VIDEO GAMES ARE COMING – Have Fun Electronically!

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NOVEMBER-DECEMBER
1976
$1.00

40 CB Channels Get FCC Green Light!

See page 78.

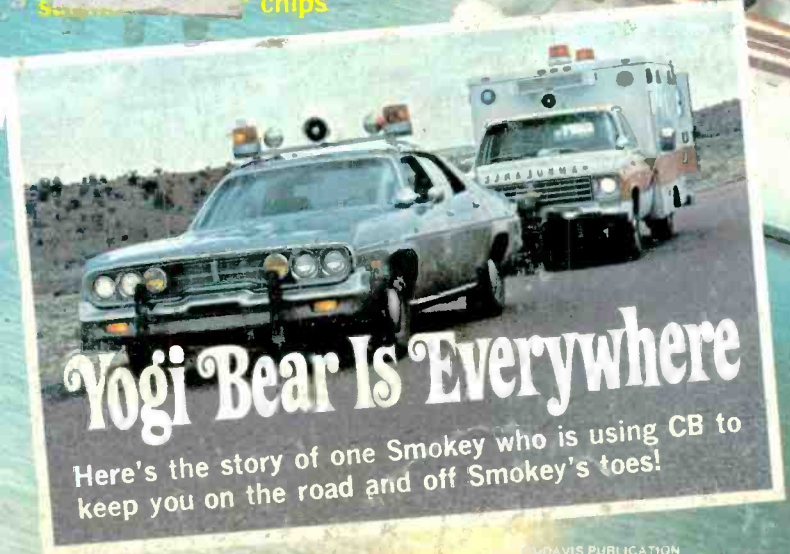
5 Ways to Eliminate RECORD NOISE

R e that C CAR RADIO

for Better Sound

T ER

ter and rapid-test chips



Yogi Bear Is Everywhere

Here's the story of one Smokey who is using CB to keep you on the road and off Smokey's toes!

CB TEST REPORTS

Our Lab Checks Out –

- Courier Gladiator PLL
- Craig 4201
- Regency CR-142

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CIE has a terrific idea for a few people who know what they want.

If you want success in electronics . . . if you want the skills people are glad to pay for . . . find out about CIE training. It's a terrific idea that can get you on your way to success in electronics troubleshooting.

Let's face it, learning valuable new skills isn't something you just breeze through. Especially in a modern technological field like electronics troubleshooting. You've got to really *want* success if you're going to build your skills properly.

But, oh boy, the rewards when you do! In today's world, the ones who really *know* electronics troubleshooting find that people . . . even industries . . . look for their help.

What about you? How much do you want the thrill of success . . . of being in demand? Enough to roll up your sleeves and work for it?

Why it pays to build troubleshooting skills.

Suppose the automated production controls on an assembly line break down. Imagine how much money the manufacturer can lose when help doesn't come *fast!* And it takes a skilled electronics troubleshooter to move in . . . locate the problem . . . solve it . . . and get the lines moving again.

Or take a TV station. Breakdowns are costly in broadcasting where time is money. Viewers won't sit forever waiting for sound or the picture to come back. Before they change channels, the station needs to get back on the air again—with the help of a skilled troubleshooter.

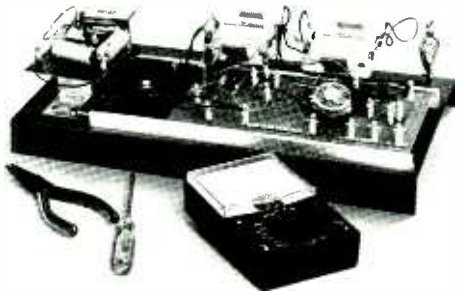
No question about it. Building new skills in electronics troubleshooting is an investment in your future. It's well worth the effort.

Why you should get CIE to help you do it.

Troubleshooting starts with *ideas* . . . principles. CIE's Auto-Programmed® Lessons help you get the idea—at your own most comfortable pace. Step by step at home, you explore each principle—each theory—until you understand it thoroughly and completely. Then you start to use it.

How CIE helps you turn ideas into reality.

If you're a beginner, you start with CIE's Experimental Electronics Laboratory. You actually perform over 200 experiments to help you grasp the basics. Plus you use a 3-in-1 Precision Multimeter to get your first taste of the testing, checking, analyzing steps you take in troubleshooting!



How 3 practical steps help you build troubleshooting skills.

You'll take your first practical step in professional troubleshooting when you build your own 5MHz triggered-sweep, solid-state oscilloscope.

As a trained troubleshooter, you'll use your oscilloscope the way a doctor uses his X-ray machine. As a student, you learn how to "read" waveform patterns on a big, 8cm. x 10cm. screen . . . how to "lock them in" for closer study . . . how to understand and interpret what they tell you.

Your second practical, skill-building step begins when you get your Zenith 19-inch diagonal, solid-state color TV—featuring nine removable modules! Now's your chance to apply the new skills you learned with your oscilloscope!

With CIE's guidance, you perform actual service operations—the kind you'd handle on the job as a trained troubleshooter! Using the TV, you learn to trace signal flow . . . detect and locate malfunctions . . . restore perfect operating standards . . . just as you would with any sophisticated electronics equipment.

Finally, step three rounds out your experience as you work with a completely solid-state color bar generator—actually a TV signal transmitter that produces ten different display patterns on your TV screen!

You study a gated color bar rainbow . . . crosshatch lines . . . dot patterns. You explore digital logic circuits . . . observe the action of a crystal-controlled oscillator!

This practical, "hands on" training takes concentration and effort. But it's enjoyable and rewarding. And it's a great way to prepare for a troubleshooting career!

Why it's important to get your FCC License.

For some troubleshooting jobs, you *must* have your FCC License. For others, employers often consider it a mark in your favor. It's government-certified proof of specific knowledge and skills!

Almost 4 out of 5 CIE graduates who take the exam get their Licenses. More than half of CIE's courses can prepare you for it . . . and the broadest range of career opportunities!

Free catalog!

Mail the card. If it's gone, cut out and mail the coupon. If you prefer to write, mention the name of this magazine. We'll send you a copy of CIE's FREE school catalog—plus a complete package of independent home study information! For your convenience, we'll try to have a representative call to help you with course selection. Mail the card or coupon . . . or write: CIE, 1776 East 17th Street, Cleveland, Ohio 44114.

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elementary electronics

November-December 1976
Volume 16, No. 6

Dedicated to America's Electronics Hobbyists—Including Electronics Digest®

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MPA

AUTHORS IN THIS ISSUE

Norman Crawford, Anthony Curtis, Ralph Fisher, Jim Fred, Richard Hudson, Don Jensen, Kathi Martin, Gary McClellan, Norman Myers, Fred Petras, Hank Scott, Art Trauffer, Martin Weinstein and the ELEMENTARY ELECTRONICS Editorial Staff.

Photo by Walter Herstatt

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Training Electronics Technicians Since 1946

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- ★ AMPLIFIER
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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 job with 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 and switches, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a usefui 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

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

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."

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.

Progressive "Edu-Kits" Inc., 1189 Broadway, Dept. 581DJ 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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CIRCLE 15 ON READER SERVICE COUPON

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WHAT'S NEW IN THE CB JUNGLE? THE TIGER MARK 2.™

Everybody is clawing away for your CB buck. The big names and the no names.

But now, the people with real experience in personal two-way communications are ready to introduce you to the finest Citizens Band radio in its price range.

The Pearce-Simpson Tiger Mark 2.

Wherever you go in the CB jungle, it comes through for you. That's because the Tiger 2 has Pearce-Simpson's exclusive HetroLock™ – "The Frequency Combination Lock" – and Receiv-O-Slide tuning that not only provides superior communications, but superior adjustment to receive signals from "off-freq." sets.

There isn't room to cover all the other features of the new Tiger Mark 2. But your Pearce-Simpson dealer would love to fill you in on every one of them. For our latest brochure, write Box 520300, Biscayne Annex, Miami, FL 33152. In Canada, Scotcomm Radio, Inc., 4643 Levesque Blvd., Chomedey, Laval, Quebec.

PEARCE-SIMPSON
DIVISION OF GLADDING CORP.

CIRCLE 46 ON READER SERVICE COUPON

Experience is the best teacher. You might settle for any CB first time around. Understandably. A lot of people think they're all pretty much alike. But you'll soon discover that, like everything else, there are exceptions.

Ask the pros. America's long distance truckers. These guys talk CB day in and day out. And they demand the best. That's why truckers refer to the Cobra 29 as "The Diesel Mobile."

Listen to Cobra. You'll hear a big difference. Because the Cobra 29 gives you features which assure crystal clear reception. Like switchable noise limiting and blanking, to cut out practically all pulse and ignition interference. Add squelch control and RF gain and you've got exceptional—adjustable—receiver clarity. Even in the heaviest CB traffic. You also get Delta Tuning which makes

IF YOUR FIRST CB ISN'T A COBRA YOUR SECOND ONE WILL BE.

up for the other guy, because even off-frequency transmitters are pulled in. Perfectly.

Talk to Cobra. And you know you're punching through. One glance at the 29's over-sized illuminated meter tells you just how much power you're punching out and pulling in. For voice modulation the DynaMike delivers at 100%. Same way with power: The 29 transmits at maximum power levels.

Sooner or later you'll get a Cobra. And you'll get engineering and craftsmanship second to none. Performance that will make your first CB seem obsolete. Reliability and durability that have set standards for the industry.

Above all, you'll get power. The power to punch through loud and clear like nothing else. Because when it comes to CB radio, nothing punches through loud and clear like a Cobra.

Cobra

Punches through loud and clear.

Cobra Communications Products
DYNASCAN CORPORATION
6460 W. Cortland St., Chicago, Illinois 60635

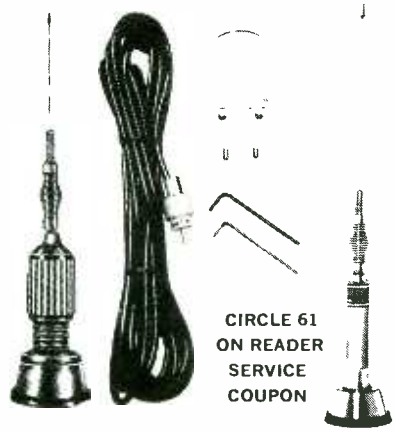
CIRCLE 8 ON READER SERVICE COUPON

Hey, look me over

Showcase of New Products

A New Way to Do It

Sparkomatic has engineered an exclusive new terminal connector assembly for both its models SA-104 and SA-204 Citizen Band mobile antennas. The connector comes prewired to the coaxial cable, ready for the customer to install. As a result the customer or installer no longer has to perform the exacting job of soldering and wire stripping, and installation time is reduced. The new terminal connector assembly has a slim profile (only ½-in. diameter at its widest) which



CIRCLE 61 ON READER SERVICE COUPON

enables it to be threaded under headliners, seats, and floor carpeting. Both the Sparkomatic SA-104 and SA-204 citizens band antennas feature a heavy-duty stainless-steel whip and shock spring, 16½-ft. RG 58U coaxial cable, PL-259 connector (also completely assembled to cable), and all mounting hardware. All internal elements are completely sealed against weather and corrosive road chemicals. In addition, on either model, coil housing, spring and whip are easily removed to prevent theft, damage in car wash, etc. Both antennas are tunable for maximum efficiency and lowest SWR. These antennas sell for $19.95 and $29.95. For more information, write to Sparkomatic Corp., Milford, PA 18337.

2-Meter Transceiver

A new 2-meter amateur mobile radio transceiver by Regency offers an optimum combination of performance and price. The HR-312 produces 35 watts of transmitter power on the 144-148 MHz amateur band. Selection of 12 simplex channels or 144 independent frequency combinations is possible by locking or unlocking the unit's unique mode switch. Off-channel interference is substantially

(Continued on page 12)

HIT THE ROAD WITH THE AUTOMATIC CB. JOHNSON.

You don't just buy a car. You fall for it. For the response of a beautiful engine . . . the quick precision . . . the superb engineering.

We think that's the way to approach CB radio, too. That's why Johnson engineers the important control functions into every Johnson CB. To give you the famous crisp, clean Johnson sound automatically. To give you superb, all-around performance – automatically.

Johnson's exclusive voice tailored circuitry automatically drops off unwanted frequencies to give you clear reception. Our automatic noise limiter keeps reception clean and built-in gain control prevents "blasting" and "fading."

Johnson's unique electronic speech compression automatically selects and compresses the clearest voice frequencies to produce uniform, high-level modulation and maximum transmit range. All automatically.

When you hit the road, go with Johnson CB. We back every Johnson with a full year parts and labor warranty and walk-in service at more than 850 locations. See a Johnson CB dealer and take off on the great American adventure.

JOHNSON

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JOHNSON CB. THE GREAT AMERICAN ADVENTURE.

HEY, LOOK ME OVER

(Continued from page 10)

CIRCLE 59 ON READER SERVICE COUPON

reduced by the set's 75 dB adjacent-channel selectivity and 65 dB intermodulation rejection. Receiver sensitivity is rated at .15 micro-volts by the 12 dB Sinad method. The HR-312 mobile unit sells for $269.00. For more information, write to Regency Electronics, Inc., 7707 Records Street, Indianapolis, IN 46226.

Door-Mount Audio

Have you thought about stepping up to quality door-mount speakers in your 4-wheeler? Well, Pioneer Electronics has the car stereo speaker for you. It is the Pioneer TS 165—it's a 6½-in. dia. model featuring coxial tweeter, free-edge woofer, attractive plastic and chrome grilles and 20-oz. ceramic magnet, and sells for $54.95. For further information, write to Pioneer Electronics of America, 1555 E. Del Amo Blvd., Carson, CA 90746.

CIRCLE 63 ON READER SERVICE COUPON

Ruggedized CD Ignition

If you need an encapsulated (potted) CD electronic ignition unit designed for marine, industrial, agricultural or severe environment use, Tri-Star has made one for you. The Tiger Max, Tri-Star's top-of-the-line CD unit, features ruggedized solid-state construction to withstand the rigors of marine or dusty atmosphere usage. It is not mechanical, and has no moving parts. The Max also features a new rubber plug switch, which is very reliable in changing the unit from CD to Standard ignition mode. The Max will increase the life of spark plugs and points by 50,000 miles, and increase performance and gasoline mileage by approximately 15%, according to the Company. The Tiger Max delivers up to 45,000 volts, which is about 3 times greater than a conventional ignition system. Also, cold weather starting is improved with the increased voltage. The unit can be installed in 30 minutes with the easy-to-follow installation instructions. Tiger Max sells for $69.95 and carries a lifetime guarantee. For all the facts, write to Tri-Star Corporation, 730 Independent Ave., Grand Junction, CO 81501.

CIRCLE 62 ON READER SERVICE COUPON

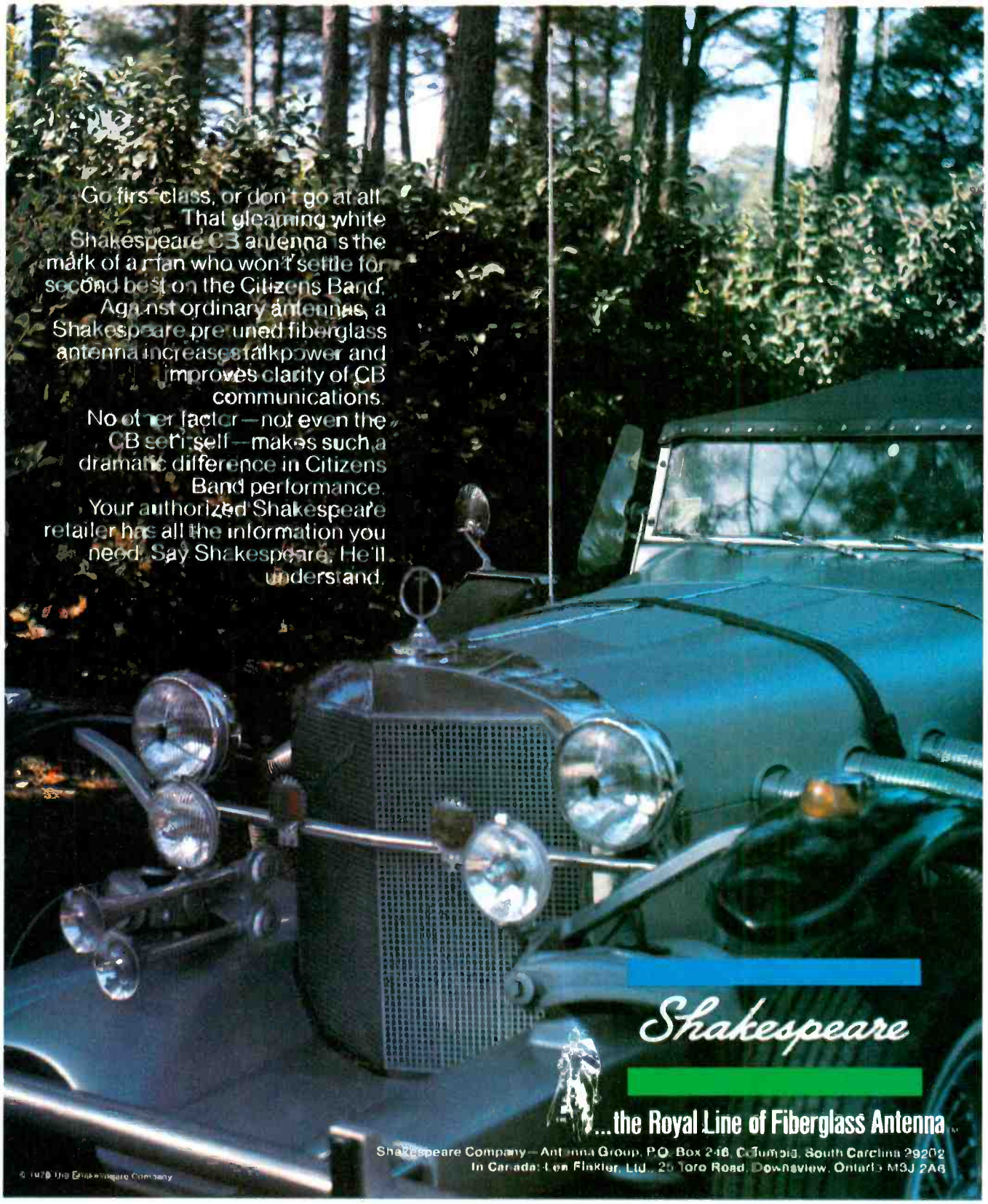
Cordless Telephone System

Unusual cordless telephone portability and a range of 2000 feet are two features of the new Model 500 Handifone System, marketed by Gutzmer International. Highly sensitive electronic circuitry, plus strict attention to telephone-quality performance, permit the Model 500 System to be adapted to many commercial, industrial and consumer situations. The new Model 500 System also includes exclusive features, such as:

(Continued on page 14)

CIRCLE 17 ON READER SERVICE COUPON

Shakespeare Powers the Citizens Band™



CIRCLE 16 ON READER SERVICE COUPON

HEY, LOOK ME OVER

(Continued from page 12)

optional pushbutton-to-dial pulse conversion, which permits operation through any telephone exchange; convenient last-dialed-number memory, for use when busy signals are encountered; and, a battery saver system that provides up to 10 hours constant talk time, or two weeks stand-by usage. It is fully FCC approved. Handifone electronics are housed in a standard desk type telephone set. This set includes a telescoping antenna that operates in conjunction with a compact Transponder base station. The attractive walnut-finished base station plugs into any standard telephone extension jack and operates from 110 VAC. The Handifone employs two widely separated frequencies for duplex operation and six different operating channels. Price of the Model 500 Handifone System is $595. It comes complete with battery-operated, rotary dial Handifone, battery charger, plus transponder and direct phone line connection. Further information on the new extended range Model 500 Handifone cordless telephone system may be obtained from Gutzmer International, Inc., P.O. Box 27243, Milwaukee, WI 53227.

CIRCLE 58 ON READER SERVICE COUPON

Fifty Range VOM

Take a look at Triplett's 60-NA portable precision VOM and you'll see its large easy-to-read 4½-in. mirrored scale meter. It has a DC accuracy of ±1½% full scale value, AC accuracy of ± 3%, plus a multiplier switch that permits more readings at the upper portion of the meter scale for greater accuracy. Meter ranges include: VDC from 0-1000 may be measured in 16 full-scale increments; VAC from 0-1000 may be measured in 10 increments; and DC current from 0-1000 mA may be measured in 10 increments for improved reading accuracy. Five resistance ranges from X1 to X100K are provided, in addition to a −20 dB to 52 dB range. AC current readings from 0-300 amps may be obtained by using a Model 10-C Triplett AC adapter with this new tester. With the husky case and suspension meter, the 60-NA VOM is virtually indestructible. If accidentially dropped from a five-foot height, deviation from stated accuracy does not exceed ± 4%. Three fuses provide unusual burnout-proof protection for the meter and extra safety for the user. It comes complete with one red and one black lead, each 48-in. long with protective insulated boots, batteries; fuses, and instruction manual. It has a suggested price of $130.00. For complete specifications on the 60-NA VOM, contact your Triplett distributor, or write to Triplett Corp., Bluffton, OH 45817. ■

CIRCLE 60 ON READER SERVICE COUPON

STRONG BOX

When we say Royce builds a strong box, we're not talking about the metal case that goes around our CB. We're talking about the insides. The electronics. Royce builds CB's with only the highest-grade components. Components that hold up under the stress of driving and rough handling. Many of our models are built with modular printed circuits. This means fewer wires. And fewer wires mean longer CB life and uniform quality and performance. Then, to make sure your Royce is working perfectly before you buy it, we electronically check every CB we build. And make sure each one is FCC-type accepted. Granted, it takes more time and know-how to build a Royce CB. But we feel the problem of keeping a CB working should be ours, not yours. That's why . . .

Everybody's talking 'bout

Royce

Write for a free brochure to Royce Electronics Corp., 1746 Levee Road, North Kansas City, Missouri 64116

CIRCLE 18 ON READER SERVICE COUPON

DX central reporting

A world of SWL info!

By Don Jensen

Nearly every DXer knows about the *Voice of America*. Many shortwave listeners are aware of the fact that besides the *VOA's* Stateside shortwave transmitter locations at Greenville NC, Bethany OH, and Dixon and Delano CA, there are a number of overseas relay stations.

These relay operations were located in such places as the Philippines, Liberia, Greece and Morocco. For many listeners these overseas relays offered the opportunity to hear—and later QSL—some interesting foreign countries the easy way, by listening to *VOA* broadcasts.

It was rather easy to hear these powerful *VOA* transmitters abroad. And, conveniently, the sites of these relay stations were announced at the beginning and end of transmissions.

Then, not too long ago, this policy of announcing the transmitter sites was discontinued. The *Voice of America* called it simplifying its station identification procedure. From now on, the only location announcement you'll hear on a *VOA* transmission is "Washington D.C.," regardless of whether the station transmitting that program is located in Greenville or Okinawa or Munich.

What's the Reason? Simplification of the identification procedure is the official reason. But more likely it is that announcements that spelled out the fact that the *VOA* had transmitters in foreign countries was becoming increasingly embarrassing to the host countries.

The end of transmitter site announcements also signaled another change, it seemed. No longer would the *VOA* include on its QSL cards the information concerning station location. And, therefore, DXers faced the prospect of no longer being able to add certain countries from which *VOA* broadcast to their list of verified countries.

Many SWLs wrote to government officials to protest this change in the verification practice, just as they did a few years back when the *VOA* announced it would no longer QSL reports from U.S. listeners. And, as with that earlier problem, the new change was also modified because of listeners' constructive complaining.

One of the public officials who threw his weight behind the campaign to change the *Voice*'s announced verification policy was U.S. Sen. Gary Hart of Colorado.

Senator Steps In. Sen. Hart recently wrote to the Association of North American Radio Clubs, "I was as unhappy as you with this so-called simplification, and made further inquiries to the *VOA*. Persistence . . . finally paid off and the station changed its mind.

"Briefly, the brand new and revised *VOA* QSL policy is this: 1. Sites will continue to be listed on VOA's frequency schedule, which will be sent to anyone requesting a copy from *VOA*; 2. After ascertaining the correct site from the frequency schedule, include the site on your reception report along with a request for verification of that site. With luck this new procedure will enable beginning and advanced DXers alike to verify sites from Greenville to Monrovia and Rhodes, without hurting the *VOA's* tight budget.

(Continued on page 92)

Introducing the CB system that's ready for 40 when you are.

Now you can have the Hy-Gain Personal Communications System that's ready for 40 channels when you are. It's our Hy-Gain II (Model 2682) citizens two-way transceiver and Hellcat X trunk lip antenna.

