTRONICS, *and just wanted to tell you that I am enjoying this publication very much. I really did enjoy the article "Solar Alchemy," by T.J. Beyers. Mr. Beyers proves he has an excellent understanding of his material and presents it in a very readable manner.*

—D.A., Alpine, Tx

I received several complementary notes on Author Beyers article on Solar Alchemy. It's good to know the Editors are giving you what you want to read. Those who sent story ideas and specific requests had their letters forwarded to the Editor. Thanks for writing.

Lend a Hand

Here are a few readers who need your help, so lend a hand, boys!

Δ Fisher Stericorder open reel tape recorder; needs manual and/or schematic diagram; Herbert W. Klumpe III, Box 32, Meredith, NY 13805.

Δ Hallicrafters Model S-85 receiver; needs schematic diagram, operational manual and alignment data; John Wilson, P.O. Box 512, Farmerville, LA 71241.

Δ National NC-57M receiver; would like to get manual and know when unit was first made; Kevin Kaff, 3803 Hilltop, Hutchinson, KS 67501. ■

Sinclair ZX80

(*Continued from page 50*)

tells you what's happening. It follows the typing, and when it changes from "K" to "L" it means the computer is no longer expecting any "token" keywords. If you were to touch the same key that produced the command PRINT, it would now produce an "O." A "block S" appearing means you have made a mistake in syntax. You don't have to wait for a RUN to find out you've made syntax errors; the ZX80 lets you know about it immediately. On a RUN the CRT screen will display error codes and the line(s) to which they apply.

All in all, the ZX80 BASIC is made as easy as is possible for the beginner. The screen, which displays up to 24 32-character lines, is adequate for many programs. The inability to touch type does slow down actual programming, as does the line count (32 characters), which is less than half of the standard 80-character width. However, the ZX80 will meet many computer needs, particularly in the area of teaching BASIC.

Programs are stored on cassette tape *with all variables and data* by simply pressing the E/SAVE and NEWLINE keys. (NEWLINE is Sinclair's term for RETURN.) The variables and data are erased when the program is loaded and run. They can be saved by using the command GOTO 1. Programs are loaded from cassette to computer by pressing the W/LOAD and NEWLINE.

The computer cannot "read" a header or other identifier from the tape; therefore, it cannot search for a particular program; it loads the first program it "sees." You can identify programs either by slipping the patch cord from the recorder and recording the name of the program by speaking into the mike, or you can simply use short tapes and record one program on each tape; indicating the name of the program directly on the cassette.

A Budget Introduction. While not intended as a substitute for a full-size computer system, the Sinclair ZX80 is a low cost way to get into personal computing with something that's really a computer and not a converted electronic game.

For additional information on the Sinclair ZX80, circle No. 75 on the Reader Service Coupon. ■

One-Tube Receiver

(*Continued from page 75*)

switching the leads.

Now is the time to see if your coil covers the broadcast band properly. Using a calibrated AM receiver set to the high end (1.6 MHz) of the band, make your regenerative radio oscillate, and tune C1 until its plates are mostly open; at some point you should hear a hiss or a whistle in the calibrated receiver as it is held nearby. Do the same for the low end (.55 MHz or so). The dials should roughly match, and if they don't, you will have to add or subtract wire from L2. Removing wire will shift your radio's range to higher frequencies, and adding wire will shift it downwards.

If you find that stations are too loud (which might be the case if you live nearby several transmitters) you can reduce the overload on the RF amp. by inserting a small (10-75 pF) capacitor in series with the antenna lead, at the receiver. Choose a value that cuts out enough signal: the larger the capacitor, the more signal gets through.

Finally. Always be super-careful when installing antennas. Stay away from power lines and avoid high dives off ladders or out of windows. B batteries can give you a small sting, but 90 volts probably couldn't injure you if you're in good shape. However, that sting could surprise you enough to make you drop your prized audion to the floor, smashing it to bits. Exercise caution.

Warnings aside, this project has many open ends that beg for experimentation: filament current might be varied with a low value (10-20 ohms) rheostat to provide volume control. The antenna coupling could be varied with a 150 pF variable capacitor in series with the antenna lead. Many different triodes are usable, or even tetrodes (double grid tubes) can be used. The coil may be re-wound for other bands, although the value of C1 might have to be lowered. Regeneration can be accomplished by varying C3 and eliminating R2, or even by physically rotating L3 with respect to L2. Try considering what negative feedback does to any amplifier.

A good book to help the experimenter is the ARRL's *The Radio Amateur's Handbook,* which has tips on safety, construction, theory, and it even has a complete index of tube types and pin diagrams for all your junk box tubes. Even if you are somewhat of an advanced hobbyist, you can still delight in an antique technology as you listen to the radio by the glow of your venerable vacuum tube. ■

Simply Basic

(*Continued from page 38*)

desired. *Scratchpad* allows up to 100 variables and answers into the data file, but changing line 300 will allow an unlimited amount of variables. The file can be printed to disk using the DISK command, but a disk system is not necessary for the operation of this program. If a file is updated, the new data will be printed to disk only if the DISK command is entered after all the new data has been entered.

```
ANSWER =  759.75

ENTER CURRENT
? 14.76
ANSWER =  1102.5

ENTER CURRENT
? 30.50
ANSWER =  2287.5

ENTER CURRENT
? 0

ENTER COMMAND  (TYPE 'LIST' FOR LIST)?
PRINT

VARIABLE              ANSWER

 10.13                 759.75
 14.7                 1102.5
 30.5                 2287.5


ENTER COMMAND  (TYPE 'LIST' FOR LIST)?
UPDATE
UPDATE MODE
ENTER CURRENT
? 54.45
ANSWER =  4083.75

ENTER CURRENT
? 0

ENTER COMMAND  (TYPE 'LIST' FOR LIST)?
END
```

The FIND command is used to retrieve data from the disk. However, this command will not print the data onto the terminal; it will only load the information found on the disk into the program's data file. To print this data, the PRINT command is used.

Computations are made in the FORMULA mode. To compute variables for your formula, enter FORMULA and type in the variables. Answers will be given after each variable is entered, and the variables and answers will be put in the data file.

Scratchpad is designed for TRS-80 Level II BASIC, and runs on little memory. It should run on most systems, provided the necessary modifications are made for your computer's particular version of BASIC. ■

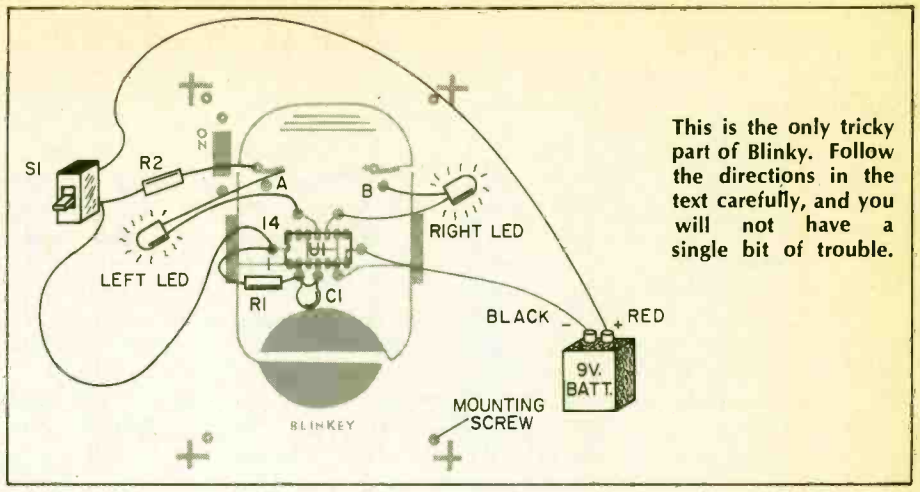
Blinkey

(*Continued from page 56*)

ohms can be used.

How to Make Him Blink. Place S1 to the ON position. Press your finger(s) across the two semicircular portions of the "mouth" (or place one finger on each hand on each of the two "ears"). You will note that the LEDs blink at same rate. By applying less pressure, the LEDs will blink at a slower rate. By pressing harder, the LEDs blink faster until (if your skin resistance is low enough) the two LEDs appear to be on continuously.