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With the Hy-Gain II you also get extra cost features like switchable automatic noise limiter. Mic preamp. Separate AF and RF gain controls. Automatic modulation control. And PA provision to let you convert the whole thing to a powerful Public Address System. There's exceptional sensitivity and selectivity. And superb adjacent channel rejection, too. So you don't get the whole gang when you place a person-to-person call.

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The following Hy-Gain 23-channel radios can be remanufactured to FCC 40-channel specifications after January 1, 1977.

681, 682, 2680, 2681, 2682, 2683, 2679, 3084.

If you currently own one of these radios, a 40-channel certificate may be obtained from your Hy-Gain dealer.

CIRCLE 35 ON READER SERVICE COUPON

No other TV/Audio home study school puts prices in its ads. Why?

Maybe it's because they can't match these values.

No other school gives you a choice of five ways to learn TV/Audio servicing, with complete courses starting as low as $445 and convenient, inexpensive time payment plans. No other school includes both an engineered-for-training 25" diagonal color TV and a four-speaker Quadraphonic stereo in its best course. In fact, to even match this kind of thorough training at another school, you'd have to take an extra course costing hundreds of dollars more. We're proud to quote our prices because we believe you get top educational value from NRI.

You pay less because NRI passes its savings on to its students.

NRI pays no salesmen. We buy no outside "hobby kits" for our experiments or training kits. We design our own equipment with special Power-On features that allow you to experiment as you build. You get low tuition rates without the penalty of exorbitant interest charges for time payments. We pass the savings on to you.

More than 1 million students have come to NRI for home training.

Home study isn't a sideline with NRI. We've been its innovating leader for over 62 years. More than one million students have enrolled in our many career courses. NRI is one of the few home study schools with a full-time staff of engineers, authors and editors to help you with any problem. NRI graduates will tell you: you can pay more, but you can't buy better training.

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7 kits: Quadraphonic Stereo... $445 or low monthly terms

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11 kits: Quadraphonic Stereo and B/W TV...$550 or low monthly terms

A complete course in B&W and Color TV Servicing, including 48 lessons (18 on color TV) 10 special reference texts and 11 training kits. Kits you build include 4-speaker Quadraphonic System, solid-state volt-ohmmeter, CMOS digital frequency counter, electronics Discovery Lab, plus a 12" diagonal solid-state black & white portable TV to build and use. At each assembly stage, you learn theory and "Power-On" application of that theory in typical solid-state TV sets.

11 kits: 19" diagonal Color TV... $880 or low monthly terms

The course includes 42 lessons and 4 reference texts plus kits and experiments to build a superb solid-state 19" diagonal color TV receiver . . . complete with cabinet, and engineered specifically for training by NRI's own engineers and instructors. This handsome set was designed from the chassis up to give you a thorough understanding of circuitry and professional troubleshooting techniques. You build your own solid state volt-ohmmeter, CMOS digital frequency counter, and experimental electronics Discovery Lab.

14 kits: 25" diagonal color TV and Quadraphonic Stereo...$1195.00 or low monthly terms

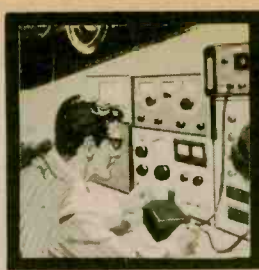
The ultimate home training in Color TV/Audio servicing with 48 bite-sized lessons, 10 reference texts, and 14 training kits . . . including kits to build a 25" diagonal color TV, complete with console cabinet; a 4-speaker Quadraphonic Center; a wide band, solid-state, triggered sweep, service type 5" oscilloscope; digital integrated circuit color TV pattern generator; a CMOS digital frequency counter, and an electronics Discovery Lab. This gives you thorough TV and Audio training for hundreds of dollars less than the separate courses you'd have to take elsewhere.

This Master Course combines theory with practice, using the "Power-On" stages for experimentation and learning. Building NRI's equipment will give you the confidence and ability to service any color TV or Audio unit on the market. And you'll have a magnificent TV and quad unit for years of trouble-free performance.

Pro Color: 19" diagonal color TV... $665 or low monthly terms

An advanced Color TV Servicing Course for experienced technicians, 18 lessons, 5 new "Shop Manuals", and NRI 19" diagonal Color TV receiver with cabinet.

6-116



Ask Hank, He Knows!

Gee, Thanks

Mercy sakes alive, good buddy, we sure like that lingo that we read in ELEMENTARY ELECTRONICS. *Keep up the good work there. I would like to know what your home 10-20 is, so we could put you down in our log. Whatever you do, keep the CB part going. Stack those 73's, 88's, 44's on you.*

—One Buck Mouth, Cameron, MO

Tnx, old buddy, for modulating kindness. My 10-20 is Park Avenue and 19th Street, in New York. Thanks for the 73's and 88's—but what are 44's? (I hope nothing out of an old western!)

Ask the Mail Man

Hank, why are you spending so much time on CB in your column?

—R.S., Milwaukee, WI

Only because the bulk of the letters received are on CB and CB happens to be the hottest thing going. Project building and antique radio are running a hot second. And, of course, a lot of readers are asking for help on particular problems. We'll tone down on CB when our readers do.

What Our Readers Say

Hank, I think your column is the best item in ELEMENTARY ELECTRONICS.

—G.K., Silver Springs, MD

Thanks, It's nice to know my work is read.

Hank, I never read your column.

—J.B., Spokane, WA

Try drinking J&B and then read the column. What am I saying, you'll never read this.

You give interesting answers in a funny way. *—P.O., Chicago, IL*

Funny you should say that!

Hank, I get more information out of Playboy *than I get from your column.*

—W.F., Atlanta, GA

Exactly what are you looking for, Pal?

It's nice of you to offer help to readers needing diagrams, parts, etc., who have a tuff time obtaining them.

—S.L., Ft. Worth, TX

We call it "personalized reader service."

(Continued on page 34)

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:

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Amazing Value—3 Achromatic Objective Lenses on Revolving Turret! Color-corrected, cemented achromatic lenses in objectives give far superior results to single lenses usually found in this microscope price range. Results are worth the difference! Fine rack and pinion focusing. Imported!

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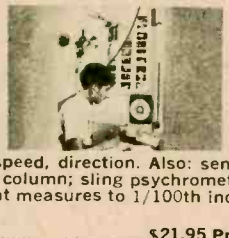

Meterology kit can give you the know-how to check your predictions against official forecasts! Has remote reading anemometer w/windvane. Indoor Indicator board flashes neon, shows wind speed, direction. Also: sensitive air-tank barometer w/2-ft. indicator column; sling psychrometer to measure rel. humidity; rain gauge that measures to 1/100th inch; forecast manual, cloud chart.

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372-PG. HARD COVER DAILY WEATHER LOG

Stock No. 9462EK ..... **$4.95 Ppd.**

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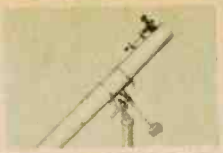

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...gets it on! Fascinates with an automatic 256-note pseudo-random tone pattern. The controls let you adjust beat, volume & pitch. Finger its 3 photocells, and you creatively vary the tone of its continuous "music." Output jack permits a patch-in to guitar or band amplifier for some really wild effects. Jack it into your stereo (use an external amplifier), or recorder for a great tape. Good executive toy? You bet! Incls. 9V tr. batt., instrs. Just 1.3 lb.

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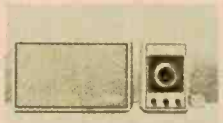

Now, the gorgeous sound of true hi-fi w/a receiver & sep. 8-ohm speaker (6⅝ x 11 x 6") small enough, and priced low enough, to go in your bedroom, den, kitchen, office, shop! Great for doctors, dentists. Its wide-range rich sound compares favorably to any stereo at its price, but its' not—it's a monophonic FM radio into which you can plug a cassette, etc. (record, play back)! Hi-fi system has Baxandall type controls (ab. 12 dB boost or cut @ 100 Hz & 10 KHz). Beautiful!

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157 mi. out in space, the Astronauts used this super 20X60 binocular (modified) to view Earth! Our biggest, most powerful for distance. Far-off objects come in big, clear & sharp to the edge through big 60mm objective lenses; 173-ft. field of view at 1000 yds. Relative brightness, 9.0. Fully coated optics; 20X spcl design eye lenses. Coated BK-7 Porro prism. Extra long All-American style with fold-down rubber eyecups. Includes case & straps.

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CIRCLE 26 ON READER SERVICE COUPON

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CIRCLE 11 ON READER SERVICE COUPON

newscan
Electronics in the News!

Calculator/Watch Combination

Electronic watches are no longer new, but how about a digital time-piece that doubles as a calculator! Hughes Aircraft Company's solid state products division recently began production on a new electronic watch module, which features a nine-function calculator in addition to a standard four-function digital watch.

The new solid-state module, which measures 1.4 x 1.25 inches, has a standard calculator keyboard on its face and an eight-digit LED display for readout of the calculator and watch functions. The keys, designed for easy operation, can be depressed with the point of a pencil or ball-point pen.

The calculator operates with a floating decimal and provides the following functions: addition, subtraction, multiplication, division, percent, memory, reciprocal, squares, and constant for multiplication and division. The watch portion displays the standard four functions—hours, minutes, seconds and date.

This Hughes' combination calculator-and-watch features an eight-digit display to read out any of the calculator's nine functions or the watch's standard four functions. Hughes is the leading supplier of solid-state modules to name-brand and private-label watch companies.

The calculator memory retains entries even when the unit is in its time-display or non-display mode. This feature, called a non-volatile memory, permits the user to call out the time without losing the figures in his calculation. The display uses .08 inch LEDs magnified to .10 inch. When in the calculator mode, the display automatically turns

(Continued on page 26)

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Hobbyist or professional there are probably a lot of circuits you build just for the fun of it. And a lot you'd *like* to build, but never get around to.

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PB-6	630	6	$15.95	Kit—10-minute assembly
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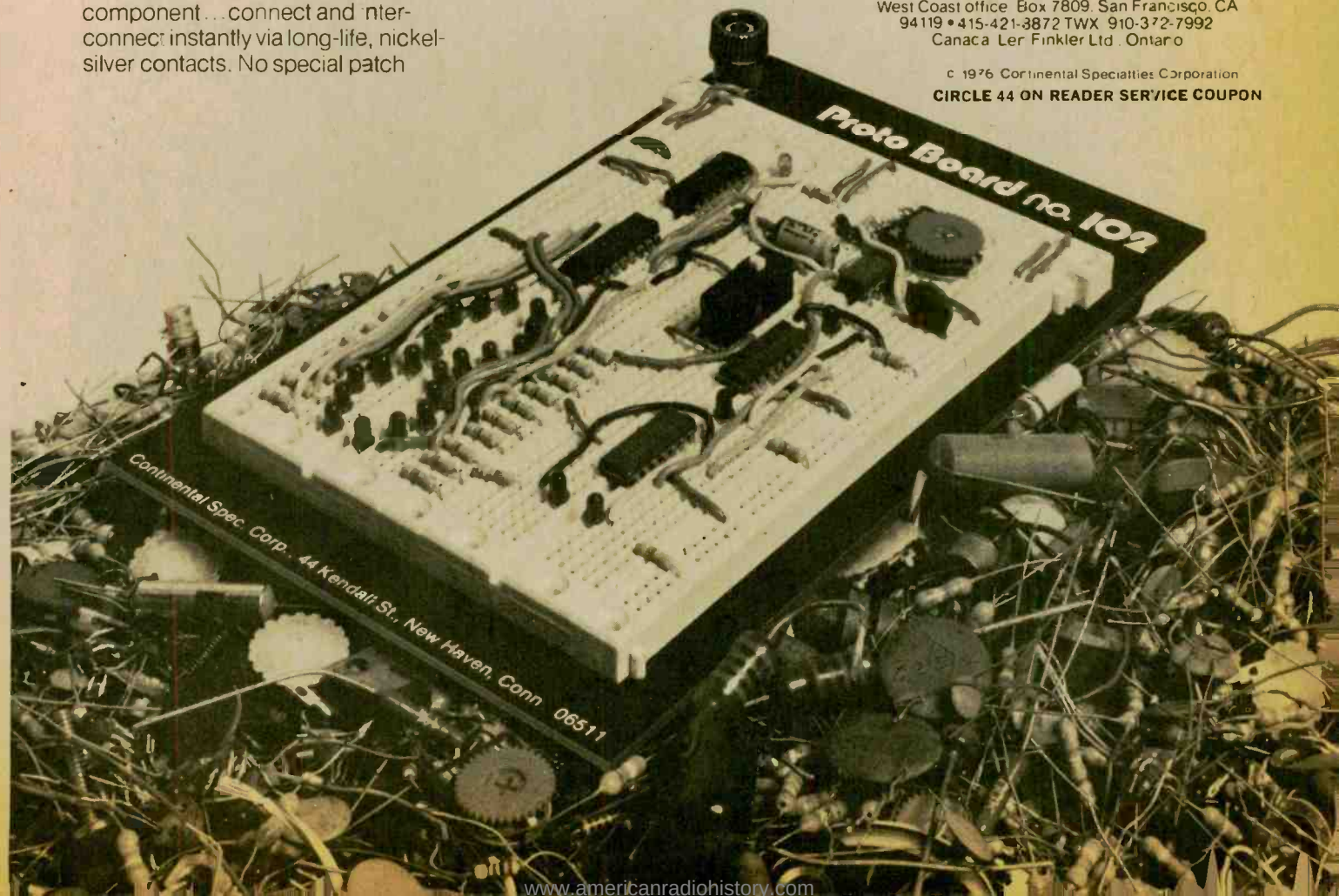
CIRCLE 44 ON READER SERVICE COUPON



NEWSCAN

off after a few seconds.

Four batteries are used, in two sets of pairs, so that the pair powering the display can be changed without affecting either the timekeeping or calculator memory. In this way, the display batteries, which must be replaced comparatively frequently, may be changed without resetting the watch or reentering data in the calculator. Initial production of the new module is committed to one of Hughes' existing customers, North American Foreign Trading Co., New York, which sells under the Compuchron label. Hughes, which supplies many name-brand and private-label watch companies with modules for digital electronic watches, does not market a watch to consumers under its own name.

Plastic Power Plant

Modelmakers at United Engineers & Constructors, a Raytheon Company subsidiary, cement one of thousands of precisely positioned pipes and reinforcing rods on an engineering scale model of a nuclear power plant. Six men will work 14 months to complete details on the $350,000 exact-scale model, which will be used by the design and construction firm to double-check drawings, which include many safety features, for a nuclear power plant. The 14-foot-high plastic model represents a finished structure 220 feet high and 150 feet in diameter. The completed plant will contain about 170,000 cubic yards of concrete, 35,000 tons of steel, and 5 million feet of electrical cable.

Modelmaker Janis Freijs of Woodbury, New Jersey, carefully cements simulated piping on nuclear power plant model.

He Has One at Home

Eight-year-old Michael Herff is learn-

(Continued on page 93).

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Kathi's CB Carousel

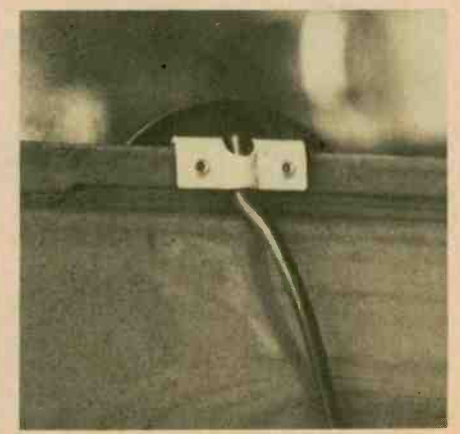
by Kathi Martin, KGK3916

☐ Somewhere around the age of six to eight every child asks its parents the question: "What does a five hundred pound gorilla do?" When the parent replies: "I don't know" the child answers with: "Anything he wants," and then rolls on the floor with laughter. What isn't funny about this joke is the implication and the certainty the gorilla doesn't distinguish right from wrong.

In a sense the FCC's recent expansion of the Citizens Band to 40 channels is another instance of the gorilla doing whatever it damn pleases without regard for anyone, or anything. Forgetting the economic aspects for a moment, on technical grounds alone the additional 17 channels are simply silly. Firstly, the new channels are easily added to the existing synthesizers but the RF output circuits cannot handle with any reasonable degree of efficiency the extra bandwidth, so there will be a considerable loss in RF output in those transceiver models that are "upgraded" by the simple addition of extra channels to the synthesizer. Secondly, most CB antennas cannot handle the present bandwidth efficiently from channels 1 to 23, imagine what happens when it tries to handle another seventeen channels. The shorter the antenna—the more inductance in the loading coil—the greater the problem. Either you will peak-tune the antenna for the low end (original 23 channels) and sacrifice performance on the high end, or you will tune for the high end and lose efficiency on the low end, which includes emergency channel 9. Though some antenna manufacturers are already delivering wide-band CB antennas, the point is you must purchase new antennas (base and mobile) in order to enjoy full utilization of the new 40-channel band.

Good CB Buys Coming. Now let's look at the economics of it all. Here you are one-up on everyone if you don't need or want the new channels. To be blunt, once the 40 channel models hit the marketplace some shortsighted people will consider 23-channel jobs obsolete and you may be able to pick up some high-performance models for pennies on the dollar. In one sense, although the transceiver will be obsolete in terms of channel coverage it will still be up-to-date in terms of typical use because channel 9 will still be the emergency channel, and with 5-million some-odd transceivers now out on the roads channels 10 and 19 will remain the "highway channels" for a long time, just as channel 13 will probably remain the unofficial "marine" channel. Admittedly, some well-heeled truckers and other CBers will move to one of the new channels to get away from the "civilians" using 10 and 19, but us civilians now form the real backbone of the "highway" channels, so I anticipate

(Continued on page 30)



Because mounting bracket for trunk-lip antenna at left is solid, antenna cable gets squashed between bracket and rain channel gasket when the lid is closed. (That's what happens with cheap antennas). Typical good-grade antenna (Antenna Specialists) has notched bracket with indentation to protect cable when trunk lid is closed.

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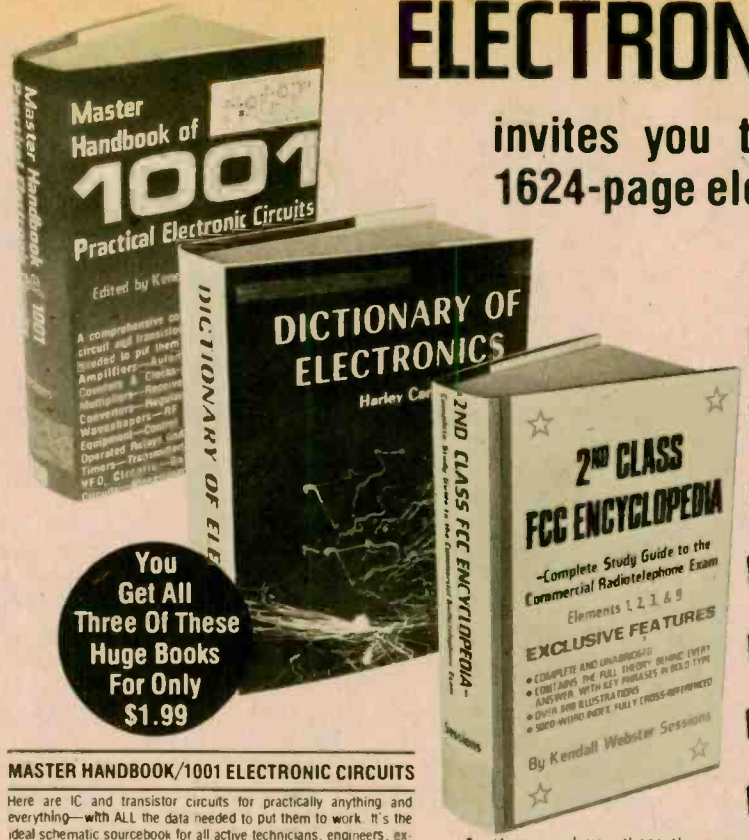

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most of the long-haul truckers will stay on 19 when driving the interstates.

From the dealer's and manufacturer's point of view the new channels may prove to be an economic disaster. Though it immediately makes their present stock obsolete, forcing sharply discounted sales, the new 40-channel transceivers don't offer much to the typical CBer, and there won't be any thundering herd rushing to upgrade their stations.

If there is any justification for the FCC's 17-channel expansion it can only be to alleviate some of the interference by providing an outlet for the well-heeled hobbyist who is certain to want the very latest in equipment. If a substantial number of hobbyists move to the new channels to avoid interference from non-hobbyists, us non-hobbyists remaining on the original 23 channels will similarly enjoy a reduction in QRM.

Why Did The FCC Act? We should really ask ourselves why the FCC chose a 17 channel expansion that apparently serves no useful purpose other than some vague hope interference can be reduced. As I mentioned earlier, the 17 channels can be accommodated by existing transceiver and antenna equipments with a loss in efficiency, so basic designs and manufacturing facilities can still be used. If there was a real desire to alleviate QRM this is an easy way to do it. But why effectively obsolete most existing unsold equipment simply to reduce interference? That has never been done before and doesn't make sense.

But it does make sense when we consider that recently the FCC tested twenty-five transceivers and found none of them could meet their type-acceptance specifications. Actually, as our own test lab discovered a long time ago, few transceivers ever met their own type-acceptance claims. Now if we consider this fact, and a piddling 17-channel expansion, what I come up with is a natural and easy way to force type-approval of CB transceivers. Type approval also provides an easy way to bring the entire transceiver under the Part 15 RFI (radio frequency interference) regulations.

In short, I believe the additional 17 channels were not a gift to the CBer nor a valid attempt to alleviate interference. Rather, it serves as a quick, easily done means to bring all transceivers under Part 15 and type-approval. By throwing in a minimal expansion that really doesn't affect most users or technologically obsolete present transceivers in use or in the pipeline, the FCC has brought equipment under their direct approval without substantial complaints by the users, manufacturers, distributors, or dealers.

Any real expansion of CB remains off in the future, and as I stated when everyone else fell all over themselves praising the FCC over their original 100-CB channel proposal, effective expansion must take place in the UHF region and I still predict it will be FM around 218 to 220 MHz, but not in the amateur radio frequencies. The logical time for the UHF expansion is the next time the consumer electronics industry needs a shot in the arm.

So meanwhile, keep your eyes open for buys in 23-channel transceivers. You'll never get a better chance to pick up high performance equipment at budget prices.

CB Accessories. Maybe it's my imagination but it appears that each time I go into my local CB equipment shop there's a new pegboard rack of CB accessories. Some items—like the so-called anti-theft mounting brackets—have value for the average CBer, but many accessories are just plain rip-offs. And if the item isn't a rip-off the pricing is. For example, my local CB shop sells a locking tape player mounting bracket which can be used for CB transceivers for $4.95. With a coaxial feed-thru so you don't have to unscrew the antenna connector each time you remove the rig the bracket sells for $10.95. Now these very same brackets, packaged for a national auto parts chain, are priced at $5.95 and $11.95 respectively. In a Radio Shack store the same items under their own label are about the same price. But in an electronic parts store, packaged under a national name brand, these items are selling for $9.95 and $19.95. I call it highway robbery.

Some Useless Ideas. Every time I turn to a CB accessory display I see a microphone "booster" or microphone "amplifier" that looks as if it was made in someone's basement as a spare time operation. There is no modern transceiver that needs, or gets increased "talk power" from a microphone amplifier. The most you can do is make distorted modulation, unless you turn the gain down so far to avoid distortion you get no additional amplification. The only talk power device of value is a compressor or limiter for those transceivers not presently equipped with modulation compression or 100% limiting. If your rig already has one or both features another compressor or limiter does absolutely nothing.

A Good Idea. Save your money for an SWR meter, for it gives a good indication of the antenna system. And considering some of the shoddy antenna equipment coming on the market your SWR meter might be the only thing that insures your signal gets out of the rig. For example, my neighbor got back

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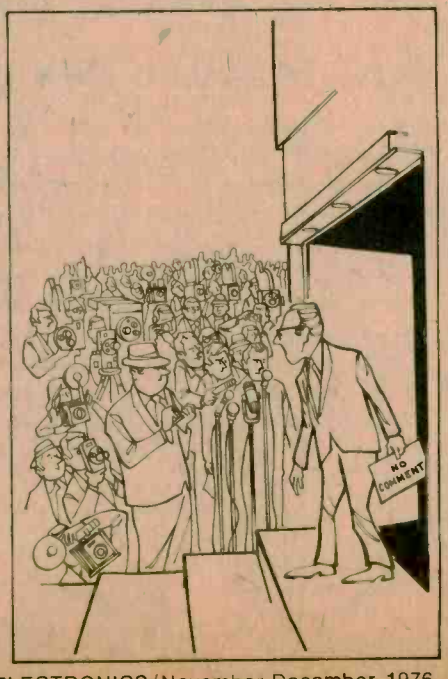
KATHI'S CB CAROUSEL

from a trip complaining she couldn't raise anyone more than a mile away, yet her rig's RF output meter was indicating near normal. A quick visual inspection of the antenna system looked okay so I did the first thing anyone should do when checking a rig, I connected an SWR meter at the rig itself. Lo and behold, the meter showed an SWR higher than 10:1, so it was back to the antenna. A real close inspection showed the transmission line of the trunk lip mount was flattened almost as thin as this page where it wrapped around the trunk lid. Now I knew what had happened.

What You Pay For. My neighbor had been suckered into buying one of those cheap imitation trunk mounting antennas, the type with a printed price of some $25 that always seems to be on sale for about $10. Well, in CB you get what you pay for, and the photographs show how this ripoff works. The upper photo shows my neighbor's original trunk lip mount. Note how the coax cable wraps around the U-bracket so it gets flattened between the bracket and the rain channel gasket when the trunk is closed. The lower photograph shows the Antenna Specialists mount I substituted. Note how the U-bracket is notched and indented so the cable bends safely around the trunk lip, with the bracket acting as a mechanical shield for the cable so the cable can't be squashed. This A/S mount is typical of what you get from the most of the well-known antenna makers—it's the "special sale" copies that resemble or are copies of the well-known brands, but save a few cents by not indenting the bracket that you must beware of. If you get stuck with the cheap copy you may also get stuck with a squashed cable.

If you must save money do it somewhere other than at the antenna. The antenna equipment is out there in all kinds of weather, it gets bent in the wind, handled by children, twisted by vandals, and yet you still expect it to work when needed. So when it comes to antennas stick to the well-known brands—at the very least you'll get your money's worth.

Next time I'll have some more info on how the manufacturers plan to handle the new 40 channel CB band. ■



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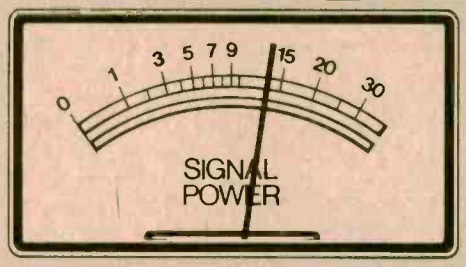
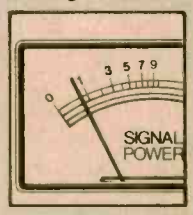


Turner mikes turn ordinary CB sets into heavyweights

Check the channels. You hear Turner mentioned a lot on CB. Most longtime CBers have a Turner mike. They often sound stronger and reach farther. It's



easy to understand why: Even a weak carrier signal can do the job if it has good mike input, while on the other hand a strong signal with poor modulation can be hard to copy. Demonstrate this to yourself by opening up your receiver squelch and listening to a distant station, a signal which barely swings the S-meter. Even though signal power hardly moves the needle, can you still copy through the noise? If so, that's good modulation. And you're probably listening to a Turner mike.

Many Turner models have a built-in preamplifier with volume control on the mike.

Mike volume control lets you adjust mike input, which allows the radio to put out a signal with all the voice modulation or "talk power" the set is designed to deliver.

A Turner mike can also add to your set's effective range by keeping input consistently high. The Turner M+3 and Road King 60 include a speech compression circuit to assure constant-level input, regardless of mouth-to-mike distances or natural rising and falling of the voice.

Or to get rid of cab rumble, traffic and

other interfering background noises that reduce effective range, consider the Road King 70, a rugged CB mike that adds noise cancelling to the other Turner features.

Ask a Turner dealer to help you get full performance out of your base or mobile CB. Or start by asking for a communications catalog from Turner, 716 Oakland Road N.E., Cedar Rapids, Iowa 52402.

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(Continued from page 22)

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How many times do I have to write to your stupid magazine to get the help I need?

—D.T., Salt Lake City, UT

I remember your letters. Next time you write, please include your return address.

Hank, I was thrilled to see my letter in your column. You are for real!

J.F., Austin, TX

It's only my wife's charge account bills that are unreal.

Hank, I have an old Zenith Radio for sale. Can I tell you about it?

—D.H., Phoenix, AZ

Sure, and if we have the space, we'll tell our readers.

Hank, I don't think you exist.

—J.S. Reno, NV

This is a recording, Beep . . . This is a recording, Beep . . . This is . .

Lend a Hand Department

Δ Our readers ask for information and materials that only you our readers can supply. So, lend a hand boys, and Hank thanks you in advance.

Δ R. W. Wick, Rt. 3, Box 4, Stoughton, WI 53589 would like operation manuals for the R77/ARC-3 and T5015/ARC-502.

Δ VW alternator noise is killing CB reception for D. W. Leibfreid, 107 Clayton Rd., Hatboro, PA 19040. If you solved the problem in your VW without yanking the motor, let our friend know.

Δ Tell Carl Diffeur how to kill RF interference from his Toyota Corona fuel pump. Write to him at 1113 Duke of Gloucester, Colonial Heights, VA 23834.

Δ H. W. Kattelmann of 163 Via Los Altos, Redondo Beach, CA 90277 needs the schematic diagram and service data on the Sargent Rayment SR51-B tuner and SR88 amplifier. He has a distortion problem.

Δ Has anyone info on the Scott auxilliary receivers used on WWII merchant ships? If yes, write to Nathan Copeland, 72 Groveside Road, Portland, ME 04102.

Δ Walter Harley would like to join our advanced electronics club. Okay, membership chairman, write to Walter at 2436 Streetsboro Rd., Peninsula, OH 44264.

Δ J. Jarvis of Box 247, Cibolo, TX 78108 needs an operation manual and a wiring diagram for a Radson radio-telephone, #Rt-70A.

Δ If you know where to get MAW-64A LEDs, write to John Sterrett, P.O. Box 2314, USAF Academy, CO 80840.

Δ Paul Prinke would like to get his newly acquired Philco Model 37-670 receiver working. If you can help, write to Paul at 34 Ferndale Rd., No. Caldwell, NJ 07006. ■

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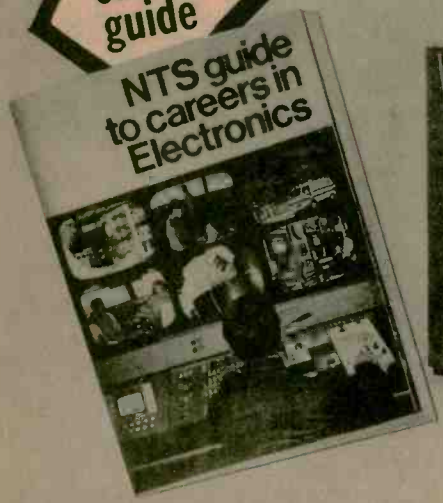

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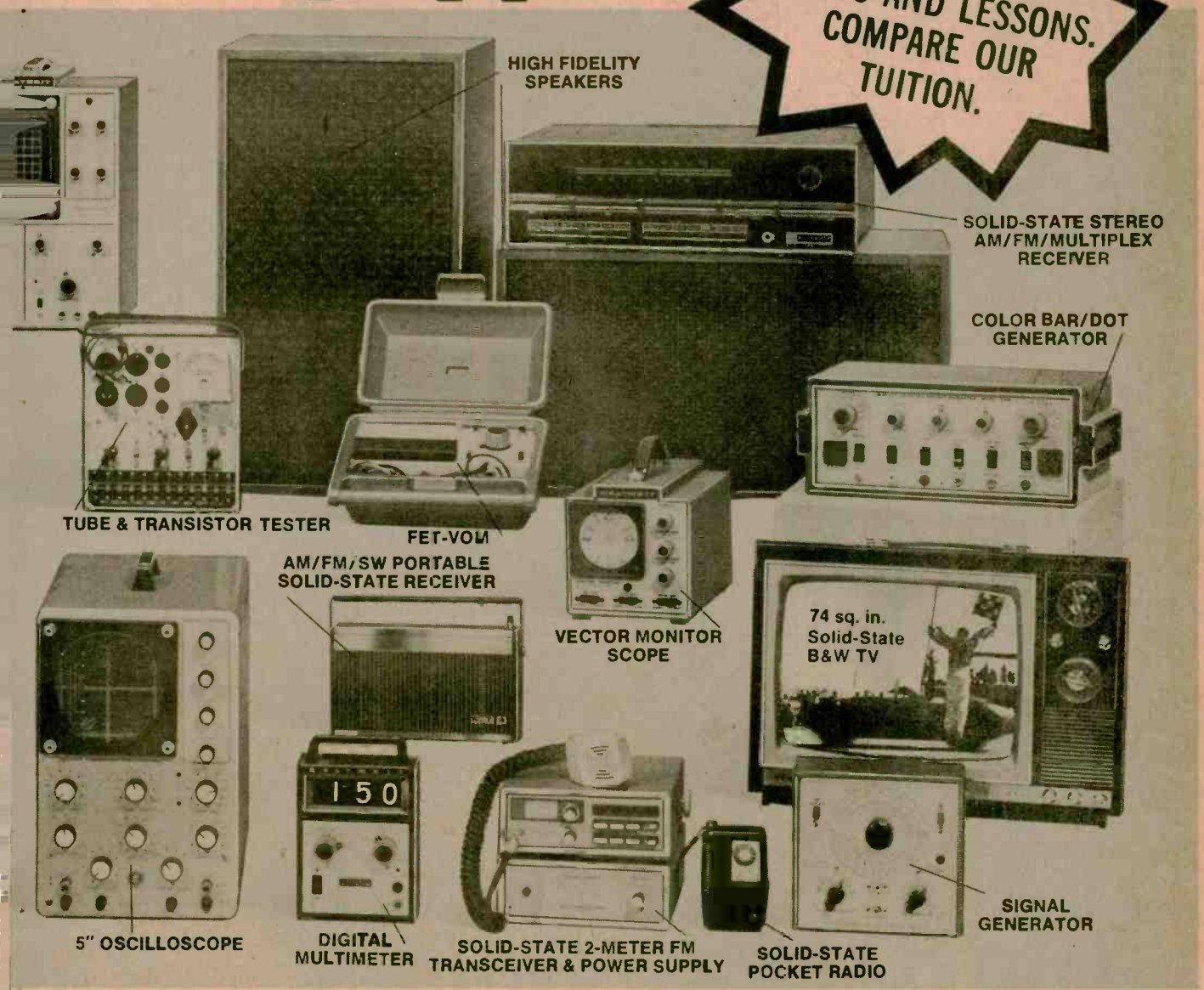

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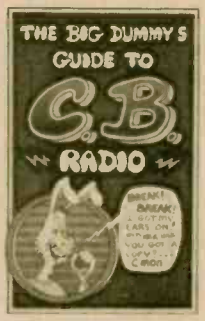
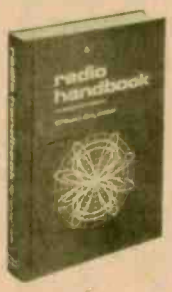
For CBers. There's all kinds of folks getting into CB nowadays. CB offers free communications for anyone who wants it, and you don't have to know a lot of fancy radio theory to get on the air. Thus, the need for a book which bears the title. *The Big Dummy's Guide to CB. The Big Dummy's Guide to CB* is a comprehensive



Soft cover
128 pages
$2.95

manual of both the technical and the non-technical aspects of CB Radio. It includes: a complete CB slang dictionary and information on the following: buying and installing a rig; power, modulation and SWR; mobiles and base stations; troubleshooting your rig; walkie-talkies; home-built antennas; and emergency procedures. This book is designed to help CBers get out! It is published by the Book Publishing Company, Box 156, Summertown, TN 38483.

A Classic! *Radio Handbook, 20th Edition*, by William I. Orr, W6SAI reflects the rapid advance in technology. One-third of the book has changed completely, and the remaining text revised to keep in line with today's techniques. Additional material has been added, covering propagation, VHF communication, recent advances in solid-state technology, and more. The



Hard cover
1080 pages
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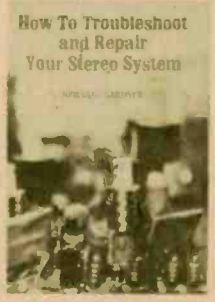
Radio Handbook gives the amateur radio enthusiast information on the latest principles and equipment of radio communications, and includes authoritative, detailed instructions for designing, building, and operating all types of radio communications equipment. The book discusses the theory and construction of all modern circuitry, semiconductors, antennas, and power supplies, and provides details on workshop practice, test equipment, and radio math and calculations. Published by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46206.

Microprocessor. A handbook providing a complete technical description of the single-chip 8-bit SC/MP (Simple-to-use, Cost-effective, Microprocessor) is available from National Semiconductor Corporation. The handbook includes 6 tables and 35 illustrations, and begins with a general in-

Soft Cover
65 pages
$3.00

troduction to SC/MP for non-technical users and follows with a preliminary design of SC/MP-based applications. *SC/MP Technical Description* describes the single-chip CPU, which needs only one memory chip to form a complete, fully-programmable system. It also discusses expanded uses through supporting hardware and software. This software includes cross assemblers, loader/debug programs, and input/output routines. The handbook also has a description of three application modules and the factory service and support programs, as well as an instruction set summary. *SC/MP Technical Description* is published by Marketing Services Department, National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, CA 95051.

Stereo Fix-it. Here's a basic guide which prepares the reader for fundamental stereo troubleshooting, analysis of trouble systems, and identification of component faults. *How to Troubleshoot and Repair*



Hard cover
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Your Servo System, Hershal Gardner, minimizes theoretical treatment, and places stress on intuitive specifics of circuit actions, exemplified by typical commercial designs. Details of effect-to-cause relationships between trouble symptoms and device or component malfunction are developed on the basis of common-sense reasoning. Test and measurement techniques are explained and illustrated for each basic subdivision of hi-fi troubleshooting methodology. As the reader progresses to more demanding troubleshooting problems, he/she is introduced to the use of the oscilloscope and specialized generators. Alternative test methods are also noted. These require only a voltmeter and a general-purpose signal generator. Published by Reston Publishing Company, Inc., P.O. Box 547, Reston, VA 22090. ■

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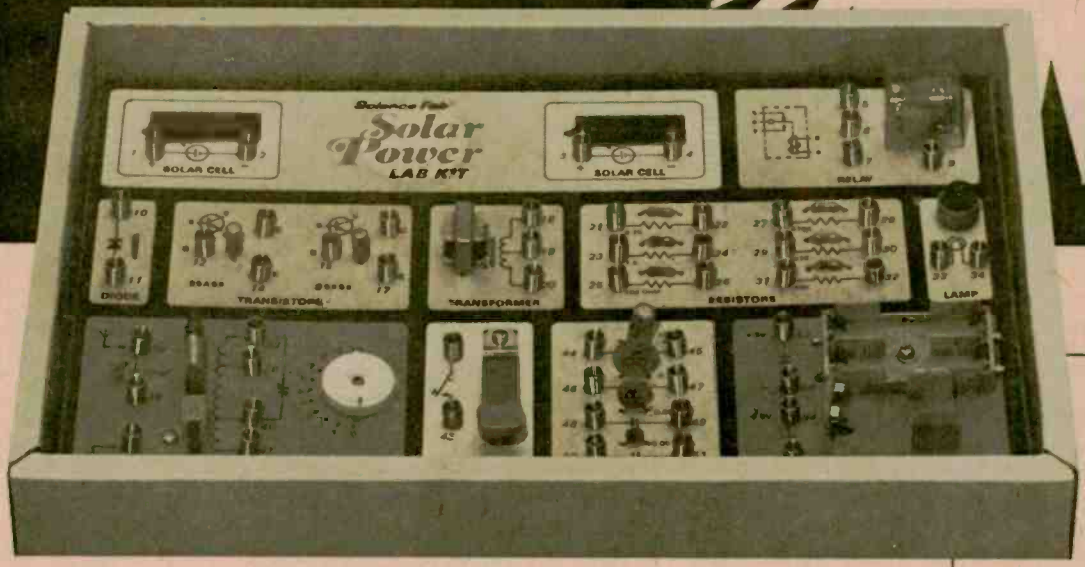

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YOU CAN LISTEN TO EARTH-ORBITING SATELLITES

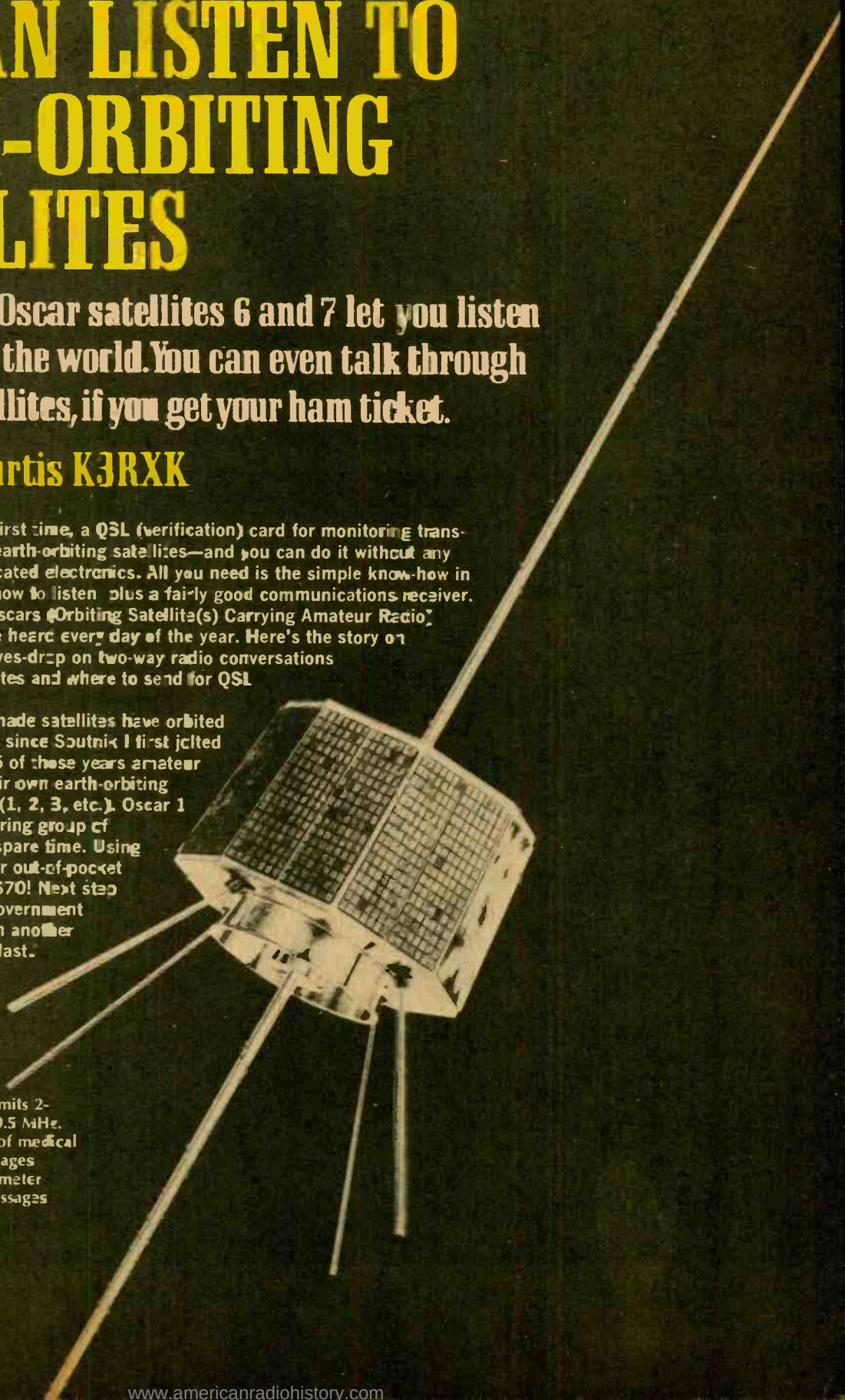
Amateur Radio's Oscar satellites 6 and 7 let you listen to hams all over the world. You can even talk through these earth satellites, if you get your ham ticket.

by Anthony R. Curtis K3RXK

You can now get, for the first time, a QSL (verification) card for monitoring transmissions from either of two earth-orbiting satellites—and you can do it without any souped-up exotic or sophisticated electronics. All you need is the simple know-how in this article about when and how to listen plus a fairly good communications receiver.

I'm talking about the Oscars (Orbiting Satellite(s) Carrying Amateur Radio) which are in orbit and can be heard every day of the year. Here's the story on the birds' origins, how to eaves-drop on two-way radio conversations passing through these satellites and where to send for QSL cards just for listening!

Satellite History. Man-made satellites have orbited the earth less than 20 years, since Soutnik I first jolted the West in 1957. And for 15 of these years amateur radio operators have had their own earth-orbiting satellites, each called Oscar (1, 2, 3, etc.). Oscar 1 was put together by a pioneering group of California amateurs in their spare time. Using left over and used parts, their out-of-pocket expenses came to less than $70! Next step was convincing the federal government to launch it "piggyback" with another satellite in place of some ballast.



Oscar 7 weighs 65 lbs, and transmits 2-watt signals between 29.4 and 29.5 MHz. Receiving ground transmissions of medical data, weather bulletins and messages from ham operators on the two-meter band (145 MHz), it can store messages for retransmission later, upon command from the ground.

e/e LISTEN TO SATELLITES

When a Thor-Agena rocket lifted on a pillar of flame from Vandenberg A.F.B. on Dec. 12, 1961, radio amateurs around the world had their own satellite. During its three-week lifespan Oscar 1 transmitted telemetry data with a power of one-tenth watt.

Oscar 2, launched June 2, 1962, was exactly like Oscar 1, with telemetry lasting 18 days.

Oscar 3, launched March 9, 1965, was the world's first privately constructed active communications satellite. It received amateur radio signals and retransmitted them with a transmitter power output of one watt. Oscar 3 was also the first free-access communications satellite, commercial or non-commercial, to be orbited. A total of 100 different ham radio stations in 16 countries communicated through the satellite during its two-week life.

Oscar 4, launched Dec. 21, 1965, was an active bird with three watts of transmitter power. It did not achieve a good orbit at launch, but hams did communicate through it (before it fell back to Earth) including the first direct U.S.-to-U.S.S.R. contact via satellite.

Oscar 5, launched Jan. 23, 1970, was built by students at Melbourne University, Australia, and launched from the United States. It transmitted a telemetry beacon and its batteries lasted 1½ months.

Oscar 6, launched Oct. 15, 1972 alongside an ITOS weather satellite and still going strong, is an active repeater—it picks up ham signals and retransmits them. The 40-pound satellite can store messages sent up from earth and repeat them on command from the ground. Its radio signals can be turned on and off by ground command. Transmitter power is one watt.

Oscar 7 was launched along with the NOAA-4 weather satellite and Spain's INTASAT satellite on Nov. 15, 1974, was built by hams in the U.S., Germany, Canada and Australia. It has two separate communications repeaters on board with two watts of transmitter power. It can receive and store messages for later replay and be turned on and off by ground command. Medical data, weather bulletins and other emergency communications have been transmitted through the 65-pound Oscar 7.

Both Oscar 6 and Oscar 7 are used for casual chit-chat among ham friends as well as for educational purposes and public service work. There's always something to hear when Oscar is overhead.

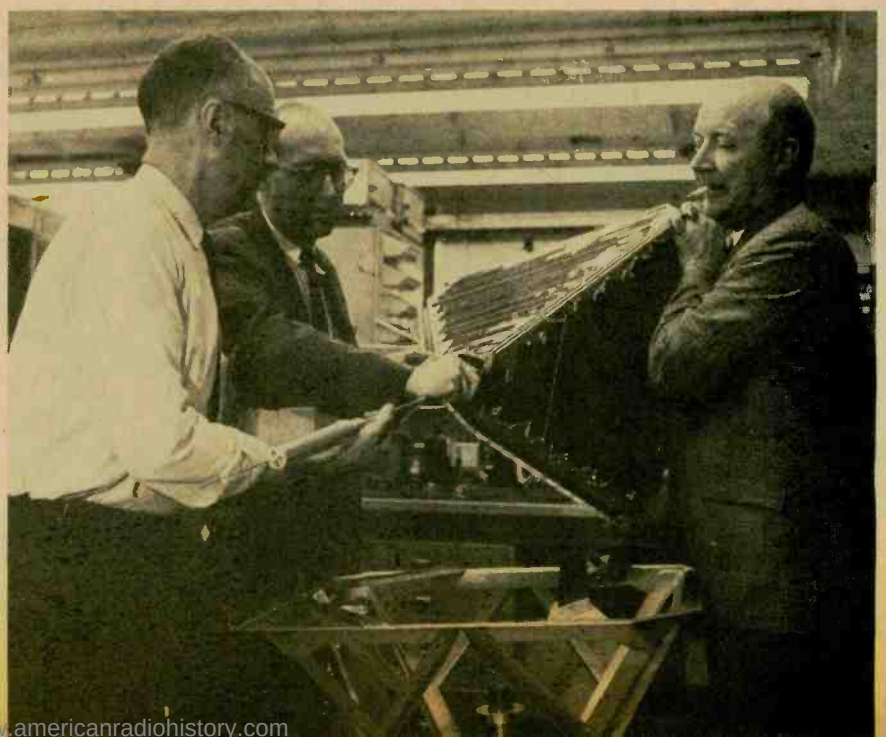
Better Oscars Ahead. The seven Oscars so far lofted for amateur radio may be divided into the Phase I satellites, consisting of Oscars 1 and 2, and the Phase II Oscars, numbers three through seven. One and Two were not active satellites, as were numbers three through seven. Now we come to Phase III Oscars, which will be launched before long. They will be a mighty leap ahead in ham radio satellite technology. They will do all the things 6 and 7 are doing but for longer periods of time. With 6 and 7, listeners can tune in the satellites for about 20 to 30 minutes every 115 minutes as the satellites circle the globe. The remainder of the time, 6 and 7 are out of sight, behind the Earth. Phase III Oscar(s) will be different.