Factors such as dryness of the skin effect the skin resistance and, therefore, the blinking rate that can be achieved by an individual. It is interesting to note the rates that can be achieved by different people. Considering this, the basic circuit could be changed slightly to create a "strength" tester similar to those seen in Penny Arcades. All that is needed is to replace the Touch Plates with a "strength tester." This can be a short (6-inch or so) length of 1-inch dowel. Glue a ⅛-inch strip of aluminum foil down the length of the dowel. Glue an identical strip opposite the first. Connect the two strips to the Touch Plate of the circuit and you have your strength tester. Although not a true indication, this is very entertaining. ■



This is the only tricky part of Blinky. Follow the directions in the text carefully, and you will not have a single bit of trouble.

Light Beam

(*Continued from page 37*)

5. With the device and mirror aligned as above, carefully adjust the position of the receiver enclosure so that the focused received beam is centralized (bore sighted) inside the tube. This is best accomplished by placing a thin strip of paper through the adjust hole over the phototransistor and adjusting the dowel to the focal length of the lens. This should place the focused received light directly on the lens of the phototransistor. Further touch up can be done by careful positioning of the phototransistor with needle nose pliers. Secure dowel, enclosures, etc., to eliminate movement and improper alignment.

6. Repeat with the other unit. You should now be able to hand-sight units along sight lines for medium range use. Good, reliable long range use should be done with a camera tripod. Nighttime use, with the visible red transmitting diodes is easily accomplished at ranges up to 1,000 meters or so by noting the reflection of the transmitting light in the receiving lens as noted at the transmitter station. Daytime operation is best with filter and IR transmitter. Securing of optical components via permanent means should only be done when optimum optical alignment can be assured.

Operation. For both transmitter and receiver to be in the OFF mode. S2 must be at R position and R7 to the OFF mode.

To use receiver only, plug in headsets to J2 jack and turn on R7 and adjust to desired level (usually no more than ⅛ turn). Point unit at a normal 60Hz lamp, TV or other light source and note hum.

To use in transmit mode, all that is necessary is to place S2 from the R to the T mode. The modulation level is preset by R7 when used in the receiver mode.

One way to test is to look into the transmitter section and note the LED flickering with audio signals. R7 can then be readjusted if necessary by this indication. Note that the LED only has to change ever so slightly for sufficient modulation.

You will see there is a trimpot R15 on PC board. This adjusts the quiescent current through this LED and should be set just where the LED is emitting with no audio signal. This saves batteries and prevents downward modulation. This probably should be reset as batteries weaken. Also, note that the units pick up 60Hz hum from power lines and normal lighting. The visible red LED (supplied in these units) obviously operates best in darkness. For normal daylight operating, the infra-red LED and fiilter must be used.

In general, reception is possible as long as the transmitter output light can be seen by the naked eye.

Applications. Aside from the line of sight communications possibilities, this communicator is extremely useful for surveillance applications. Install one of the communicators in a location that is vulnerable to trespass by intruders. You can buy an inexpensive sound activated alarm, with its microphone taped to an earphone. The alarm will be activated whenever there is noise at a normally quiet location which is under surveillance.

Another application is Morse code practice. Two people up to a mile apart, with a pair of practice code oscillators, can use the Light Beam Communicator to sharpen their code skills. ■

CB Spectrum

(Continued from page 60)

out its maximum RF energy only when it "sees" a 50-ohm load on its output. If the load is greater or smaller than 50 ohms, the transmitter puts out less than normal RF.

Antennas Need Loading. The transmitter load is the antenna. The energy is fed to the antenna through a coaxial wire called a transmission line. The coax wire is of a special design, with an impedance of 50 ohms, that is esentially *transparent* when the antenna is 50 ohms also. As far as the transmitter is concerned, under these conditions the wire does not exist, and the antenna *is* the transmitter load.

If the antenna is not precisely adjusted to the CB frequencies, it appears to be something other than 50 ohms; it could be 15 ohms, or perhaps 100 ohms.