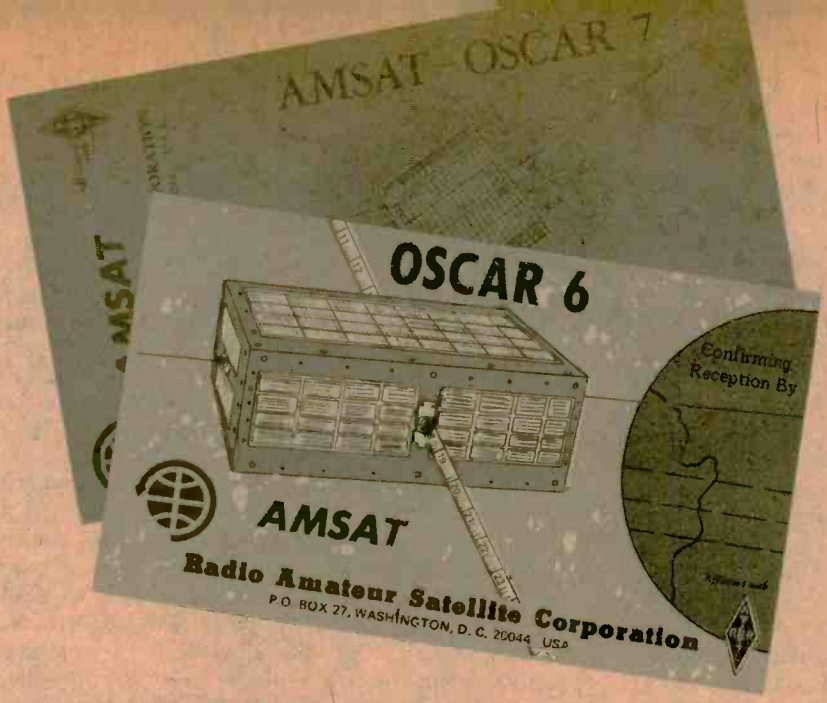
Phase III Oscar(s) will be lofted into a 900-mile high orbit (like 6 and 7). But, once in orbit an on-board kick motor will push the satellite into an elliptical orbit as far as 20,000 miles from Earth over the Northern Hemisphere. The other end of the orbital path, over the Southern Hemisphere, will be only 900 miles above earth.

Phase III Oscar(s) will thus be out of sight behind the earth only about one hour and in sight above the Northern Hemisphere as long as 12 hours before disappearing again behind the earth for one hour. It will be usable from North America, Europe and Asia for 23 hours of each day. Hams will be chatting through Phase III Oscar repeaters without regard to time of day or signal skip.

Receiving Satellite Transmissions. Here's how to eavesdrop on Oscar. All that's needed to hear Oscar 6 and Oscar 7, now in orbit, is an inexpensive general-coverage shortwave receiver tuning 550 kHz to 30 MHz. You will be listening to the 10-meter ham band so any receiver capable of tuning approximately 29.4-29.55 MHz will let you hear the satellites.

First Oscar satellite (left) being loaded into small plane for test flight over San Francisco Bay area in 1961. Antenna shown in Oscar 1's side transmitted 145 MHz beacon signal at 0.1 watt. Oscar engineers in final assembly of Oscar 4 (right). Note the launching spring in the cradle below satellite. The triangular sides on Oscar 4 are covered with electricity-producing solar cells.





These are the QSL cards you can get to prove you caught transmissions from either or both Oscar satellites now transmitting to earth.

Fancy equipment is not needed to hear Oscar. The author regularly listens with an inexpensive Kenwood QR-666 all-band communications receiver, and the satellite comes in loud and clear. Bob Peters, operator of ham radio station K3EZS at State College, Pa., listens to the satellite with a 25-year-old National tube-type receiver. The author has even listened in on a Panasonic RF-1150 all-band portable radio. So you see it's not hard to hear Oscar.

Signals go up to Oscar in the two-meter ham band in the frequency range of 145.850-146.00 MHz. You won't be able to hear these signals directly from a ham earth station. unless, by chance, that station is very near where you live.

Signals come down to Earth from Oscar for you to hear in the 10-meter ham band between 29.4-29.55 MHz. You can hear these by tuning when the satellite is overhead and in view of your listening post.

Hams transmit through the satellites in radiotelegraph code (CW) and single-sideband (SSB) voice. To hear these signals and understand what is being said, your receiver will have to have a BFO (beat frequency oscillator) or other means of detecting SSB and the beep-beep of Morse code. Most shortwave radios have a switch marked *BFO On/-Off* or a mode switch which can be turned to select CW, Code, or SSB.

Many conversations are relayed through the satellite at the same time. If you tune your receiver carefully, up and down the dial from 29.4 to 29.55 MHz you can hear several different QSOs (amateur conversations) going on at the same time.

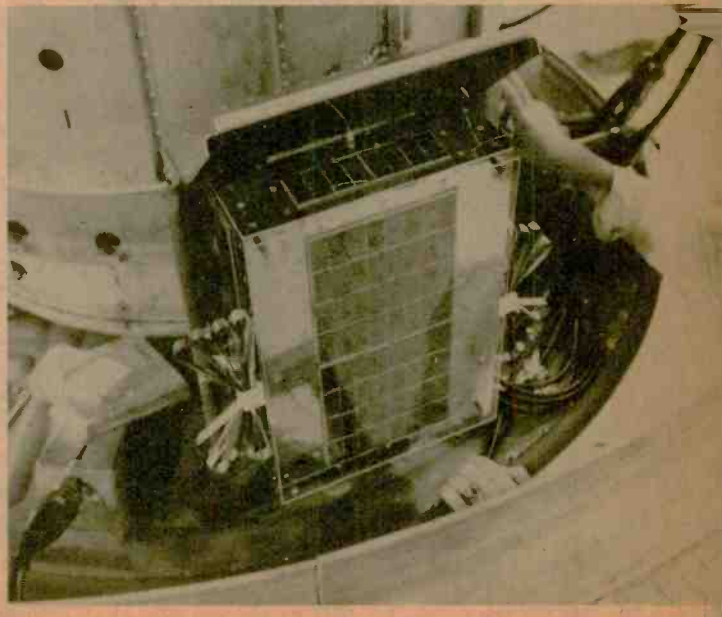
Listen On These Frequencies. Here are the exact frequencies used by each satellite: Oscar 6 transmits down to Earth between 29.45 and 29.55 MHz. Oscar 7 transmits down on 29.4-29.5 MHz.

Since these satellites are at an altitude of 900 miles you can be as far as 2,450 miles away and still receive signals from Oscar when it comes into view over your horizon. So two hams up to 4,900 miles apart can talk through the satellite when it is between each ham station and up to 2,450 miles away from each!

As the satellite moves along its orbital path, stations in different parts of the world come in and go out of its range.

Antennas. Antennas for receiving do not need to be fancy either. The author heard Oscar with both vertical and long-wire antennas cut for a wide variety of other short-wave and ham bands. Almost any outdoor antenna can be hooked to your shortwave receiver to bring in the satellite. Bob, K3EZS, uses a

Get your QSO via slow-scan TV. Photo (left) shows the first QSO ever transmitted via satellite—Oscar 6 is still aloft transmitting one watt on the amateur 10-meter band between 29.5 and 29.55 MHz. Oscar 6 aboard the Delta launching rocket (right) at the Lompoc, California Western Test Range of NASA (National Aeronautics and Space Administration) prior to launch.



LISTEN TO SATELLITES

130-foot length of wire from his ham shack out to a tree, and regularly makes contacts through Oscar!

A very good antenna cut especially to hear Oscar is a simple horizontal wire dipole antenna. This kind of dipole is constructed with two eight-foot lengths of wire running from a center insulator. A length of RG-8U or RG-58U coaxial cable (available at your Radio Shack store) serves as lead-in from the center insulator to your receiver. This is the familiar center-fed half-wave dipole described in most radio manuals. I have one hanging between two chimneys on my house which puts the antenna about 30 feet up in the air. It works fine.

If your shortwave receiver is nearly dead on the 10-meter band, you can pep it up and get Cadillac-quality reception by installing a small transistorized preamplifier. These can be purchased for about $6 in kit form (or $12 wired and tested) from dealers such as Hamtronics Inc., 182 Belmont Road, Rochester, N.Y. 14612.

As the satellite tumbles slowly in orbit, its signals are affected by passing through the ionosphere, so don't be discouraged if voices seem to fade slowly in and out. That's normal. One way around the fading would be to use two matching antennas, one mounted horizontally and one mounted vertically. While listening with one antenna, when the signal from the satellite starts to fade, switch quickly to the other and signals will come back to original strength. Such two-antennas systems are ideal, but are not needed for casual listening to Oscar. It's easier to put up with the slow fading. In fact, it's not usually necessary to put together a special 10-meter antenna just to hear Oscar the first time. Unless your receiver is pretty dead on 10 meters, just use whatever shortwave antenna you have available.

The earth is moving under the satellite so Oscar appears to move westward. For instance, if the satellite comes up south-to-north over the southeastern United States one hour, it will come up over the Rocky Mountains a few hours later. And even later it will come northward over the Pacific Coast. And so on, around the Earth in a corkscrew pattern, Oscar covers the United States, and the world.

Since Oscars 6 and 7 were launched at different times and are in slightly different orbits, they will not be overhead at the same time. Their distance apart varies. Twice a year they come close enough together for hams to talk through both at the same time.

What To Listen For. Both satellites have telemetry beacons, transmitters which send strings of numbers in radiotelegraph code (CW) which can be easily copied and deciphered to determine temperatures, voltages and current drain from batteries in the satellites.

Oscars are powered by rechargeable nickel-cadminum (NiCad) batteries, constantly revitalized by the sun through solar cells.

Oscar 7 telemetry beacon can be heard at 29.502 MHz and Oscar 6 telemetry beacon can be found at 29. 450 MHz. Listen for those continuous strings of numbers in Morse code.

First-time listeners usually listen for the telemetry beacons. Then they tune for chatting hams. They also might hear such serious uses as transmission of medical electrocardiograms (EKGs) from California to the National Institutes of Health at Washington, D.C., or Miami hams maintaining hurricane watches and transmitting weather bulletins, tests in locating downed aircraft or using portable Oscar Earth stations transported in suitcases flown to earthquake and other natural disaster sites.

When To Eavesdrop. A sure-fire way to hear Oscar is to turn on your shortwave receiver any night except Tuesday, when they're often switched off. Oscars will pass overhead or near enough for you to hear at least twice in an evening. Oscar 6 is turned on for hams on Sundays, Wednesdays and Friday nights local time in the United States. Oscar 7 will be turned on during odd-numbered days of the year.

A pass near or over eastern North America will take place between 7:00 and 9:00 p.m. Eastern Standard Time, and pass over or near western North America will take place between 9:00 and 11:00 p.m. EST (6:00 to 8:00 p.m. PST). You should be able to hear, at the least, the stronger signals coming through the satellite for 10 to 30 minutes each pass depending upon how close Oscar is to you.

How To Get QSL Cards. Here's how to get a QSL card for listening. Copy the radiotelegraph code (CW) numbers being transmitted by the satellite itself as its telmetry beacon. Get as many in the string of numbres as possible, hopefully 100 or more. If you miss a number, write in a dash and continue to copy down following numbers. Send the numbers you copied and a reception report (including exact time and date, and signal strength) to the Radio Amateur Satellite Corp. (AMSAT), Box 27, Washington, D.C. 20044.

AMSAT is an international organization of hams and listeners interested in amateur satellite work. AMSAT sponsors the satellites and coordinates activities.

AMSAT will send you a QSL (verification) card. If you can't copy the Morse code, you also could send AMSAT a report of voice-transmitted satellite news bulletins about Oscar-related events you may hear transmitted by bulletin stations through the satellites.

You can get additional QSL cards by listening for the call letters of individual hams you hear talking through the satellites. Let's say you hear me, K3RXK, taking with another ham in single-sideband (SSB) voice through the satellite. Jot down my call and make note of how well you receive my signal. Look up my mailing address in the Radio Amateur Callbook Magazine (published by Radio Amateur Callbook Inc., 925 Sherwood Dr., Lake Bluff, Ill. 60044). Then mail your SWL QSL card or letter-of-reception report to me. In turn, I would check my logs to make sure you did hear me when I was operating and I would send you my QSL card. It's as easy as that!

The American Radio Relay League (ARRL), in Newington, Conn., a national organization of hams, makes available free to interested teachers a curriculum book for classroom use of Oscar in teaching math, physics, astronomy, communications, electronics and space science. The book explains in elementary language how to use a simple shortwave receiver to teach and learn what keeps a satellite in orbit, what governs its speed and how to use Oscar for many other math and science classroom activities. Thousands of students already have participated in the program.

Students using the educational package learn how to determine the satellite's period (how long it takes to go around the globe), its increment (how many degrees farther west it will be when it crosses the equator the next time) and its inclination (the angle at which the satellite's path crosses the equator).

For more information about the educational programs or how to tune in Oscar, write ARRL, 225 Main St., Newington, Conn. 06111. Other information, such as how you can become a member of the AMSAT organization to be kept up-to-date on wave lengths and orbiting times of Oscars launched in the months and years ahead will be sent to you on request if you write to AMSAT, Box 27, Washington, D.C. 20044. ■

YOGI BEAR IS EVERYWHERE

Prowl the highways with this much respected patrolman and his CB Radio

by Ralph Fisher

☐ Donald W. Sarrells, a patrolman in the Department of Public Safety District Number 2.3, is stationed at Jacobs Lake in the Kaibab National Forest in the extreme northern part of Arizona. He lives in a mobile home at the well-maintained highway yard at Jacob Lake.

Officer Sarrells is called "Yogi Bear" by many regular long-distance truck drivers and other travelers with CB radio contact. He prowls along highways U.S. 89-89A and U.S. 67, over to the north rim of the Grand Canyon constantly working his CB radio as well as his regular police-band transceiver.

Don is on call twenty-four hours daily. Emergency calls often come through and immediately, Officer Sarrells is on his way to assist.

During a recent weekend visit with Don, his superiors allowed me to accompany him on a tour of duty in the beautiful north country. We left the yard early in the morning on May 8th. We began the eight-hour tour with a look at the condition of Highway 67, from Jacob Lake to the North Rim, since during the night, a wet snowstorm had coated the high country. Four miles out of Jacob Lake, we ran into drifts on the roadway, and at several bends we were forced to slow for rock slides. We stopped the cruiser to clear the larger rocks from the highway and to place a call for a snowplow. We came off the mountain onto the Kaibab Plateau to find better conditions and returned to Jacob Lake to refuel.

A two-day rodeo was scheduled to open at Page that morning, and Officer Sarrells suggested that we cruise over to the junction where Highway 89 passes through Echo Cliffs toward the city of Page. Traffic increased as we left Marble Canyon and headed towards Bitter Springs. We located an off-the-highway spot and set up a radar gun lookout for speeders heading for the rodeo.

Most of the main highways in the area are subject to dips which can conceal traffic. The traffic's speed registers lower mileage while it is in the dip. But, as the traffic enters or leaves the dip, the speed accurately registers on the radar equipment.

A pickup with a boat-trailer and boat, headed towards Lake Powell, passed us at a moderate speed, staying within the 57-60 mile-per-hour limit. Don noticed that the trailer was minus a license plate, and the chase began. The driver paid no attention to the signal lights flashing behind him, so the officer pulled up abreast of the driver and signalled him to stop. The driver had the appropriate legal registration, which meant no problem or cause for a ticket, and the four fishermen continued on their way.

A few minutes after the rig departed from our view, we heard over CB radio, "Yogi Bear is parked along 89 about four miles north of the junction. Please beware." Don gave a big grin and said, "We will fool 'em." We drove north for about four miles and stopped to set the radar gun in action. A fast-traveling car gave a 75.3 miles-per-hour reading on the level that dropped to 29.8 in the dip. As the car emerged from the dip, its reading jumped back to 75.8, but

when the driver spotted the parked cruiser, he eased his heavy foot from the gas pedal. Officer Sarrells stood in the middle of U.S. 89 and waved the car to a stop. He checked the driver's license and asked him a few questions. The officer then gave the day's first ticket to a surprised out-of-state motorist who thought that no "law" was watching in the vast desert country.

"Yogi Bear is on the air . . . Yogi Bear is everywhere," came over CB radio as a truck driver heading north passed by and waved, holding the 55 miles-per-hour limit until safely out of sight. Another trucker cut in on his CB with a "Thank you, Steve," and Don replied, "Don't you wish that you knew where?" as we drove to a new location and waited.

"You gave me a bum tip, pal," the CB set in Steve's truck shouted, as it passed the spot where "Yogi Bear" was supposed to be. The radar gun registered 69.5 mph as the big van came over the rise, and Don waved it down. He checked the driver's licenses and equipment, and wrote out another ticket to a very meek and surprised driver. Speeders who are ten miles over the 55 miles-per-hour limit merit a warning citation, an admonition to be careful and to obey the law. Those who speed over 65 miles-per-hour earn themselves a ticket.

At noon, we visited the little community of Trading Post, and enjoyed good food and homemade pie at the lunchroom of the Cliff Dwellings. Officer Sarrells received a warm greeting, for those in business have great respect for this law man who is always ready, on any cold winter night, to assist them in their time of need.

We were eating and relaxing when a trucker came in for a cup of java and told Don that he had just passed a bad accident near mile post 502. Don picked up his police radio and could hear Officer Vincenti of the Highway Patrol, already at the scene of the accident, requesting assistance as quickly as possible. "10-4," repeated Don, "we are on our way."

As we drove towards the accident scene, the two-way police radio reported that a car had run off the highway and was wrecked about 100 feet off the road. A woman passenger had possibly suffered a bad spine injury.

"A sleeper," Don informed me, "the driver fell asleep in midday and wrecked his automobile." Don called on CB to request an ambulance from Tuba City, the nearest town with ambulance service. Our cruiser and the ambulance arrived within minutes at the accident scene. Officer Vincenti had the responsibility for filing all reports and issuing any summonses, since the accident occurred within his district. Don was there to assist and he did.

Yogi Bear's cruiser is seen parked in front of an ambulance while the medics are placing a highway accident victim on a litter.

The couple from Utah were headed north for home when the husband fell asleep at the wheel. The ambulance crew took great care in gently slipping the woman onto a board, so that she could be moved safely from car to ambulance. It was reported later that she had sustained a serious back injury. A wrecker soon arrived to remove the badly wrecked vehicle after which as it departed, Officer Sarrells cleared his location over police radio and we headed for a place to set up the radar lookout along U.S. 89.

"Here it comes!" whispered Don, and over the hill came a speeding pickup truck. As the driver emerged from the dip, the radar reading dropped from 73.5 to a safe 55.5 miles-per-hour speed. Don waved him down, and got a loud protest at once! "We pay good taxes for good highways, and then you set up these silly 55 miles-per-hour limits in this huge desert wasteland so that it takes us all day to get out of it. It's senseless!" barked the angry driver. Don issued him a citation and he asked, "How the h—— can you prove that I was hitting the 73.5 you claim I was doing?" The highway officer escorted him to the cruiser where the radar was still ticking off the 75.5 speed just clocked.

Highway officers like Don Sarrells, who patrol our highways, have been nicknamed "Smokey the Bears" by cross-country truck drivers. The stiff brim campaign hats they wear, part of their required dress, are similar to the hat worn by Smokey, the Bear.

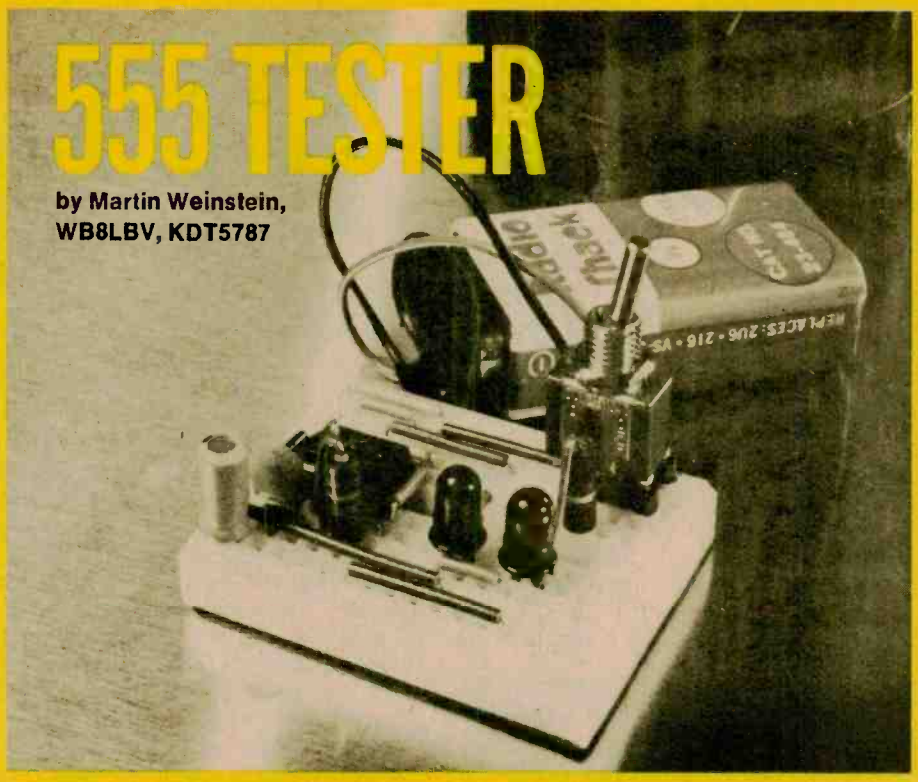
I fully enjoyed my eight hours riding with "Yogi the Bear" in the beautiful north country and hope to do it again some day. Don and I drove up the mountain behind several cars with drivers who may have been uncertain of their safety on the winding curves. "Smokey the Bear" rode behind them and advised his superior that he was enroute to his den in Jacob Lake and that all was well. The rocks and slush of the morning had been removed by highways crews who had waved a greeting as we passed. The highway was secured, the sun was setting behind the rugged Vermilion Cliffs and the famous Kaibab North deer were feeding, but alert in the brush of the rolling hillsides. Also alert were many CBers on the highways, keeping in constant touch, and ready to assist when advice or help were needed.

We left the cruiser under the shelter of a tall Ponderosa pine in the highway yard at Jacob Lake, after the alert officer told his home base, "623—5:00 P.M. home safe—10.4." He threw a well-worn frisby for his dog to retrieve, discarded his "Smokey the Bear" hat, drew a long breath of fresh pine air and asked me, "What do you wish for dinner tonight, barbecued steak or breaded veal cutlet?"

I returned to my home the following Monday with a grand feeling of assurance and knowledge of the great respect that the small community's ranchers and businessmen hold for their "Yogi the Bear," and of the great respect that this man has for his district, his friends and for his twenty-four hour call-to-duty along the highway from the Gap to the border of Utah. And it's good to know Yogi and others like him, are tuned in to CB 'cause I know any emergency call I make will be answered promptly and efficiently. ■

555 TESTER

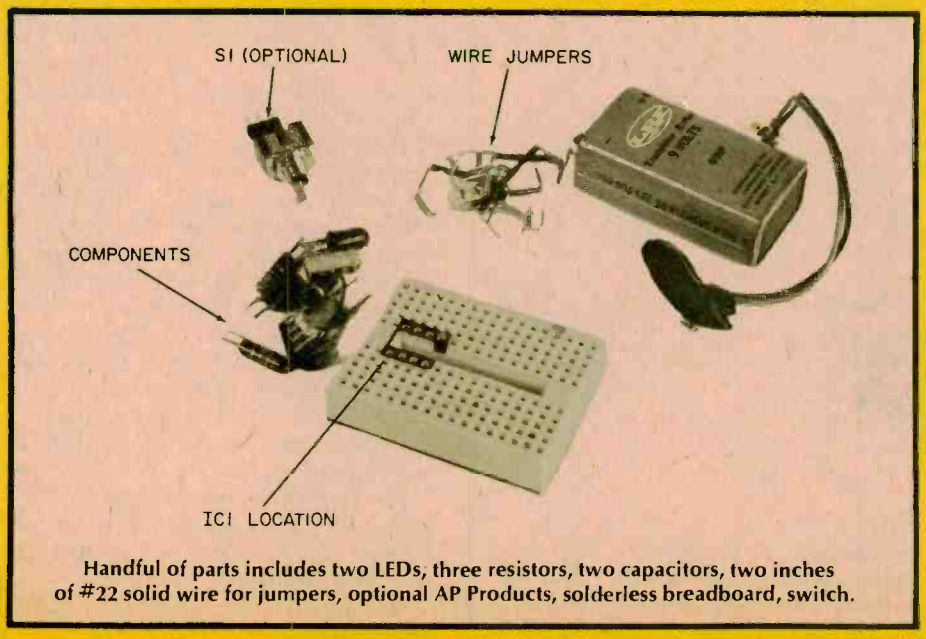
by Martin Weinstein,
WB8LBV, KDT5787



You can test surplus 555 integrated circuit chips in one second with this easy-to-build, simple, project.

ONE OF THE MOST frequently-used integrated circuits today is the 555 timer chip. It's an 8-pin IC, most often found in the Mini-DIP package (rectangular, with the pins in two rows or four each of the long sides). It's also seen in the less-common round transistor-like shape, the TO-5 or TO-99 packages.

It's an IC which can produce a time-delay from a few micro-seconds to about an hour, with five percent accuracy. It can also run free as an oscillator, at frequencies as high as a megahertz (1 MHz) or as low as one pulse per hour! The only external parts are one or two resistors and a capacitor. It can also be used as a comparator, a Schmitt trigger, a controlled switch, and much much more. And today, even though the prices of new integrated circuits are still coming down, you can find untested 555s on the surplus market at great bargains.



Handful of parts includes two LEDs, three resistors, two capacitors, two inches of #22 solid wire for jumpers, optional AP Products, solderless breadboard, switch.

This project shows a ready way to test these widely-used, widely-available ICs.

Inside, the 555 has many transistors and other components, arranged to make up the following circuits: two comparators, one flip-flop (which is a bistable multivibrator), and an output stage. Connections are brought out to several terminals (up to 8) which hobbyists call "pins."

Inside the 555. First we have a comparator, a kind of balancing beam. It looks at two inputs and compares them. Some comparators supply an output when the voltage at one of its inputs is *larger* than the other. Other comparators, like this one, provide an output when both inputs are *equal*.

Now look at the two inputs this comparator is connected to. One input is a voltage divider inside the 555. This consists of a string of three identical resistors connected between Vcc (B+) and ground (−). Since this leg of the comparator is connected 2/3 of the way up the resistor string, it always measures a voltage equal to two-thirds of the supply voltage.

The other input leg of the comparator is connected to the external timing chip capacitor you use in your particular 555 IC timer circuit. The timing capacitor is charged through a timing resistor (two, actually, series-connected and tapped by a connection to pin 7 in most applications). Together, the timing resistor and timing capacitor determine how fast the 555 will oscillate (or how long an output pulse it will deliver). Here's how.

When the charge on the timing capacitor at pin 6, the *threshold* input, reaches a value equal to the voltage at the on-chip voltage divider (2/3 Vcc), the comparator turns *on*. When the comparator turns on, it toggles the flip-flop that switches the 555 output.

The flip-flop also turns on a transistor that discharges the timing capacitor.

How It Works. To start the 555 working, a trigger pulse at pin 2 initially sets the flip-flop to turn the 555 *on*. It does this by comparing the input pulse to 1/3 Vcc at a second comparator. This turns off the transistor across the timing capacitor and allows the timing capacitor to begin to charge. The 555 stays *on* until the timing cycle turns it *off* again by resetting the control flip-flop.

The timing cycle can be made to start over again by applying a pulse to the *reset*, pin 4. This turns on the transistor that discharges the timing capacitor, thereby delaying the charge from reaching 2/3 vcc.

In some applications, the *reset* (pin 4) is connected to the *trigger* input

(pin 2) so that each new input trigger signal restarts the timing cycle.

When the *threshold* voltage at pin 2 drops, at the end of a timing cycle, that voltage drop can be used to start a new timing cycle immediately by connecting pin 6 to pin 2, the trigger input. This is how the 555 works when it is used as an astable (free-running) oscillator.

The 555 output circuit includes two high current transistors, each capable of handling 200 ma. One transistor is connected between the *output* pin 3 and vcc, the other between pin 3 and *ground*. Thus, so you can use pin 3 to either supply Vcc to your load (*source*) or provide a ground for your load (*sink*).

Testing is Fast and Easy. I once asked an applications engineer friend of mine how he could tell if a particular gadget of his would work. "Make sure it isn't between you and the door, and then plug it in and turn it on!" he said.

This 555 tester borrows on his advice. Instead of trying to measure specific conditions at each pin (the way most tube and transistor testers make their tests), it plugs the 555 under test right into a simple circuit and puts it to work. A good 555 will flash the LEDs alternately. A bad 555 will cause either or both of the LEDs to light and remain lit, but without flashing.

Construction is Fast. The prototype circuit you see here is built on a modern solderless breadboard, this one an A P Products terminal strip. A spring clip behind each hole grips both wires and component leads. Since each conductive metal spring clip is five "holes" long, the breadboard is organized as a group of five-tie-point terminals.

Jumper wires are used to connect between terminals, and component leads may be inserted directly. Any solid wire from #30 to #20 slips right in and holds securely. I prefer to use #22 solid, and I've bought it in several colors to help me keep track of what's going where. A quarter inch or so of insulation stripped from each end provides a perfect jumper.

The Tester's Circuit. The 555 performs as a simple astable oscillator, alternately flashing the two LEDs. We can drive both LEDs from the single output (pin 3) because of the way the 555 is designed. It is made to either *source* (provide a positive voltage, and thereby current, to its load) or *sink* (provide a minus voltage—ground connection, for the load current) its output. So by connecting one LED from B+ to pin 3 (sinking output) and the other between pin 3 and GND (sourcing output), we can take advantage of both capabilities.

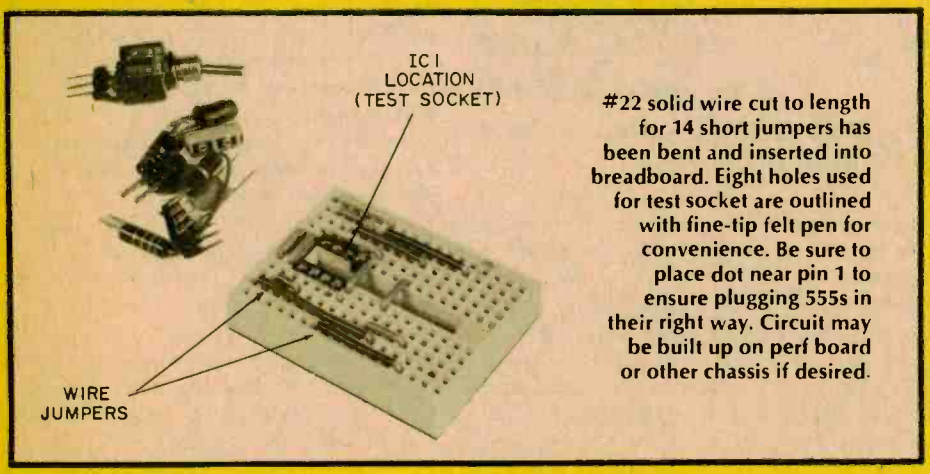
You will notice that I've not included the usual current-limiting resistor in series with each LED. What actually happens is that a single resistor, R1, limits current through the entire circuit. In addition to protecting the LEDs from too much current, it does the same for the 555 under test, and it also prolongs battery life. Finally, it also protects the tester's circuitry in case the 555 under test has a dead short between any combination of pins, as often happens when ICs are removed from surplus printed circuit boards, leaving solder bridges.

The circuit's time constant, which governs the flashing rate, was chosen to make the flash easily discernible. Too quick a flash rate could appear to be a steady *on*. Too slow a flash might look like just one LED lighting. You can alter the flashing rate by changing the value of C2.

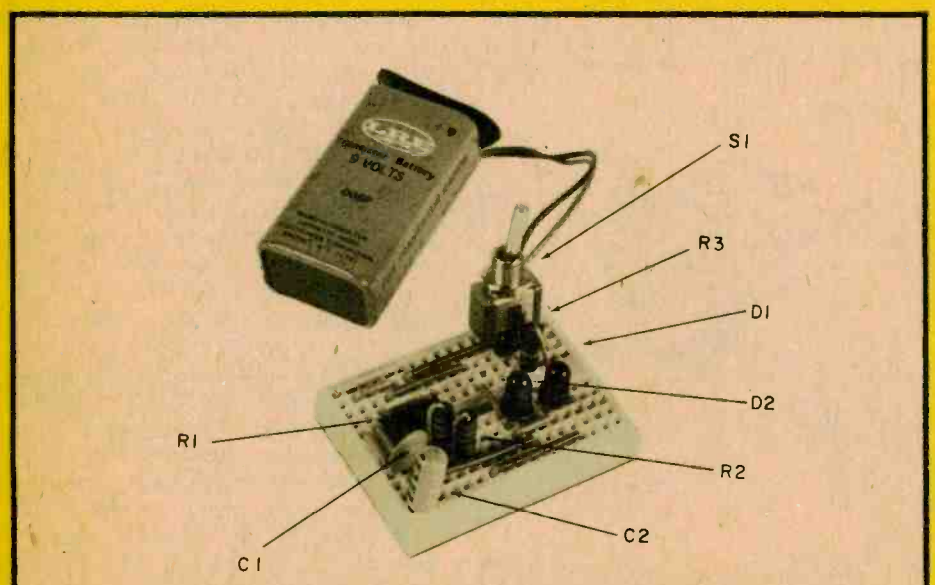
R2 and R3 also affect the flash rate, and the ratio of their values determines the *duty cycle* (how long one LED is illuminated versus how long the other is on, in this case). While other values for R2 and R3 could have been chosen, the values shown here were used for several reasons. For one, they're standard and easy to find. Second, they yield a very readable flash rate. And most important, they fit within the ratio-of-resistances required by the internal workings of the 555.

Building It. If this is your first experience with solderless breadboards, it's only fair to warn you that they can be habit-forming.

You'll have the circuit together in less time than it takes to lay out a



#22 solid wire cut to length for 14 short jumpers has been bent and inserted into breadboard. Eight holes used for test socket are outlined with fine-tip felt pen for convenience. Be sure to place dot near pin 1 to ensure plugging 555s in their right way. Circuit may be built up on perf board or other chassis if desired.



Circuit assembled on solderless breadboard, a 555 plugged in, and optional switch S1 in place. Use of different-colored wires makes it easy to trace circuit. Polarity of diodes is important.

printed circuit board or solder up a haywire circuit. You won't need any hardware at all. You can even leave out the switch if you like, and plug and unplug the leads to the battery.

One of the reasons these solderless broadboards are so fast and easy is that they're designed with a .1-in. x .1-in. hole spacing. Modern DIP (dual in-line package) ICs are designed with leads spaced in multiples of .1-in. So everything we use can plug right into the breadboard. An IC socket here would only be redundant.

This standard .1-in. spacing appears in another handy device that AP Products makes called a *header*. The header is a plastic strip with small contact posts every .1-in. You can break off as many of these as you need, with 36 of them being supplied on each strip. I soldered a piece of header to the back of a small toggle switch so it could plug right in, too. Another small piece soldered to the battery connector makes the entire project plug-in easy.

Follow the diagrams and illustrations as you place each part in position in the breadboard. Mark the breadboard with a felt-tipped pen to show where the 555 under test plugs in, and be sure to index pin 1. Also mark the positive and negative battery connection points.

Jumper Wires. Use #22 solid wire. Cut about ½ inch longer than jump (connection) needed. Strip ¼-inch of each end bare and bend at right angles. You will need one .1-in. jumper, one .2-in., six .3-in., one .4-in., one .5-in., one .6-in., two .7-in. and one 1-in. long.

Be very careful removing 555s from the tester to avoid bending their pins. Use an IC removal tool if you have one. If you don't a small screwdriver used as a lever in the deep depression in the center of the IC will let you ease it out safely.

Smoke Test. It won't burn up, if you've been careful. There aren't very many ways to do this circuit wrong. But just to be on the safe side, double check your wiring before you connect the battery.

Then, with no 555 in the circuit, connect the battery and turn the switch (if you've included it) *on*.

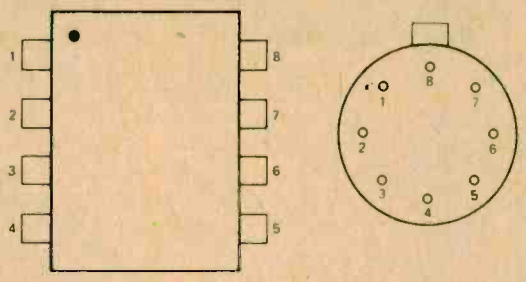
If you've wired everything correctly, both LEDs will light. The most likely cause of a LED not lighting, assuming your wiring is correct, is that it has been plugged into the board backwards.

Now go ahead and plug in a 555. Choose one you know is good. The LEDs should start flashing. Play with the value of C2 to alter the rate.

Using the Tester. Since the solderless breadboard is its own chassis, you're

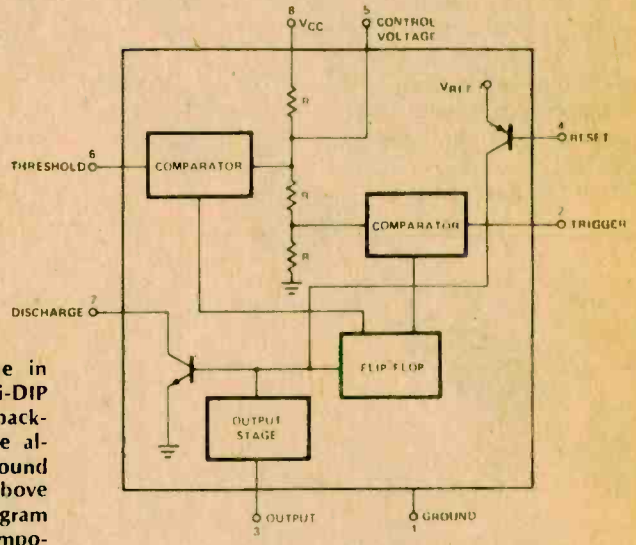
(Continued on page 94)

INSIDE THE 555

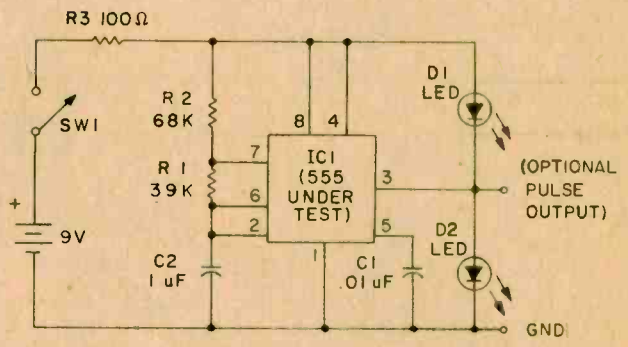


(Top View)

1. Ground
2. Trigger
3. Output
4. Reset
5. Control Voltage
6. Threshold
7. Discharge
8. V_{CC}



Most 555s come in rectangular mini-DIP (dual in-line package), but they're also found in round "TO-" package (above right). Block diagram shows major components of timer.

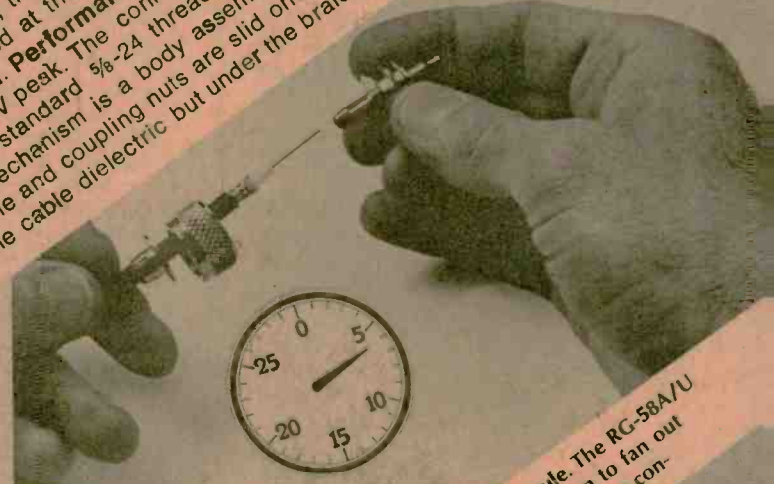


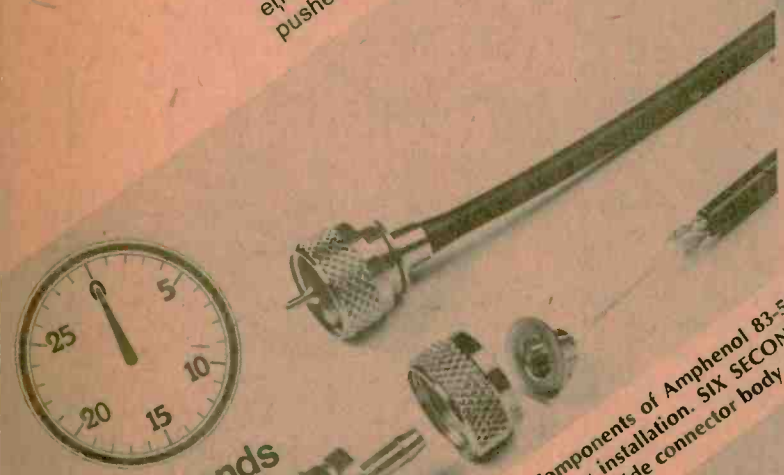
PARTS LIST FOR 555 TESTER

C1—.01-uF capacitor (Radio Shack 272-1065 or equiv.)
C2—1-uF, 16-volts or better electrolytic capacitor (Radio Shack 272-996 or equiv.)
D1, D2—LED red indicators (Radio Shack 276-097 or equiv.)
R1—100-ohm, ½-watt resistor (Radio Shack 272-000 or equiv.)
R2—68,000-ohm, ½-watt resistor (Radio Shack 272-000 or equiv.)
R3—39,000-ohm, ½-watt resistor (Radio Shack 272-000 or equiv.)
S1—SPST subminiature switch (optional—see text) (Radio Shack 275-324 or equiv.)
Misc.—Jumper wire, #22 solid, insulated, various colors (Radio Shack, 278-1306 or equiv.) Solderless breadboard and header strip—AP Products 217L terminal strip. Available at dealers, or order AP 923273, $4.75; Headers are 929834-01, $.87 for a strip of 36. Add $1.00 for postage and handling on mail orders to AP Products Inc., Box 110-EE, 72 Corwin Drive, Painesville, OH 44077.

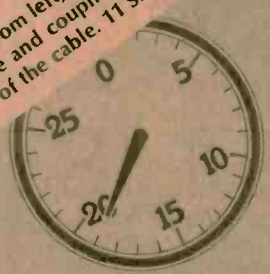
No Solder for this CB Antenna Connector

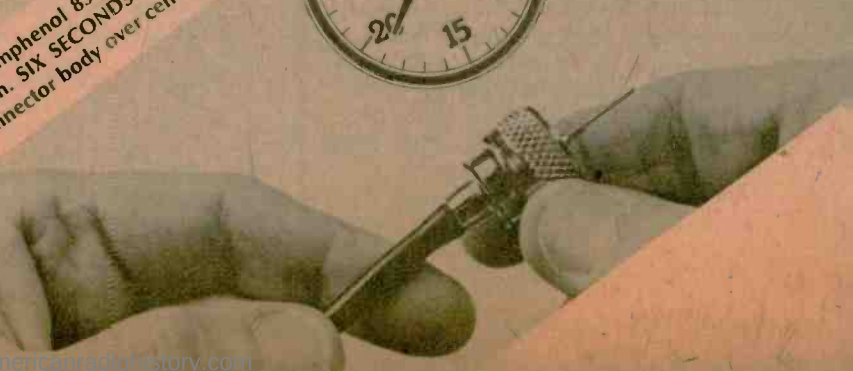
☐ Improper RF antenna connections have been the biggest cause of CB Radio transmission and antenna systems' failures since 1958. The root of the problem is with the conventional solder-type PL-259 connector, which is difficult to assemble onto a cable by the novice, and can't be inspected visually for faults. Thus many CBers experience communications failure, or reduced CB performance without ever knowing it. How can the CBer avoid this problem? He could buy preassembled cables, which are usually the wrong length and expensive. Or, he can use the new Amphenol 83-58FCP (for Field Crimp Plug) that provides a fool-proof termination for RG-58A/U coaxial cable without solder, special tools or adaptors. **Easy to do.** To complete a cable termination, the CBer simply strips the coaxial cable and pushes the connector parts onto the center conductor and braid. The contact is squeezed at the tip to secure the center conductor. No braid soldering, combing of cable braid, special crimping tools, or adapters are needed. **Performance Specifications.** Amphenol 83-58FCP connectors have a frequency range of 0-300 MHz, and a voltage rating of 500-V peak. The connectors are non-waterproof. Roof-top installations require waterproofing with plastic tape. The contact has standard 5/8-24 threads, and mate with standard UHF receptacles and adapters. At the heart of the solderless connecting mechanism is a body assembly, featuring a hollow barrel with a barbed end. After the cable is stripped, the slotted outer ferrule and coupling nuts are slid onto the cable. Then the body assembly is pushed onto the cable so that the barrel fits over the cable dielectric but under the braid. The coupling nut is then slid over





ZERO SECONDS. Components of Amphenol 83-58FCP connector are (from left) body, coupling nut, and outer ferrule. The RG-58A/U cable is stripped for installation. SIX SECONDS. Slide outer ferrule and coupling nut onto cable. Rotate insulation to fan out the braid slightly. Slide connector body over center conductor of the cable. 11 SECONDS. Push barbed barrel of the con-





CB has gone a long way to affect the design of the electronic parts used in this two-way radio service. Amphenol answered the call to hobbyists everywhere with their new goof-proof RF cable connector. By Jackson Kaye

Test. We tried our hand at wiring the solder type RL-259 connector and new solderless 83-58FCP to see how long it would take. The Editors have had considerable experience with the solder-type connector and averaged 15 minutes to assemble the old type of connector to a cable. The solderless type 83-58FCP took an average of two minutes to terminate properly. The editors did not race the clock, and included the cable preparation time. In racing the clock, as illustrated in the photos, after a few tries, the editors equaled or slightly bettered the time of 23 seconds. The most important single feature of the 83-58FCP connector is the ease and perfection of installation at mobile sites, using every-day hand tools. Our hats are off to Amphenol brand type 83-58FCP connector made by Amphenol RF Division, Bunker Ramo Corp. Try the Amphenol 83-58FCP, you'll like it! ■

Editorial

Offer expires January 31, 1977

Attention: N. de Zara

Amphenol Connector Systems
Bunker Ramo Corporation
33 East Franklin Street
Danbury, CT 06810

I like your offer of a pair of working samples of the new Amphenol UHF Connector (P/N 83-58FCP) for only $1.00 postpaid. Enclosed find my check for one dollar (no cash or stamps, please). I understand delivery will take about four weeks.

Name

Address

City

State

Zip

CB XCVR CHECKOUT

- Courier Gladiator PLL
- Craig 4201
- Regency CR-142

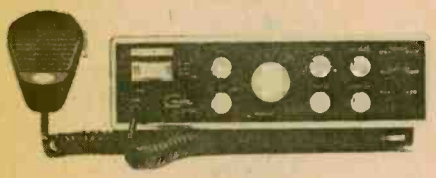
☐ ELEMENTARY ELECTRONICS regularly publishes test reports on current CB transceivers. Only those models with FCC type acceptance and now on dealers shelves are included in CB Xcvr Checkout. We do not test prototypes or one-of-a-kind sets because the performance of the final production model you purchase might well be different from that of the tested unit. Those CB transceivers which are "stock standard" have been thoroughly tested and checked, and you can depend on our test results and reports before you put your money on the counter.

If you don't find the particular unit you are interested in reported on here, check the newsstands for the 1976 CB BUYERS GUIDE which contains reports on more than 120 different CB transceivers, or look for the next edition of the CB YEARBOOK 1977, which will be on your local newsstands after November 1976.

• COURIER GLADIATOR PLL

$479.95 (Fanon/Courier Corp.)