The antenna does not accept all the energy fed out of the transmitter; it reflects part of it back down the coax, where it interacts with energy still coming out of the transmitter to form "standing waves." These standing waves are "seen" by the transmitter as a new load impedance, and the coax is no longer transparent. Depending on the antenna mismatch and the length of the coax transmission line, the load can appear to be so high or so low that very little RF comes out of the transmitter; and, of the reduced RF fed out of the rig, little is accepted by the antenna to be transmitted.

The antenna mismatch, that is, the degree to which it does not present a 50-ohm load, is represented by the SWR. SWR means only one thing: the ratio of the antenna impedance to the coax wire impedance with the ratio inverted to provide a value larger than "1." For example, if the antenna impedance is 100 ohms and the coax is 50 ohms, the SWR is 100/50, or 2:1. Similarly, if the antenna is 25 ohms and the coax 50 ohms the ratio is 50/25, or 2:1.

CB Tuning Meters. The device that measures VSWR is a VSWR meter. A VSWR meter connects between the transceiver output and the coax wire. Depending on the design of the meter, you simply key the transmitter and read the VSWR directly, or you key the rig, adjust a control for a full scale meter reading, flip a switch, and then read the VSWR (this is the least expensive way to do it). To get optimum performance from your anenna, you simply adjust its overall length (if adjustable) for the lowest SWR. That's all there is to getting the most RF out of the rig and into the antenna.

SWR and VSWR meters come in all types and shapes, and are priced from about $7 up to well over $100. Regardless of the price, they all give the same SWR values. The extra expense often goes into extra measurements, such as forward power or forward and reverse power (the RF reflected back by a mismatched antenna).

Which ever type of meter appeals to you, you should have one of your own. Of all the things that cause problems with mobile signals, the antenna system is *numero uno*. And, with your own SWR meter, you can make periodic checks of the antenna. If the SWR shoots up and you can't tune it down, you know for certain that you've got big trouble—like corroded connections.

But, checks or not, any CB antenna that *can* be tuned (adjusted) *must* be tuned, and there's no way to do it without an SWR meter. Depending on another station for "guesstimates" rarely insures optimum performance. Also, adjusting the antenna for maximum indication on the transceiver's RF output meter is a waste of time because all RF output meters are voltage sensitive devices calibrated for accuracy at 50 ohms. If the antenna is mismatched, the meter calibrations are worthless; for a "high" output power reading can actually occur when the real RF output is very low. ■

Atari 800

(Continued from page 42)

turn a novice into a pro, if not overnight, then over the course of a week.

The one thing we missed in all the documentation was a really good, complex, demonstration program or two. We stopped at a computer store in midtown New York City and they showed us some delightful demonstrations they had programmed for the Atari.

Into The Future. The Atari 800 is a full-fledged microcomputer which Atari can be proud of manufacturing, and the computerist can be proud to own. Technology will continue to change and improve, but a computer like the 800 will keep its value for many years.

If you're thinking of buying a personal computer, now is as good a time as ever. And if you are looking around, take a good look at the Atari for it is worth a second glance! For more information, Circle No. 70 on the Reader Service Coupon. ■

Directional Antennas

(Continued from page 73)

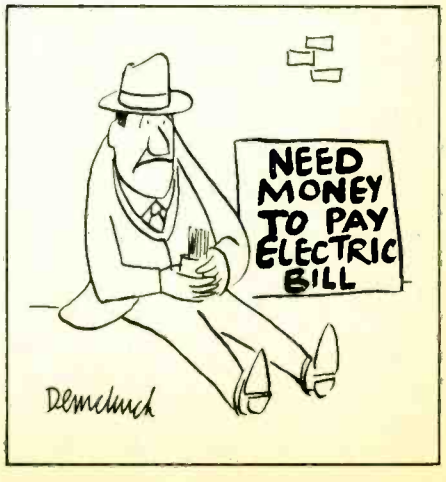
Antenna Rotation. Most antennas can be rotated, even those monsters used by the miliatry services. But most of us have a balanced budget, and are concerned about deficit spending. For those reasons, as well as the possibility of partially rotating the house under the antenna, we shall confine our discussion to small directional antennas.