General Description: A 23-channel AM/SSB transceiver for mobile, PA operation. Variable tuning ±600 Hz provided. Power supply 12 VDC with positive or negative ground. Overall dimensions are 3-in. h x 10⅝-in. w x 12-in. d. Front panel controls and switches for Channel Selector, Volume, Squelch, Clarifier, RF Gain, SWR Meter Calibrate, Meter Function, AM/LSB/USB, On-Off, PA/CB, and Noise Blanker. Standard accessories are microphone, all crystals, mobile mount, DC power cable.



CIRCLE 57 ON READER SERVICE COUPON

Receiver Section Test:

Input Sensitivity	0.7 μV (AM)
Adjacent Channel Rejection	66 dB
Image Rejection	60 dB
AGC Action	7 dB
Input Level for S9	100 μV

Transmitter Test Section:

RF Output	3.7 watts AM, 12 watts PEP (SSB)
Modulation to 85%	yes
Relative Sensitivity for 85% Modulation	—28 dB
Modulation Limited to 100%	yes

Editorial Remarks: The Courier Gladiator PLL has a relative reading S-meter, internal transmitter tuning, double conversion, external and PA speaker jacks, and S/SWR/RF output meter. ■

• CRAIG 4201

$239.95 (Craig Corp.)

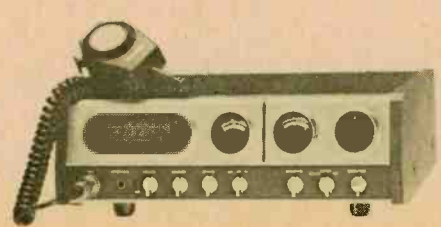
General Description: A 23-channel AM transciever for mobile, base, PA operation. Delta tuning ±1000 Hz provided. Power supply 12 VDC with negative ground and 117 VAC. Overall dimensions are 4-9/16-in. H x 13-1/16-in. W x 10⅞-in. D. Front panel controls and switches for Channel Selector, Volume, Squelch, Delta Tune, RF Gain, SWR Calibrate, SWR / Modulation Meter Mode, ANL/Noise Blanker/PA. Standard accessories are microphone, all crystals, mobile mount, DC power cable.

Receiver Section Test:

Input Sensitivity	0.6 μV
Adjacent Channel Rejection	52 dB
Image Rejection	47 dB
AGC Action	9 dB
Input Level for S9	100 μV

Transmitter Section Test:

RF Output	3.7 watts
Modulation to 85%	yes
Relative Sensitivity for 85% Modulation	—31 dB
Modulation Limited to 100%	no



CIRCLE 56 ON READER SERVICE COUPON

Editorial Remarks: The Craig 4201 has an S-meter that reads 6 dB per S-unit, internal transmitter tuning, double conversion, external and PA speaker jacks, S/RF output meter, and Modulation/SWR meter. ■

• REGENCY CR-142

$199.00 (Regency Electronics, Inc.)

General Description: A 23-channel AM transceiver for mobile, PA operation. Delta tuning ±800 Hz provided. Power supply 12 VDC with negative ground and 117 VAC. Overall dimensions are 5½-in. h x 12⅜-in. w x 9¾-in. d. Front panel controls and switches for Channel Selector, Volume, Squelch, Microphone Gain, Delta Tune, PA/CB, ANL, RF/Modulation meter. Standard accessories are microphone, all crystals, mobile mount, AC and DC power cables.

CIRCLE 59 ON READER SERVICE COUPON

Receiver Section Test:

Input Sensitivity	1.0 μV
Adjacent Channel Rejection	44 dB
Image Rejection	48 dB
AGC Action	8 dB

(Continued on page 99)

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GREAT FOR CHRISTMAS GIFTS! A UNIQUE SELECTION OF MEMORABLE, LONG-LASTING GIFTS FOR ALL AGES.

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New antenna assist turns a tiny transistor into a tiger, has pulled in stations up to 1000° miles away! Just set beside radio (no wires, clips, grounding) and fine-tune Select-A-Tenna's dial to same frequency—"gangbusters"! Great for clearing weak signals in radio depressed areas, off-coast islands, crowded frequency stations. Solid state—uses no electricity, batts., tubes.

Stock No. 72,095EK ..... $19.95 Ppd.
ULTRA SELECT-A-TENNA
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Parabolic mike w/ 18¾" reflecting shield & 2 I.C.'s in amplifier magnifies signals 100X that of omni-directional mikes. Catch a songbird ½ mile off; QB's huddle strategy; sounds never before heard. Super directivity gives highest signal to noise ratio poss. Safe: auto. cuts off ear damaging noises. Earphones, tape recorder output, tripod socket. Req. two 9v trans. batt. (not incl).

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BIG EAR "TOY" MODEL #80,176EK ..... $36.25 Ppd.

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No. 72,105EK . (HI-IMPACT PLASTIC) ..... $17.95 Ppd.

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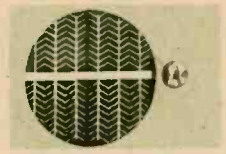

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CIRCLE 48 ON READER SERVICE COUPON

VIDEO SPORTS

Electronic action games are here —you play 'em on any TV set, competing against one

YOU HAVE PROBABLY SEEN VIDEO GAMES in taverns, stores, or hotel and motel lobbies where they are usually available for play at so much per game (25 and 50 cents are popular prices). Most people know that they are becoming popular for home use. And these are just the tip of the iceberg which is beginning to surface as more and more manufacturers prepare video games for the home consumer market.

The burgeoning video game market is being hailed by many in electronics as an explosion that is shaking up the entire industry. It is attracting droves of prospective purchasers to all kinds of stores where they can buy the new games, priced from $60 to $695. Some experts predict that from three to five million video games will be sold this year. The situation is not unlike the birth of the transistor radio and the advent of pocket calculators. Electronic video games are so hot an attraction that they bid fair to take the spotlight away from another burgeoning business, Citizens Band radio—CB.

Commercial, coin-operated versions of these games are attracting thousands of viewers in public places—bars, restaurants, airports—where they help many people while away the time. Video games are reviving TV as an entertainment source in taverns, just as early color sets did back in the Fifties. In fact, some video games are even being played on commercial airliners.

When It Began. Video games made their public debut in November 1973 on a Sunday night TV spectacular starring Frank Sinatra. The first game was Odyssey, made by Magnavox and priced at $99.95. Crude as it was—it required a green plastic screen taped over the picture tube—it was an immediate hit, pulling people by the thousands into retail stores to buy it. Today Odyssey is still available, but in three different versions and it no longer requires that plastic screen cover.

At press time more than 40 companies were tentatively in the video games business. I say "tentatively" for good reason. While they all had products to offer, not all of these products were approved for marketing by the Federal Communications Commission. Video games come under FCC supervision because they generate a television RF (radio frequency) signal that feeds into the TV set antenna terminals, just as do some video tape decks and video disc systems. If the level of the RF output is too high it may leak annoying interference to viewers whose TV sets are nearby. That's why games that exceed a certain output level radiation are disqualified by the FCC. In some cases the company can rectify the problem and come back with an improved game—one that will pass inspection and get approval. If not, they junk

to three opponents or the set itself. / by Fred Petras

the design because it is too costly to modify.

By the time this appears in print many of the games now awaiting approval will have type-approval by the FCC and will be in retail stores in your shopping area. At the moment, many of the games are pretty much alike, with a limited number of functions/activities. This is because about half of them use the same LSI chips, all made by General Instrument. However, the situation will change as manufacturers find other chip sources that permit them to make different types of games. Texas Instruments, MOS Technology and National Semiconductor are three such sources.

More Sophisticated Games. Not far over the horizon is a totally new crop of sophisticated video games that will use a microprocessor game chip. Such a chip can be programmed to perform innumerable functions. The microprocessor chip, in effect a mini-computer, will make possible the manufacture of highly complex second-generation video games, such as those now found in amusement arcades. The video games business will be one of rapid change, resulting in a flow of new games. There will be video games in variety not yet dreamed of.

What Games Are Available. The typical electronic video game can be played by one, two, or four players. In "Television Tennis" by Executive Games, you can play alone against the set, or with a partner, using one or two individual controls linked to the set by a six-foot cable. It sells for $69.95. On the screen of the TV set to which Television Tennis is attached you'll see a dotted line down the center and two solid horizontal lines, indicating the boundaries of the court. On each side of the screen are short moveable lines that represent the tennis racquets, and moving from one side of the court to the other is the tennis ball —a large dot. Manipulating the controls simulates the action of a tennis game. The players control the pace of action, with novices starting off playing slowly, and building up speed as they get the feel of the game and the movements involved.

Manufacturers' Offering. "Pong" is a somewhat higher-priced ($79.95) tennis game from Atari. It is much like the Executive game, but more elaborate. It has on-screen digital score-keeping, emits a "pong" sound when the racquet hits the ball, and shows the action and scoring in color. Up the line a bit is "Pong Doubles," basically Pong with two additional detachable controls so that four can play.

Atari utilizes the basic Pong game in Super Pong, a four-game unit that offers Pong, Super Pong (four-paddle tennis), Catch, and Solitaire (handball). Except for Solitaire, the games are played by two people. Super Pong sells for $89.95.

First Dimension Corp. offers the FD-3000W, a three-game unit priced at $130. The games are hockey, tennis and "play-the-robot," the latter described as "a challenging game for one or two players." The hockey and tennis games can be played by either two or four players. On-screen scoring is indicated by index bars that advance each time a player scores. The unit shows ball rebound from any side of the screen to increase action and excitement of play.

Allied Leisure in its "The Name Of The Game" priced at $99.95 offers six games—tennis, hockey, squash, handball, rifle, and target. Four persons can play.

"Adversary," a new game from National Semiconductor, priced at $99.95 offers a choice of three games: tennis, played on a green court; ice hockey on blue ice; handball, played on a brown court—on the TV screen, of course. In addition the players have a choice of three paddle sizes. The games provides seven modes of operation: three games for two players, three games for the player against himself, and one game with the player against the machine. A special feature allows "time out," during play without changing the score on the TV screen.

Better and Higher-Priced Games. Several other companies offer variations of the above, each with its own proprietary differences, most of which are minor. The most deluxe of this group is

e/e VIDEO SPORTS

Videomaster's "Olympic," an English-made unit offering seven games for one or two players at $199. One feature common to many of the games is that of solitary play, for the player who prefers to play alone or cannot find a playmate.

An off-beat electronic video game is a racing game, "Video Action IV by Universal Research. Two players race each other or one player races against the unit to sharpen his skill. Realistic sound effects simulate engine acceleration noise and crashes. Universal also offers a Video Action Game Table, combining the four games of the IV (tennis, hockey, robot, road race) in an octagonal-shaped table which can also be used for card-playing, backgammon and chess. Price, about $475.

Another company offering video games in card table form is Electronic Displays. Further, it also sells them in the form of home bars. Limited to tennis only, the table units come in round and octagonal shapes, in a variety of finishes and colors. Prices range from $495 to $695.

They Use Ray Guns! At press time, three companies had announced electronic video games that utilize ray-guns whose "bullets" are a ray of light: Unisonic, Lloyds and Phone-Mate. The Unisonic "Tournament 2000" at $129 offers hockey/soccer, squash/handball, tennis/table tennis, single-player practice on the foregoing, target shooting and skeet shooting. In target shooting, a small square target pops up and bounces around on the screen, staying put for just a moment. Plug in the pistol ray-gun, aim, and fire away. A special signal indicates a hit, and the score appears on the screen. In the skeet shooting mode the player "pulls" his targets via a manual serve control and the "birds" fly across the screen, ready to be downed. Scoring is automatic.

In Lloyds' "Sports 802," offering six sports, Target #1, skeet shooting, is a single, straight-line proposition. Target #2 is a random moving target, zig-zagging all over the screen. In this game an electronic rifle is used, attached by a cord to the player console. Digital scoring flashes on the TV screen. Price, $89.95.

Phone-Mate's "Zonk" is also a six-activity game, with two assigned for use with a "space ray gun": a target game (Space Age), and outerspace skeet shoot (Ray Play). It's price is $119.50.

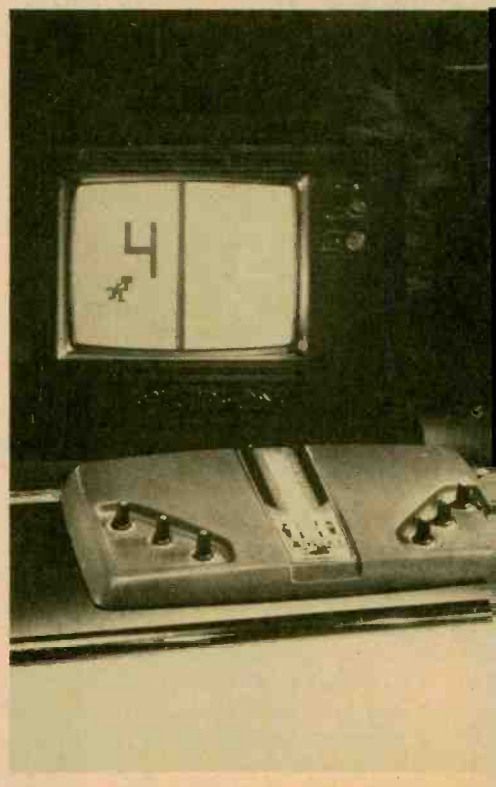
Not Just Games, Pointing what may be the way of the future for electronic video games are products from two companies, Universal Research Laboratories, and Fairchild Camera and Instrument. They utilize drop-in cartridges containing the program material, be it games or what-have-you.

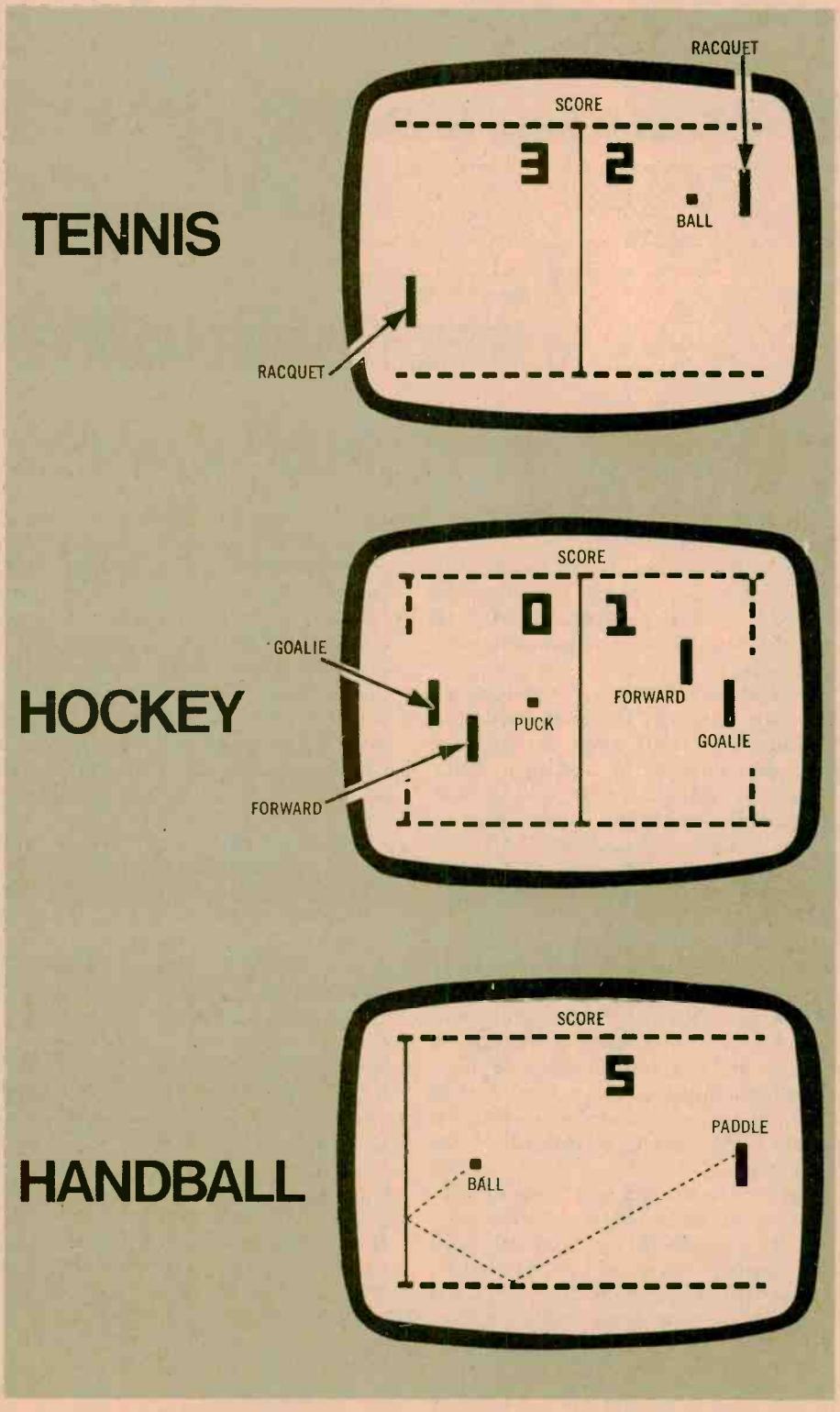
Universal's "Fact," described as "A computer for your home," might be called an "intellectual" game. It uses a series of multiple-choice game cartridges which permit two people to pit their knowledge against each other, or one person to play against the computer alone. Questions are displayed on the TV screen and players press numbered buttons for answer/responses.

But "Fact" can be more . . . Here's an excerpt from the game description: "FACT is more than just a game, however—cartridges for learning are available that will improve your child's reading, math, history or many other skills. Or how would you like to brush up on your flying, driving or any one of the hundreds of other categories that will be available? . . . It's not only fun to play, it can bring a new dimension to learning in the home." "Fact" will sell at approximately $400.

In Fairchild's "Video Home Entertainment System" you use game cartridges called "Videocart." These contain a semiconductor memory programmed to reproduce specific games, in full color, on the TV screen. Game selection is made through a keyboard console with mobile screen elements manipulated by means of dual controls that may be placed up to eight feet from the TV receiver. Initial game cartridges are Hockey and Tennis. On the way are Tic-Tac-Toe, Shooting Gallery, and a tracing ("Doodle") game. Fairchild plans to have a total of 17 games available by the end of 1976.

The Fairchild system allows a player to set a time limit on a game or select the speed of play that matches his skills. The game score and elapsed time are continuously displayed at the bottom of



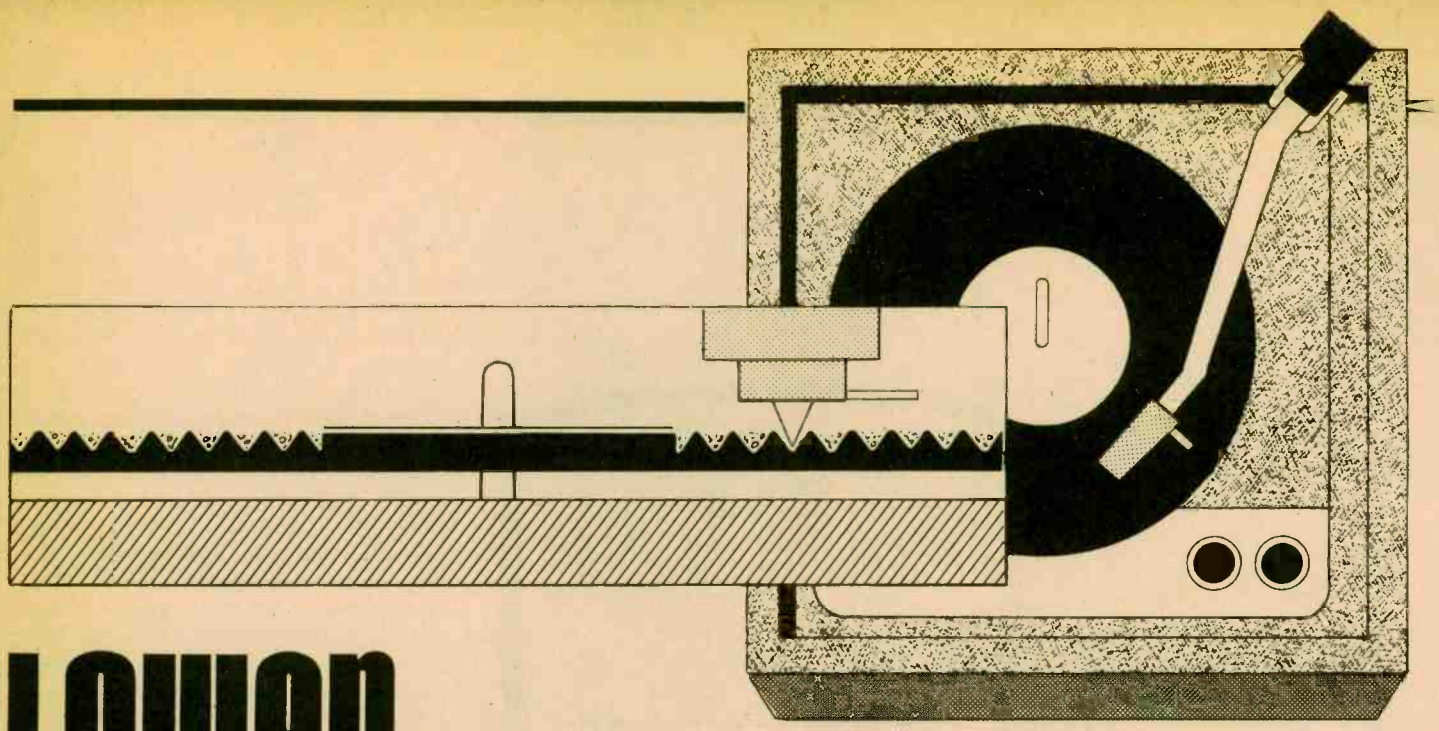


the TV screen. A freeze switch on the console permits interruption of play for any length of time; the game is resumed at the press of a button. Sound effects give the games added realism. At press time the price range was indicated as $100 to $150, with Videocart cartridges selling for $20. Heart of the Fairchild system is the game console, which incorporates a Fairchild F8 microprocessor and four solid-state random access memories. Microprocessors are the key to sophisticated video games and may actually become the foundation of the video games industry before long.

Few Discounts Right Now. At the present time, discounts on video games are hard to find. But as the initial demand is met and as more companies push their products into stores, the laws of supply/demand/competition will come into play, and you'll be able to pick up some games at true bargain prices.

Video games at prices markedly lower than those now in retail stores are a distinct possibility. The electronics industry is known for not sitting on its hands. It is constantly on the move, pushing ahead, moving from one-state-of-the-art area to the next in terms of technology. Texas Instruments for example, has reached a point in its production capability where it can reportedly offer to game manufacturers a chip priced at about $4, making a video game priced at $29.95 possible within a matter of a few months. So watch out—there's probably a video game lurking ahead in your future! ■

Typical video athletic games are shown on these TV screens. In each game the ball (or hockey puck) is the single (moving) dot. Vertical bars are moving paddles (or hockey stick) which the players(s) move about using manual levers. In handball court, ball bounces off the three walls. Goalies' sticks in hockey are positioned to guard goals. The numerals automatically change when points are made. Upper left photo shows a Fairchild game in progress; lower photo is Magnavox's Odyssey.



Lower that record noise

Five electronic systems you can use to reduce the noise of recording and playback in tape and disc systems.

By Fred Petras

IN JUST ONE YEAR the hi-fi industry will be celebrating the 100th anniversary of the phonograph. Originally designed as a home entertainment device, it was invented in 1877 by Thomas Edison. By its centennial, it is hoped that the industry will have attained a goal it has been aspiring to for the past 99 years—eliminating record noise.

Noise has also been the despair of the tape recorder. It has plagued that medium since 1903 when the first wire recorder, invented by Valdemar Poulsen, was manufactured. And it has plagued the magnetic recorder since its birth in Germany back in 1936, and in the United States since 1946 when Ampex produced the first domestic tape recorder.

As for radio broadcasting, noise has been a distraction ever since the early 1900s when crystal sets were the vogue.

Whatever the program source, noise is inimical to it. The hi-fi industry is well on the way to quelling noise in its many ramifications, to a level that it will no longer disturb or irritate the audio buff seeking perfect sound reproduction.

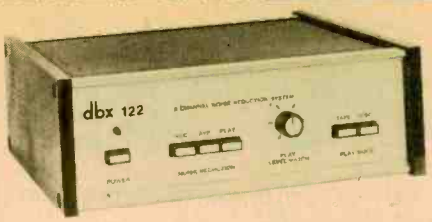
Several companies have come up with systems of noise reduction. Their systems and products offer from 10 to 30 dB of signal/noise ratio improvement—enough to rescue some recordings and radio broadcasts from limbo, enough to make others virtually noise-free.

Currently there are five popular methods of achieving noise reduction. Each is proprietary and each has its own "personality" and attributes. The five methods are in two basic types, called closed-end or double-end, and open-end or single-end. In the former, *professional* noise reduction equipment used in recording studios and sometimes radio stations to "encode" the program material. This is *one end* of the processing procedure. The *other end* is, in effect, the home listening environment in which "decoding" of the processed signal takes place via *consumer-type* noise reduction units before playback. The closed/double-end approach also embraces consumer-grade equipment available to the recordist to do both the encoding and decoding in his own home.

There are three proprietary systems within the closed/double-end approach. They are *Dolby, ANRS,* and *dbx*. Let's take a look at them. . . .

Dolby. The most widely known and popular noise reduction systems are those developed by Ray Dolby, head of Dolby Laboratories, Inc. One system, for professional use, called Dolby "A," is used in the recording of master tapes from which phono discs are developed. The other system, called Dolby "B," is for home use by tape recordists and for use by radio stations in broadcasting.

Because the equipment for Dolbyizing professional setups cost many thousands of dollars *per channel,* it was impractical to use it in home tape recorders at first. Henry Kloss, at that time the head of KLH, reasoned that it should be possible to simplify the Dolby A circuits enough to make the basic advantage of Dolby (reduction of tape hiss, mainly) available in consumer machines. Kloss flew to England to see



CIRCLE 54 ON READER SERVICE COUPON

DBX system increases dynamic range of any tape or disc recording system.

Ray Dolby, and in just three days they worked out the basics of what became the Dolby B system.

After selling KLH to the Singer Corporation Kloss founded the third successful high fidelity company in which he has been a principal, the Advent Corp. (The first was Acoustic Research, Inc., which introduced the acoustic suspension loudspeaker to revolutionize the loudspeaker industry in the early Fifties). He soon had Advent producing the first cassette recorders, using Dolby B as well as chromium dioxide tapes. Combining these two innovations Kloss was able to bring out the first high fidelity cassette deck, the Advent 200. Thus he pioneered the now nearly-universal use of these developments in cassette decks.

One of the best overall descriptions of how the Dolby B system works comes from Advent.

"The Dolby system is a two-step symmetrical process which operates at *both* the time the tape is recorded and when it is played back.

"The Dolby system goes into operation on quiet passages, based on the fact that in louder passages, the material being recorded effectively masks the noise that is added by the recording process. The signal being recorded is processed by the noise reduction unit *before* it reaches the tape deck. When the signal being recorded is sensed by the Dolby system circuitry as falling below a level threshold, the circuit boosts the higher frequencies of the signal. The amount of boost varies with the strength of the signal, ranging from no action at all on loud passages above the threshold, to as much as 10 dB boost on the very quiet passages. The signal is then recorded in this Dolbyized form, that is the quieter, high-frequency parts of the signal are louder than they originally were.

"During playback, the same circuit which boosted the signals before recording is turned around so that when the tape is played through it, the previously-boosted parts of the signal are *reduced* to their original level in a way which is a precise 'mirror image' of the original record Dolby system action. When the signals are reduced to their original strength by the playback action, tape hiss, which made its appearance *between* the two halves of the Dolby process, is automatically reduced at the same time. Because of the very precise mirror-image relationship of the two halves of the Dolby system process, the Dolby system causes no apparent change in the material being recorded.

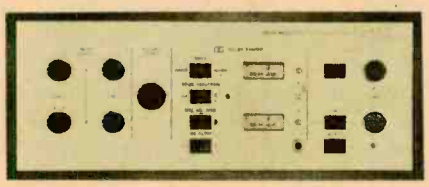
"The Dolby system has been designed to reduce the most annoying noise inherent in the tape recording process, that is 'tape hiss,' and therefore it operates on the middle and high-frequency portion of the audible spectrum. The maximum noise reduction occurs in precisely the region where the ear is acutely sensitive to hiss."

Noise reduction achieved by the Advent units is 3 dB at 600 Hz, 6 dB at 1,200 Hz, 9 dB at 2,400 Hz, and 10 dB at 4,000 Hz and above. Other companies making Dolby noise reduction units, such as Teac, claim approximately the same results.

The three closed/double-end systems offer a certain degree of "compatibility," i.e., the ability to play tapes made by the one method, via another. But, tapes cut in the one format will not offer flat response in playback through one or the other two systems; you'll have to juggle the tone controls for optimum results. The levels of noise suppression will also vary.

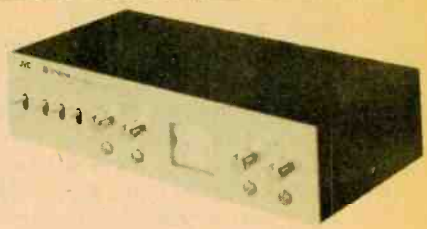
Dolby-processed tapes in addition to being playable on ANRS or dbx-equipped rigs, can also be played on "straight" equipment, but without noise reduction. For instance, if you play a Dolbyized tape on a friend's home deck or car player, the tape will sound somewhat "brighter" or "crisper." That sound may be more satisfying than a regularly recorded tape. However, if the highs are too bright for your taste, you can attenuate them with the tone control.

What about Dolbyized phonograph records? Compatibility is not a consideration. Discs developed from Dolbyized master tapes contain the *end result* of the de-noising process; the sound imbedded in the grooves is comparable to what you hear in playing a Dolbyized tape on a Dolbyized tape recorder. Perhaps you didn't know it, but most of the records you've bought for nearly a decade are from Dolbyized master recordings.



CIRCLE 52 ON READER SERVICE COUPON

Advent's 100A, one of the first, and still most elegant Dolby noise reducing units.



CIRCLE 53 ON READER SERVICE COUPON

JVC's ANRS works with any tape recorder to reduce hiss up to 10 dB at 5 kHz.

Over 100 FM stations are using Dolby in broadcasting. By increasing the signal/noise ratio of an FM broadcast by 10 dB, the stations are able to 'reach out" substantially farther for a greater listening audience. Listeners with non-Dolby tuners and receivers can receive such broadcasts; to many listeners there will be little if any apparent difference between them and regular broadcasts, except for brighter highs. However, listeners with Dolbyized tuners or receivers will hear Dolby broadcasts with a markedly better signal/noise ratio.

ANRS. The Automatic Noise Reduction System method developed by Japan Victor Co. (JVC in the United States) is basically similar to the Dolby approach. The company describes its system as follows:

"When two sounds occur at the same time and there is a large difference in intensity, only the louder sound will be heard. ANRS works using this principle. The sound signal is boosted before being recorded, whereas tape hiss is not. In playback the whole signal is reduced so that noise is a smaller part of the reproduced sound. Annoying noise is heard only in middle and high frequency range so frequencies below 500 Hz go straight through the system recording; higher-frequency low-level signals are boosted.

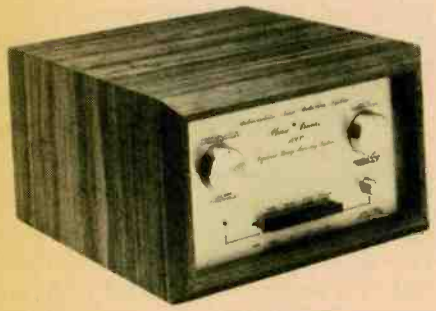
"In playback, frequencies below 500 Hz go straight through the system and higher frequency signals have their level reduced by exactly the same amount as that by which they were boosted. Because noise is a lower proportion of the recorded signal and the

whole signal is reduced, noise is played back at a much lower level than it would be if ANRS was not being used. ANRS is effective in those frequencies where tape hiss is heard."

JVC says that ANRS improves the signal/noise ratio by better than 5 dB at 1,000 Hz, and better than 10 dB at 5,000 to 10,000 Hz.

The ANRS system is used only on the home recording front at present.

dbx. The dbx closed/double-end noise reduction system uses compression/expansion principles to achieve noise reduction in records and tapes of up to 30 dB, and a broader dynamic range. This is accomplished by electronically compressing the recorded sig- called that simply because they work on one end of the sound system—the reproducing end. Unlike the closed/



CIRCLE 56 ON READER SERVICE COUPON

Newest, most sophisticated system—Phase Linear's Dynamic Range Recovery.

double-end models which can do nothing about removing *existing* noise from program materials they are to process, the open end units *can* do something about it. They can reduce the noise from existing discs or tapes, or radio broadcasts, by varying degrees, ranging to 14 dB in some cases.

The two most popular open/single-end noise reduction units currently in the marketplace are from Burwen and Phase Linear. The Burwen DNF 1201 "Dynamic Noise Filter" priced at $299.95 is an active low-pass filter which virtually eliminates noise from nal by a factor of 2:1 at the time the master disc (or tape) is cut, and expanding the signal by a complementary factor of 2:1 at the point of playback. The basic process is, of course, encoding/decoding.

The dbx process is being used commercially in the limited production of "super-discs" which, dbx claims, are totally free of surface and background noise. These records are available on the "Klavier" and "Creative World" labels. To play them you need a dbx decoder, available in a small choice of models.

In terms of equipment availabilities, the widest choice is in the Dolby format. Dolby consumer-type add-ons enabling a tape recordist to both encode (in recording) and decode (in playback) program material are available at prices ranging from $90 for stereo, to $400 for quadraphonic models. JVC has a single add-on for stereo use, priced at $149.95. In the dbx format, prices start at $179 for a stereo unit, and $379 for a double-duty quadraphonic/stereo unit. If you don't record; the equipment can be used for playback—decoding tapes and broadcasts. In the case of dbx, there is also a record/play/decode model for decoding dbx-encoded discs.

Dolby is additionally available as a built-in in dozens of cassette recorder decks, a handful of cartridge recorders, and a half dozen open reel decks.

There's More. The open-end or single-end noise reduction systems are all sources without encoding. By sensing the high frequency content of programmed material, the unit varies the bandwidth of a *dynamic noise filter* so as to accommodate program material while excluding unwanted high frequency noise. Through this technique, the DNF 1201 can achieve up to 14 dB of noise reduction. The device has no effect on rumble or low frequency noise below 500 Hz. The DNF 1201 has pushbuttons for optimizing the dynamic noise filter characteristics for various types of source material—Tape, Phono, Phono 78. The pushbuttons change the sensitivity of the bandwidth controller versus frequency and its attack time. The fastest attack time is achieved in the Tape position; the slowest is Phono 78. The slower attack times make the system less sensitive to the scratches, clicks, and pops of phonograph records.

Phase Linear's Model 1000 "Signal Processor" priced at $349 is a noise reduction system reflecting techniques used in the space program to improve spacecraft photo transmissions back to earth. It is extremely complex, perhaps more so than any of the other noise reducers. Essentially the device uses a series of electronic "gates" through which energy in correlated (music) or uncorrelated (noise) form passes—or does not pass. These one-octave gates are assigned a frequency range from 2,000 Hz up. The "autocorrelator" circuit of the Model 1000 "examines" the input signal so as to permit music and harmonics (correlated information) to

CIRCLE 55 ON READER SERVICE COUPON

Burwen model DNF 1201 noise filter reduces noise during playback.

be set apart from noise (uncorrelated information), allowing the music to pass through the various gates unaltered, but preventing the noise from going through. Up to 10 dB of noise suppression is achieved above 2,000 Hz. The Model 1000 also contains a dynamic filter which acts below 200 Hz to eliminate low frequency noise such as turntable rumble that occurs below a certain level.

The autocorrelator circuit used in the Phase Linear Model 1000 Signal Processor as well as the dynamic filter are also used in the firm's Model 4000 stereo preamplifier, priced at $599.

What They Will, and Won't Do. The five noise reduction systems described above are all quite worthwhile and bring about a substantial improvement in signal/noise ratios in reproducing music. But they have limitations. . . .

For example, the closed/double-end systems won't do anything for you in ridding an existing tape or disc recording, or radio broadcast, of noise. Encoding/decoding it via Dolby, ANRS or dbx will bring about no improvement. The three systems can only keep out further noise generated during the recording process—noise of the audio system's electronics or the recording tape, etc.

The closed/double-end systems work best in cassette tape recording, where they bring about a dramatic boost in the signal-to-noise ratio—enough to elevate the cassette from low-fi to hi-fi. Cartridge recordings can also be improved substantially, using any of the above noise reduction approaches. But reel recording offers little improvement potential for noise reduction. The low cost differential between Dolby in cassette form versus the high cost of Dolby in reel form is something to be weighed. In the case of reel equipment, the return from a Dolbyized deck is in inverse ratio to the investment.

The closed/single-end noise reducers can be a boon to audio buffs wanting to "clean up" existing tapes or discs, or radio broadcasts. As noted, they provide up to 14 dB improvement in signal/noise ratios. While this can be sub-

(Continued on page 99)

CIRCLE 75 ON
READER SERVICE COUPON

e/e checks out the...

TENNELEC MCP-1 PROGRAMMABLE LO/HI/VHF SCANNER

Scans any combination of up to 16 channels you select via pushbutton automatically. Remembers the ones you want, too.

☐ New technological advances nearly always require the sacrifice, at first, of one or another convenient feature previously available. And this is certainly true as regards receivers for monitoring the public safety frequencies. When VHF monitor receivers were tuneable (only), or tuneable with one or two crystal positions, the user could sweep (scan) each band to discover new, unknown stations or services. When we started using fully-crystal-controlled receivers, which eliminated station (dial) drift, we got the advantage of rock-stable, drift-free tuning, but now we had to know the exact frequency of every station we wanted to monitor. Then we usually had to wait several weeks for delivery of crystals for anything other than the local police and fire frequencies. In short, users traded off tuning flexibility for ease of frequency selection and tuning stability.

Scanner Features. But now, using modern solid-state frequency synthesis, you can have the advantages of crystal control as well as continuous tuning. All you need is Tennelec's MCP-1 Programmable Scanner—actually a minicomputer attched to a LO/HI/UHF receiver.

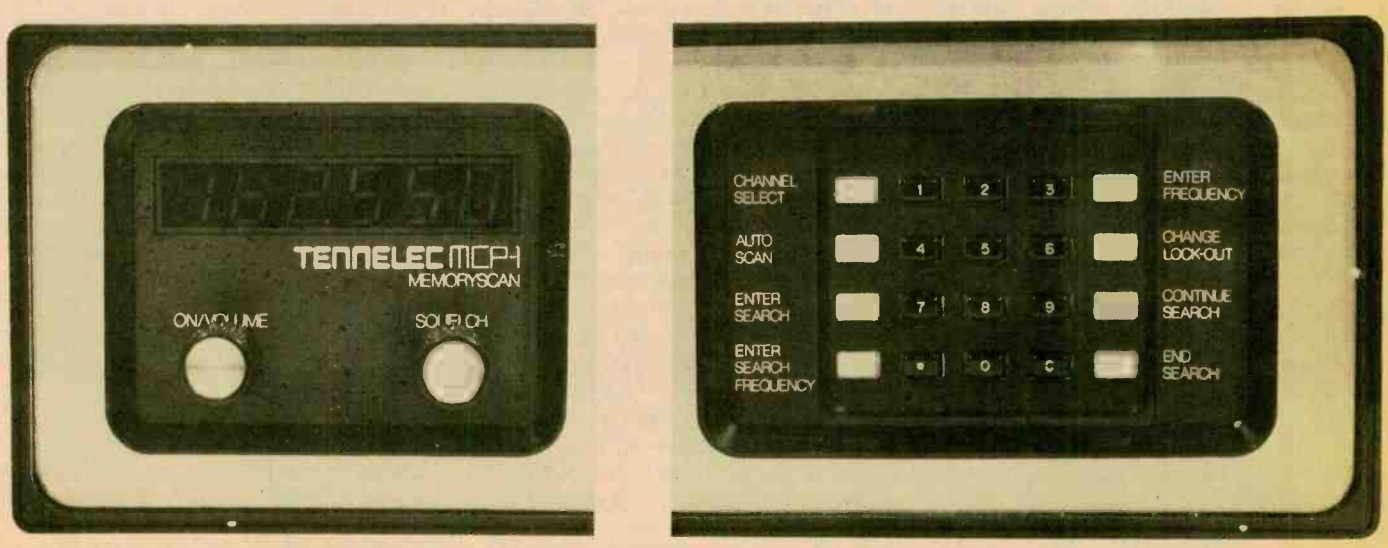
It's difficult to describe the MCP-1 because there's so much, so take a look at the photographs to familiarize yourself with the controls and then we'll discuss its frequency selection.

The MCP-1 has *Volume* and *Squelch* controls, a blackout panel that becomes a digital readout during operation, a set of ten pushbuttons labled 0 to 9, *C* (for *clear* digital display), along with eight operating (function) pushbutton selectors.

The digital display serves as the frequency readout and also as a channel indicator. The MCP-1 has 16 storage memories (channels) which are indicated as 00 to 15 on the display. Whenever the storage memory (channel) number is indicated (at the left) the number 1 or 0 is also displayed (at the right) to indicate that the memory is *on* (1), for scanning, or locked *out* (0), for exclusion from scanning. The display automatically switches about once each second, displaying the selected memory, and the frequency which is in that memory (channel).

How To Select Stations. To tune in a station, such as the weather service on 162.550 MHz, you press the *Channel Select* button until the display indicates the memory (channel) you want reserved for the weather service. Then you press the C (clear) button and punch up 162.550. If you make a mistake you simply clear the entry by pressing the C button again. When you have the correct frequency shown on the display you press the *Enter Frequency* button and 162.550 is stored in the selected channel. Each of the 16 channels can be programmed in a similar manner. That is, up to 16 frequencies can be stored at one time.

The three ranges the scanner works in are 33.1-45 MHz, 151.180-163 MHz, and 453-460 MHz. Whenever any frequency in these ranges is punched in it is programmed into memory (or the search started, according to the func-



Large clear digital readout at left shows the frequency punched in on the number buttons on the right panel. The desired function, including Enter, Search, Scan, and Manual are also entered by punching the appropriate control button on the right-hand panel.

tion which has been selected). If a frequency outside these ranges, such as the amateur frequency 146.850, is punched in, the display may read it (or it may read garbage), but the number won't go into memory, nor will it initiate scanning at that (improper) frequency. When a frequency in one of the three ranges is selected the correct front end is automatically selected.

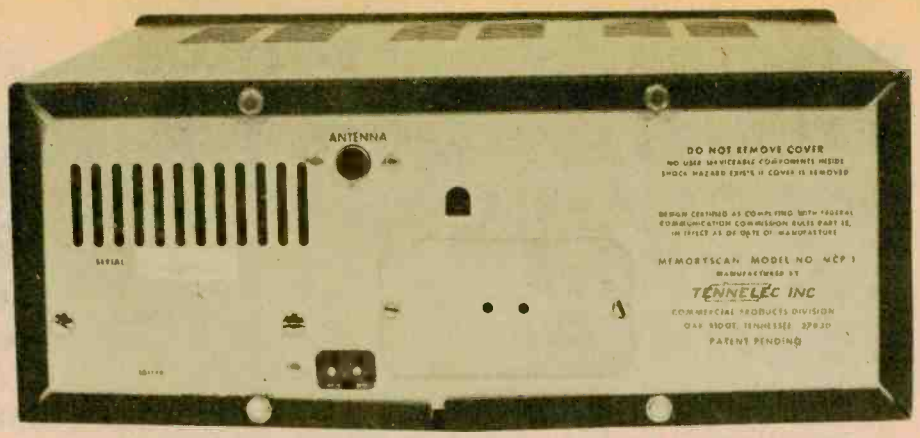
The MCP-1 can be programmed to scan any combination of, or all of the programmed channels. To change the frequency entered in a channel you simply punch up the new frequency and press the *enter frequency* button.

Okay. We've totally eliminated the need for crystals. But what about stations of unknown frequency? This is where the MCP-runs rings around most other scanners. This receiver will automatically search out stations within any desired 1.2 MHz segment of its entire frequency range, tuning in 5 kHz segments, to match the 5 kHz spacing used for public safety and service stations. For example, assume you know there is a police frequency somewhere around 155 MHz, but you don't know the exact frequency.

Digital readout combined with pushbutton synthesis of desired frequencies, plus memory make scanner nearly the utimate.

All you need do is select an unused memory (or a programmed memory but the previously-programmed frequency will be erased) and punch in 154.900 MHz. Then press the button labled *Enter Search*. The scanner will start scanning upward from 154.900 MHz in 256 consecutive 5 kHz steps. When it finds a station it will lock onto the frequency as long as the station stays on the air, or as long as the squelch is released. If this is the station you want you simply press the *Enter Search Frequency* or *End Search* pushbutton—they both do the same thing. This enters that frequency in memory and returns the receiver to the manual mode.

If you find this is not the station you want just press the *Continue Search* button to resume scanning. Since VHF stations don't transmit continuously, the way broadcasting stations do, your first search might not find the station you want, but the search will continue over the same 1.2 MHz until it finds and locks onto a station, If you enter a Start Search frequency which is less than 1.2 MHz below the top of any band the start frequency is automatically shifted to 1.2 MHz below the top of the band. A procedure is also described in the instruction manual for scanning a complete band.



Large clear readout at left shows frequency punched in on bottons at right. Functions Enter, Scan, Search, Manual are also punched up on right.

That's how it works. You, the user, can program any frequency via memory, select the frequency manually, scan up to 16 channels in any combination of bands in any frequency order you want, or search out the frequencies of unknown stations.

Sky Hooks. Though the MCP-1 tunes three bands there is only one antenna input. A short VHF whip is supplied with the unit, but the manufacturer recommends that a VHF outdoor antenna be used if a more sensitive antenna is needed.

How It Works. Like many other pieces of modern radio equipment, the MCP-1 uses a phase-locked loop, programmable, digital frequency synthesizer for local oscillator control in three front ends. But instead of providing a fixed digital code through a frequency selector knob, or requiring you to punch in a long digital code, or prepare a digital code from extensive calculation, Tennelec uses a microprocessor to convert the pushbutton frequency entry into the required digital code and front end-selector-control code. You need no formulas or charts to program the frequency synthesizer—just the tip of your finger.

The one drawback of this method of frequency selection and storage, is that the memory banks are *volatile*—they're *non-permanent;* easily erased. When the volume control switch is turned off power is still applied to the memory circuits. Should there be a power interruption or a brown-out there may be a loss of the frequencies stored in the memories. For this reason you should keep a record showing the frequency stored in each memory channel.

Unlike many other scanners which step rather slowly from channel to channel, the MCP-1 scans 10 channels per second. We have found that where a service uses two separate frequencies for transmitting—one for base and one for mobile—the MCP-1 can track both sides of the conversation with 100% copy, if only those two frequencies are programmed.

The Tennelec MCP-1 is line powered (115 VAC) and draws 35 watts continuous to power the memory. It draws 50 watts when the complete receiver is on. Overall dimensions are 10¾-in. wide x 4½-in. high x 9¾-in. deep. Its weight is 6.5 lbs. The unit, supplied with plugin line cord and whip antenna is priced at $399.95.

Summing Up. Though it's expensive, theMCP-1 is just about the ultimate in scanning monitors. Everything worked perfectly. The relatively small speaker (typical of communications receivers) nevertheless produces sound which is crisp and clean. As would be expected of any receiver, its maximum sensitivity (0.5 uV) is not maintained across the entire range from 451.180 to 471.655 MHz. Any 7-MHz segment within that range can be adjusted for that sensitivity, however.

Overall, the performance is most impressive and you should try one at a Tennelec dealer just to see how it works, even if you're not presently in the market for something this sophisticated. At the very least you'll find out what dreams are made of.

For additional information circle No. 75 on the Reader Service coupon. ■

An Ounce Of CB Prevention Will Save Your Rig

by Richard E. Hudson

☐ Along with the increase of CB's popularity is an alarming increase of CB theft. They're being stolen and sold all over the United States and it's hard to tell which is being done the most.