The trouble with the remote positioning of the ferrite loop is its inaccessability for tuning. The listener must be satisfied with a narrow frequency range, or mount the loop low enough to be easily accessible when changing the receiving frequency.

A better approach is the use of a broadband antenna. Experimentally, we tried a waterproofed version of Datong's popular AD-170. It is capable of continuous 70 kHz to 70 MHz performance. It comes from the factory with wire leads for its dipole elements.

By mounting the preamplifier against a sturdy wood or plastic brace, and replacing the wire elements with two lengths of self-supporting alumium tubing at least four-feet long per leg, the assembly makes a good rotatable directional shortwave antenna. The problem of skywaves distorting arriving waves will still make true directivity a little difficult to obtain, but the system does work after a fashion. Aside from the unreliable bearings—no fault of the Datong—the AD-170 is an excellent receiving antenna.

Conclusion. While any hunk of wire is theoretically capable of intercepting radio energy, a little planning can make a big difference. By analyzing the requirements of your particular receiving installation, an antenna can be designed and installed with expectations of excellent performance. ■



Antique Radio

(Continued from page 68)

Letting a set "cook" for 24 hours will sometimes break down the defective component. Likewise, tube type portable radios have a tendency for the oscillator tube to quit working with lower than normal line voltage. The selenium rectifier will get old and the plate and filament voltages on the tubes will be too low for proper set operation. A well designed portable radio should operate on a line voltage as low as 105 volts. If it doesn't, look for low plate and filament voltages.

In my last column I told you how important an isolation transformer was in your shop. Remember that the variable voltage transformer we have been talking about is an autotransformer, and doesn't provide any isolation from the line. Be sure you have an isolation transformer between the electrical outlet and the variable voltage transformer.

Building Replica Radios. Many experimenters and collectors are now building replicas of some of the very scarce radios. Several months ago I ran a photo of an AC Gilbert radio, and I received a letter from one collector who had one. I also received many letters from readers who would like to build a replica of it. I am now making arrangements with the owner of the radio to take pictures and make measurements of all its components. I will then write a story on how you can build one, too.

I believe that the AC Gilbert radio originally used a WD-11 tube; if so it will be easy to substitute an 864 in its place. 864s are becoming very hard to find, but fortunately a collector friend has managed to find a small quantity; new, in original boxes. These are war surplus VT24/864 tubes. They will be on sale for $5.00 each, plus $1.50 for shipping three or less, or $2.50 for shipping four or more. There will be a limit on how many each collector can purchase. Write to Antique Radio Parts, P.O. Box 42, Rossville, IN 46920 for information on VT24/864 tubes, adapters and plug-in replacement WD-11/864 tubes.

Tube Socket Replacement. Finding tube sockets is becoming nearly as difficult as finding the tubes themselves. As you know, there are two kinds of 4-pin sockets. The UX type has a pin in the side of the base that locks into a socket with a high collar and a bayonnet hole in the side. The other type has no pin in the side of the base, and is called a UV type. This tube and the UX will both fit a socket with contacts that grip the pin tightly.

Two more reprint booklets, now available, musts for radio collectors. Arthur W. Aseltine, 345 Glenwood St., Ann Arbor, MI 48103 has made available at his cost these booklets. One, "Tuska Radio Apparatus Catalog Number Three," serves as a valuable reference to products of the C. D. Tuska Company. The other booklet is called "Instructions for Atwater-Kent Open Mounted Style Radio Receiving Sets." In other words it is an instruction book for A-K breadboards. The booklet covers models 9, 5, 10, 9A, 10A, 10B, 12, plus 2 more variations on models 9 and 12. The pictures will help you identify Atwater Kent breadboards. The booklets are $3.00 each, postpaid, and you may order them direct from Mr. Aseltine at the above address.

Antique Radio Parts catalog number 2 for 1980 is now available from Antique Radio Parts, P.O. Box 42, Rossville, IN 46920. Send 25¢ coin or stamps for your copy. ■

DX CENTRAL REPORTING

A WORLD OF SWL INFO

BY DON JENSEN

☐ Central America. A region of sunshine and sandy beaches fronting two seas; lands of contrast: guitars and marimbas, bananas and coffee, modern office buildings and wretched shacks, tourism and terrorism, relaxation and revolution.

For DXers, Central America is a fascinating place to visit—by radio. Even for those whose understanding of the Spanish language is minimal, the shortwave stations of the Latin countries south of Mexico and to the isthmus of Panama are interesting tuning targets.

Central American stations have much to recommend them. First, of course, there's the music, which anyone can appreciate regardless of language. But best of all, they're relatively close at hand. Even lower powered shortwave transmitters can often be heard well in the U.S. and Canada after dark.

Region of Changes. Many things have changed in Central America. Fifteen years ago or so, shortwave broadcasting flourished in the six Spanish-speaking countries of the region. Here more than half a hundred shortwave outlets operated. In 1965, Honduras and Guatemala each had about 20 SW stations active; Nicaragua and Costa Rica each had about six or seven, and several operated in El Salvador and Panama.

But then medium wave broadcasting became the dominant force in Central America. Stations abandoned shortwave. By 1975, there were only about half as many stations as there had been a decade earlier.

Things are still changing—especially political events—and we seem to be seeing a resurgence of SW broadcasting in Central America.

Let's take a look at some of the more recent additions to the shortwave bands, plus a few of the old reliables on the Central American broadcasting scene.

Costa Rica. Cropping up rather mysteriously in June 1979 was Radio Noticias del Continente in San Jose, Costa Rica. The station's name, in translation, means News of the Continent, though news *to* the continent may be more accurate.

The station, according to verification information, runs a 50 kilowatt transmitter—extremely powerful by Central American standards—into a rhombic antenna beamed toward South America. It is, as the name suggests, heavily news oriented.

There are some curious aspects to Radio Noticias del Continente. It uses a shortwave frequency once used by another San Jose station, which allegedly had links to the U.S. Central Intelligence Agency. The station began broadcasting a heavy dose of Nicaraguan news to the rest of Latin America at a time when that country was in the midst of its Sandinista revolution. And, from verification data, there are some Americans on the station's staff.

Most recently, Radio Noticias del Continente was heard on the shortwave frequency of 9,615 kHz, after earlier operations on 9,610 and 9,490 kHz. Its operation may be sporadic.

The most recent Costa Rican SW addition is Radio Rumbo in Cartago. This is a longtime commercial medium waver that recently decided to add shortwave.

Radio Rumbo operates on 6,076 kHz, in the 49 meter band, where it can be heard often both in the evenings and early morning hours.

A third Costa Rican station new to shortwave is Radio Nueva Victoria, in Heredia, which began operations on shortwave last November, after success on the medium wave bands. Like Rumbo, Radio Nueva Victoria is a commercial broadcasting venture. It has been operating on 6,082 kHz.

It is possible to hear English programming from Costa Rica too. The "Lighthouse of the Caribbean," TIFC, Faro del Caribe in San Jose, is a religious station which has English from shortly after 0300 GMT on 5,055 kHz. This station has been around for a good number of years.

Nicaragua. Since the 1979 revolution, shortwave broadcasting in Nicaragua is all governmental. The main shortwave outlet in the capital of Managua is now called La Voz de Nicaragua. Its schedule seems somewhat irregular.

For months the station has been promising an English language foreign service, which may actually get on the air eventually. Politically, that seems a reasonable move. When operating, it is easily heard on 5,950 kHz. You might also try 5,920 or 11,840 kHz.

The pre-revolution commercial station, Radio Atlantico at Bluefields on Nicaragua's east coast is now called Radio Zinica. It is operated by the government on 6,120 kHz.

The Bluefields area was settled by retired buccaneers centuries ago, and therefore has something of an English tradition. This is undoubtedly the reason why some listeners have reported at least a few English language identification announcements over Radio Zinica.

Guatemala. The new voice on shortwave from Guatemala, since last March, is TGMUA, Adventist World Radio's Union Radio in Guatemala City. During its initial period of broadcasting at least, this station had a program for SWLs especially, and it frequently airs recorded religious programs in English.

AWR Union Radio has been juggling its shortwave frequencies, but recent reports from listeners put this one on 5,980 kHz.

Backtalk. The letters continue to arrive here at DX CENTRAL; letters with news about what you're hearing and questions that you may have. They're always welcome, although unfortunately only a few of the questions can be answered in the column.

The address to write is Don Jensen, DX CENTRAL REPORTING, Elementary Electronics, 380 Lexington Ave., New York, NY 10017. ■

DX GLOSSARY

DX, DXer, DXing—distant broadcasting stations; one who listens to these stations as a hobby; the hobby itself.

FM—Frequency modulation.

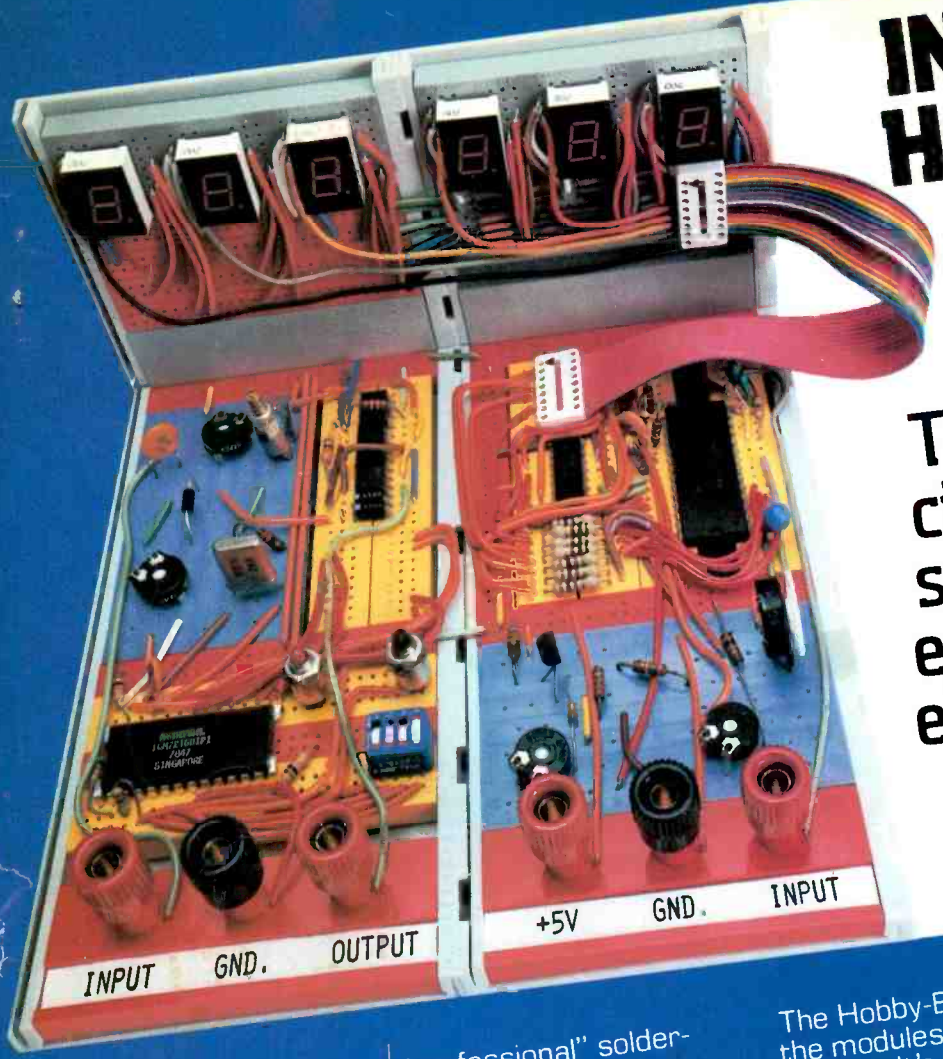
GMT—a universal time reference, Greenwich Mean Time, equivalent to EST+5 hours, CST+6 hours, MST+7 hours and PST+8 hours.

kHz—kilohertz, a unit of frequency measurement equivalent to 1000 cycles per second; formerly expressed as kilocycles per second, or kc/s.

Medium wave—broadcast band in the 540 to 1600 kHz range; normal AM radio broadcasting frequencies.

SW, SWL—Shortwave, shortwave listener.

INTRODUCING HOBBY-BLOX™



The new modular circuit building system designed especially for electronic hobbyists.

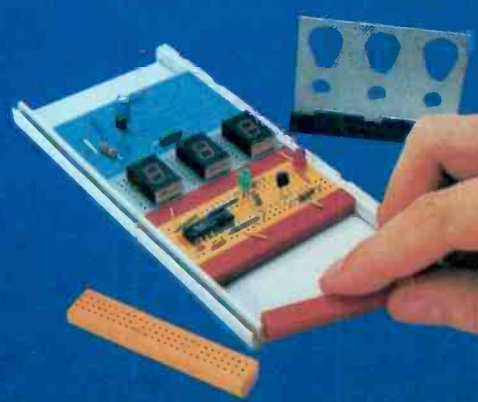
Until now, you had to buy "professional" solderless breadboards for your projects and pay "professional" prices. Now there's Hobby-Blox™, a totally new circuit-building system that's not only economically priced but offers many more advantages to the hobbyist.

At the core of the system are two expandable starter packs (priced under $7.00), one for discrete component projects, the other for integrated circuit projects. Each comes with a number of Hobby-Blox modules that fit into a tray and an illustrated project booklet. In addition, the system includes 14 separate component packs you can purchase individually — terminal, distribution and bus strips, speaker panels, binding posts, etc. — priced from $1.29 to $3.59.

The Hobby-Blox system is easy to use because the modules are color-keyed and letter/number indexed. It's time-saving, because they're solderless. It's compatible with DIP's of all sizes and a wide variety of discrete components. And you save money, because the parts can be reused again and again.

How far can you go with the Hobby-Blox system? Take a look at the example above. Then you'll know why we say, "your only limit is your own imagination."

For a free catalog and the name of your nearest Hobby-Blox dealer call toll-free (800) 321-9668.



A P PRODUCTS INCORPORATED
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CIRCLE 16 ON READER SERVICE COUPON

BUILD 20 RADIO AND ELECTRONICS CIRCUITS

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- ★ 12 RECEIVERS
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- ★ SIGNAL INJECTOR
- ★ CODE OSCILLATOR

- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools Needed
- ★ Solid State Circuits
- ★ Vacuum Tube Circuits

YOU DON'T HAVE TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing. THIS IS A COMPLETE RADIO COURSE IN EVERY DETAIL.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester, Square Wave Generator and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the low price you pay. The Signal Tracer alone is worth more than the price of the kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a Professional Radio Technician.

Included in the "Edu-Kit" course are Receiver, Transmitter, Code Oscillator, Signal Tracer, Square Wave Generator and Signal Injector Circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build twenty different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, selenium rectifiers, coils, volume controls, switches, solid state devices, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C. Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

FREE EXTRAS

• SET OF TOOLS

- SOLDERING IRON
- ELECTRONICS TESTER
- PLIERS-CUTTERS
- VALUABLE DISCOUNT CARD
- CERTIFICATE OF MERIT
- TESTER INSTRUCTION MANUAL
- HIGH FIDELITY GUIDE • QUIZZES
- TELEVISION BOOK • RADIO TROUBLE-SHOOTING BOOK
- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

SOLID STATE

Today an electronics technician or hobbyist requires a knowledge of solid state, as well as vacuum tube circuitry. The "Edu-Kit" course teaches both. You will build vacuum tube, 100% solid state and combination ("hybrid") circuits.

Progressive "Edu-Kits" Inc., 1189 Broadway, Dept. 605-DJ Hewlett, N.Y. 11557

Please rush me free literature describing the Progressive Radio-TV Course with Edu-Kits. No Salesman will call.

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PRINTED CIRCUITRY

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal Injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

Printed Circuitry is the basis of modern Automation Electronics. A knowledge of this subject is a necessity today for anyone interested in Electronics.

CIRCLE 15 ON READER SERVICE COUPON