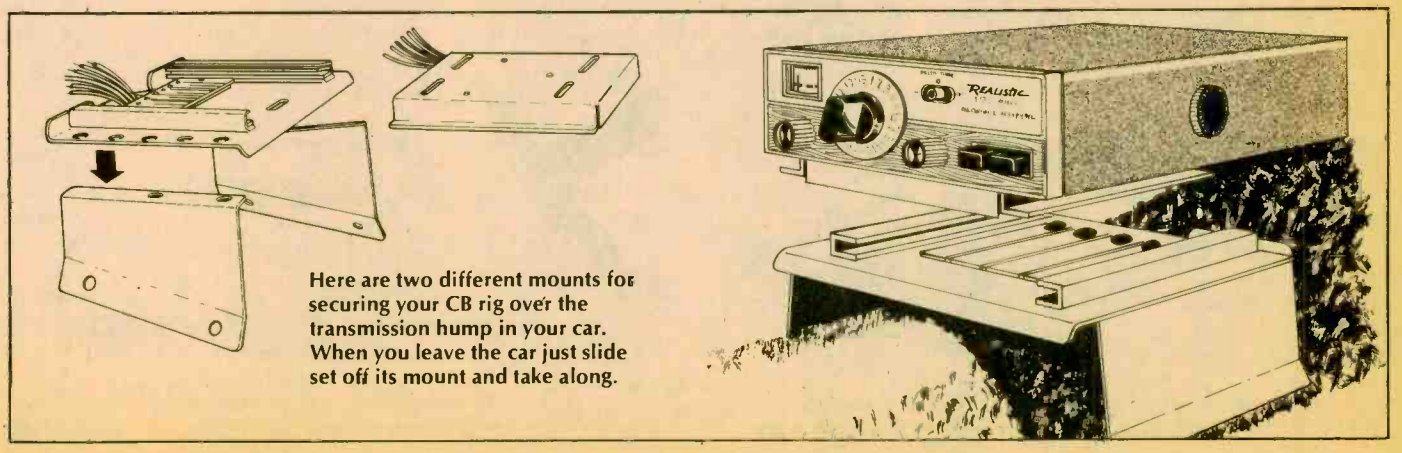
I've heard of cases where CB radios have been stolen, resold, stolen and resold again and again, almost like a chain-letter! Anything as popular as CB is to the average honest citizen is just as popular, to the average thief. There was a time when car thievery was a nighttime practice confined mainly to backstreets, alleys, and houses in rich neighborhoods whose occupants were away, and thieves back then were a frowned-upon minority. But now thieves are bolder and there seem to be more of them, at least, when it comes to CB.

Last year, from Nov. 1 through the 17th, Toledo, Ohio police received theft reports on 258 stolen CB radios valued at $54,000. Based on this they predicted a loss of more than $100,000 worth of CB equipment for that month alone.

CB theft is also a statewide problem in Nebraska, according to a survey recently conducted by their Crime Commission covering October and November of last year. They reported 511 radios stolen in October and 428 in November for a total loss estimated at $164,000. The survey reported that radios were taken from 882 vehicles, with 64% of them forcibly entered. That means that damage was done to 2/3 of the autos while the thieves were doing their work. And that really runs into big money for repairs.

In Ft. Worth area, police report CB theft their greatest headache, with something like 400 stolen rigs a month. They say that it has tapered off a bit in recent months, but they don't expect this to last long.

One truck driver went so far as to call it a fad that even honest people are getting caught up in. He based this



Here are two different mounts for securing your CB rig over the transmission hump in your car. When you leave the car just slide set off its mount and take along.

e/e PREVENT CB THEFT

claim on the fact that he had been approached on several occasions within the past year by friends-of-friends offering to sell him his choice of CB equipment at flagrantly cheap prices. And he went on to say that many of his trucker friends were losing one and two radios a year because of theft. He cited one of his buddies who had two radios stolen within a month, both while his truck was being serviced, with the engine running! He termed the CB theft situation so bad that, "it's become a national disgrace."

You can see CB theft is not an isolated problem. It's all over, and running rampant.

Regardless of this, most of the CBers I've talked to who have lost CBs to thieves don't plan to give up. They have already or plan to replace that stolen unit because it's a valuable piece of equipment to have on those long trips, out fishing or hunting, even for personal around-town emergencies, like unexpected car trouble.

Thus CB theft has generated a market for a number of anti-theft devices. Some are pretty ingenious, but only a few are really effective as permanent deterrents.

Auto Alarms. Among these devices is a sensitive electronic auto alarm you can install in about 15 minutes. It not only goes off when your radio is tampered with, but you can wire it so that it sounds off should anybody decide to include your antenna as part of the loot. You can buy a good auto alarm from most consumer electronics stores. Radio Shack offers an excellent alarm that'll work on any standard 12-volt negative ground vehicle, for $34.95.

Another ingenious device consists of a small CO_2 bottle that lets off a dense cloud of tear gas the second a thief tries to man-handle your radio. Check your local CB stores first. If they don't have it, you can mail order it from Miltronics, Inc., 12015 Manchester, St. Louis, MO 63131. A one-bottle kit with instructions and mounting hardware costs $7.95, plus an extra 85¢ to cover mailing cost. You can get a two-bottle kit for $14.

Locking Brackets. There are the various locking devices that strap to your radio and bolt to the floor or under your dash. Most are made of heavy, black-finished steel with a tamper-proof lock furnished with two keys.

These make it easy to remove your radio and carry it with you—by far the best protection when you plan to be absent from your car for any length of time. And because it takes a thief more time to crack one of these beefed-up contraptions, they're less apt to make off with your radio the few minutes it takes you to run in and out of a store. Thus you don't have the inconvenience of removing the radio everytime you park.

One disadvantage here is that the experienced thief often comes prepared with a crowbar or other "big stick" instrument to use on super-strong mounting devices. That, plus trying to remove the CB radio in the shortest possible time, will guarantee you a damaged car or radio, or both. There's always the possibility, too, of returning to your car to find a mangled radio, still strapped securely in place!

But, if you think this type of mount will suit you perfectly, then plan on spending from $14 to $40 for one. Most are available at your local CB store.

The Best Answer. Even better than the massive, lockable radio set brackets are the (cheaper) floor and under-dash mounting devices designed to make it easy to remove and reinstall your CB rig, either for use in another vehicle, or for safekeeping. These provide slip-in, slide-out convenience without any buttons, knobs, keys, or levers, and they're extremely easy to use. However, since they have no keys, you must always remember to remove them. If you happen to forget and leave a set in your parked car in one of these brackets, you can just kiss your set goodbye. And the thief will love you for it, because it makes his job so easy.

Police everywhere recommend these mounting devices above all others. The reason is that they allow you to remove your radio quickly for locking in the trunk when the car is parked. They reason that it's better to lose a radio than to have your car sustain several hundred dollars worth of damage as well. If you can make it easier for the thief, at least your loss will be confined to the value of the CB radio—you'll be spared a car-repair bill.

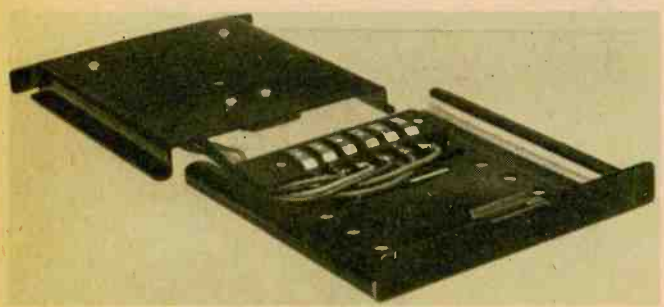
There are many mounting devices like these and they sell for $4 to $10 at most CB stores. In Ft. Worth the two most popular slide mounts are sold by Radio Shack stores. The reason for their popularity is due to their sturdy design, the ease with which you can install and operate them, and their reasonable price. Each sells for $7.95.

Radio Shack's under-dash mount no. 270-016 consists of only two parts—a female section which attaches to the radio cabinet and a male section which attaches permanently under the dash. You simply slide the female section, with the CB set, onto the male section to secure it. Then when you leave your parked car, just slide the radio off the male mount and place it in the trunk of your car for safekeeping while you're away.

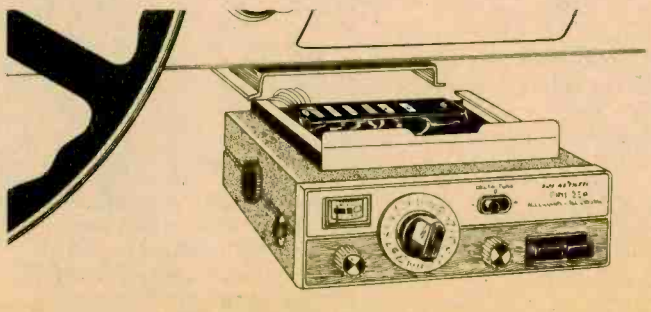
Radio Shack's floor mount no. 270-018 operates the same as the under-dash mount, except that it has two additional plates which allow mounting on the transmitter shaft hump in the floor of your car. It's ideal where under-dash space is limited.

A Safe Antenna Mounting. Keeping your antenna is yet another problem. However, it's one that's not neglected by the manufacturers. Of the many devices they've turned out, by far the best I've seen for the price is the "Flip-Flop" antenna mount. For $11.95, plus

(Continued on page 101)

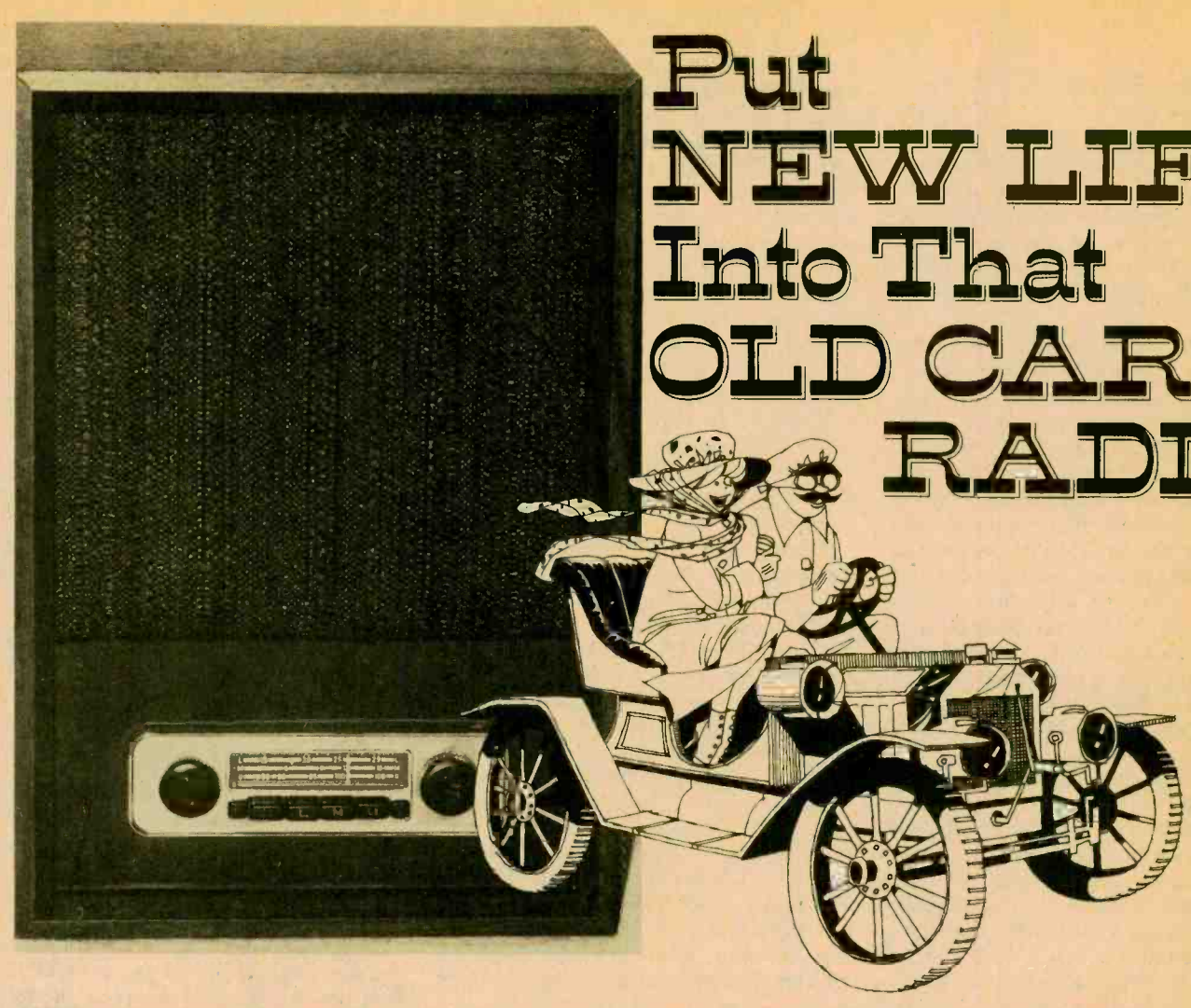


Radio Shack's convenient slide mount comes in two pieces
Upper (left) unit secures under car dash with three or four screws.



CB transceiver is secured to lower
slide-in bracket with several screws. Antenna plugs in to rear panel.

Put NEW LIFE Into That OLD CAR RADIO



With a loudspeaker and a simple power supply your old car radio will become a high-quality home receiver. Good for DXing, too.

by Gary McClellan

☐ For years now Americans have bought 10 million or so new cars every year, and most of those cars have radios in them when new. As a result millions of used cars are sold by their original owners each year. Now the price a car dealer will pay, or allow you on a used car is a combination of the so-called "book" value, which he gets from a little blue book, and of the bargaining. He doesn't care whether your used car has a radio or not, and many people, knowing this, take out the car radio before trading in the old bus on a new one. The result is that there are hundreds of thousands of used car radios lying around in garages, attics and cellar storehouses, waiting to be thrown out some year in the annual spring cleaning.

Most of these radios are perfectly good, but won't be used because it's usually too much trouble to install them in a car other than the one they were originally set up for.

But there's no reason such sets can't be put to work as house radios, especially since they will almost always work better than most table model radios, and even most console sets you can buy today. Their tone is as good or better than most home sets—obviously we're not comparing them with high fidelity component sets, which cost many times more than regular table or console radios. Their selectivity and sensitivity is also better than that of most home sets because they have an RF (radio frequency) amplifier stage ahead of the converter stage, and most home sets don't bother with an RF amplifier stage which car sets need.

Going for AM DX? DX fans can have a ball with converted car radios. The sensitivity and selectivity of most car sets, when combined with a good outside antenna can get you AM stations from all over the country. Here in California I've been able to get stations like KOMA, Oklahoma City, WLS Chicago, and many others regularly, at night. For more on AM DXing see ELEMENTARY ELECTRONICS Sept./Oct. 1976 "The Secrets of Split-Frequency DX." White's Radio Log, regularly published in our sister publication, COMMUNICATIONS WORLD, is an excellent source of info on the super DXing you can do on AM radio.

Car Radios Are Better. The typical car radio was built to perform in one of the toughest environments—your car. The set has to work with a ridiculously small antenna, and yet get distant stations. It also must have enough volume to overcome road noise and tone quality to offset the shortcomings of the small, poorly baffled speakers found in most cars. And to top it off, the car radio must perform well over a wide temperature range.

Conversion is easy and inexpensive.

All you have to do is add a power supply, antenna, and a good speaker to a car set and you are in business! So if you have an old car radio, or know where you can get one, don't pass it up. You won't know how good radio can be until you convert a car set to home use.

First Get Your Radio. What car radios are best for conversion? Just about any old car radio can be converted to home use, provided it's a *transistor set*. Tube sets will be too old, and more important to us, they use much too much current (to heat up the tube filaments) to be practical for conversion to home use.

You can use an AM-only set, or an FM/AM set. If it's a really recent car radio it may be one which has a four- or eight-track tape player built in, and with a stereo radio section. If it has a tape player you'll have to use a heavier power supply than if it's just a radio receiver, but that's the only other restrictions (besides no tube sets).

Of course the car radio should be a 12-volt unit. 6-volt car radios haven't been made for quite a while, though it's possible you might happen across one. And don't convert one of those fancy car radios which has "signal seeking" (sometimes called "Wonder Bar," because you just touch a little bar to activate it). These sets have a motor inside the set to drive the tuning mechanism and the tuning dial. The motor draws several amperes of current, and would require a heavy power supply costing much too much. In addition, these automatic-tuning units are likely to get out of whack, and they're not easy to repair. In fact many car radios have been consigned to the junk box just because the auto tune failed and it was too expensive to repair.

And another thing. Try to use a radio which has all its knobs and the dial plate. It'll save you the trouble of scrounging around to find matching knobs and a dial escutcheon plate later. However, if you happen to already have a good car radio—for example, one with separate bass and treble tone controls, don't let the absence of knobs hold you back. They *are* available at some specialized stores. And you *can* make up a new escutcheon plate from a piece of scrap aluminum.

Check It Out First. Before you convert the car radio to home operation, be sure it's working OK, or is worth repairing. To do this make up an antenna as shown in the diagram, and connect it and a speaker (just about any speaker will do) and a power supply to the radio as shown.

Hook up a 12-volt battery or battery eliminator to the radio, being careful to hook the positive (red) side, usually marked +, to the "hot" lead of the radio. The negative (ground, or common) nearly always goes to the case of the radio. Check the markings first to be sure.

Adjust the antenna trimmer capacitor to get maximum sensitivity. This is done by setting the tuning dial to a weak station around the high end of the dial (1400 kHz is ideal) and adjusting trimmer C2 for maximum volume. The setting of C2 will be different when you connect the final antenna to the set, later. Measure the current drawn by the radio. Most solid state sets draw ½ amp or less—if its draws much more than this we suggest you use a commercial power supply such as those made for CB radios and tape players. The Radio Shack 22-127 power supply will work fine in most cases. Make sure that the radio works properly. Clean it off and wipe the dial glass clean. Spray the volume/tone controls with a good control cleaner, and remove the dial lamp. This will save power and allow the power supply to run cooler.

Making the Conversion. Start by building the power supply shown unless you buy one. If you use the commercial power pack mentioned, skip this section. I built my supply on a 4-in. x 3½-in. piece of U-shaped aluminum. The components, with the exception of transformer T1 are all mounted on the sides of the "U", which are about 1½-in. high. You can build yours in the same way, or mount the parts in a commercial chassis instead. Or you can mount the power supply on the top or back of the radio. But just be sure if you do this that you can install the radio in a cabinet. Install the components and wire them up, being careful of the connections of IC1, a voltage regulator. The case is ground so you don't have to isolate the case from the chassis. When you complete the component wiring, add leads at least three feet long so that the power supply may be easily attached to the radio.

You have an option at this point as to how you connect the AC power switch. You may use a separate unit as I did with the second radio shown, or open up the set and use the existing switch. If you choose this method, be sure to carefully remove the existing wires and solder them together. Then connect the AC wires from the power supply. Connect up the ground and 12-volt positive wires to complete the job. Check the radio out again with speaker and antenna. If all's well, install the radio.

Selecting a Loudspeaker. You can generally use any of a wide variety of loudspeakers with a car radio. The smaller speakers supplied with car sets are four or five inches in diameter, while the better ones, which usually have much better tone, are oval-shaped units either 4-in. x 6-in., or 6-in. x 9-in.

You can use one of these, if the impedance is correct, or you can go to a small high fidelity speaker for even better tone. First you should carefully examine the radio to see if it uses a special-impedance speaker. For many years most car sets used 3.2-ohm speakers. This is the nominal value if there

Car radios may be converted for home use using any convenient enclosure, a simple power supply, and a better loudspeaker, as shown at the right.

is no special indication. Many of today's sets use higher impedances, however, such as 10, 20, or even 40 ohms. If the set you're converting is so marked, you can use one of the Radio Shack multi-impedance speakers listed in the Parts List. If it's not specially marked, use any speaker of 3.2, 4, or 8 ohms. Choose the largest speaker, with the heaviest magnet (and costing the most, generally) for the best tone.

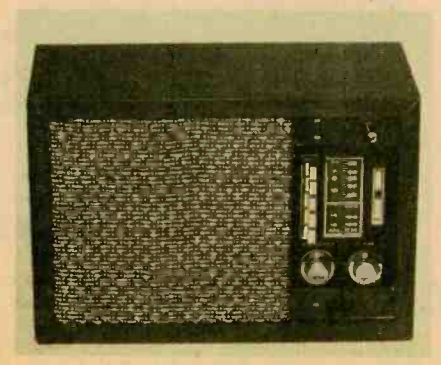
Installation. This is where you get to exercise your creative talents. There are many different places you can mount your converted car radio. You can go my route and install it in a speaker cabinet. This worked great because reject cabinets were available from a local speaker company for $1.00 each. I installed both radios in reject cabinets. I bought speakers to match the cut-outs (8 inches in both cases). Then I added grille cloth to cover the speaker area and installed it. If you do this you will find the going very easy as most of the work has been done for you by the cabinet manufacturer.

Some other places you can put your radio are in a room divider or end table. Or how about the wall in your kitchen? What about under a shelf in a cabinet? The choice is up to you. If you have room for the radio only, you can locate the speaker somewhere else.

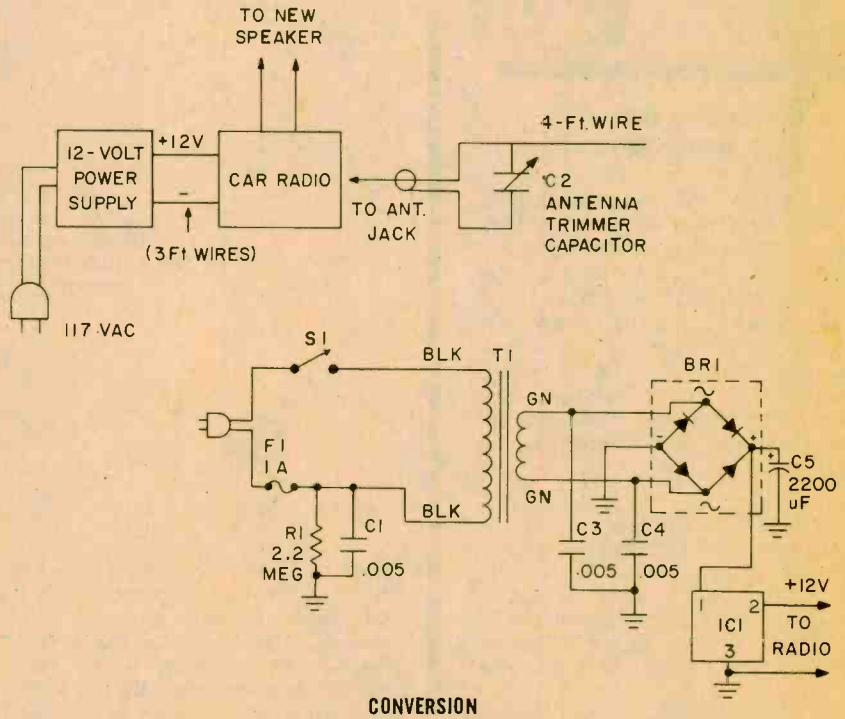
Operation. After you have installed the radio, power supply, and speaker, connect the antenna. Place C2 in a convenient spot where you can get at it. Then turn on the radio and tune in a weak station around 1400 KHz on the dial. Adjust C2 for maximum volume. The antenna lead may be stapled around the back of the cabinet. If you've converted an AM/FM set you might wind several turns of the antenna around the AC cord for better reception. The lead may also have to be carefully positioned for best results on FM. This was necessary for the two radios that are seen here. That's all there's to it! Sit back and enjoy your new radio. You'll be amazed at the performance; it will far outstrip the radio receivers you buy in the drugstores, and the AM sections of all but the best stereo sets, too!

If You Don't Have A Car Radio. If you don't have one, a good place to get car radios is from junk yards and used car dealers. Better yet, check out flea markets, garage sales, and other similar places. You'll generally be able to bargain and get a set for a lower price from the former sources. You shouldn't have to pay over $10.00 for a set. You might get a radio that needs repairs and cut the price even farther. I bought several broken radios for fifty cents each, fixed them, converted them and gave them away as gifts! ■

Another loudspeaker cabinet (cost: $1.00!) houses this converted car radio. Sounds great!



Out of a VW and into a reject speaker cabinet goes this car radio. AM, FM, and short-wave.



CONVERSION PARTS LIST FOR CAR RADIO

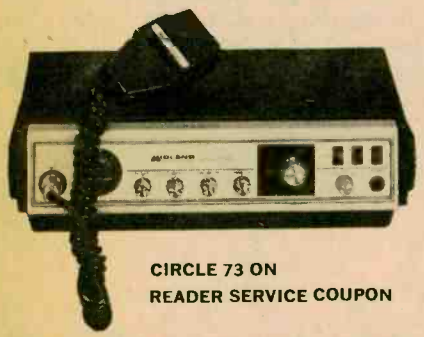
BR1—6-ampere, 50-volts AC or better bridge rectifier (Radio Shack 276-1146 or equiv.)
C1, 3, 4—0.005-uF, 600-volts or better capacitor (Radio Shack 272-130 or equiv.)
C2—365-500-pF (maximum) trimmer capacitor (Radio Shack 272-1431 or equiv.)
C5—2200-uF, 35-VDC or better electrclytic capacitor (Radio Shack 272-1020 or equiv.)
F1—1-ampere fuse (Radio Shack 270-739 or equiv.)
IC1—Voltage regulator chip (Radio Shack 276-022 or equiv.)
R1—2,200,000-ohm ½-watt resistor (Radio Shack 271-000 or equiv.)
S1—SPST switch (Radio Shack 275-611 or equiv.)
T1—Power transformer, 117 VAC primary, 12.6-volt, 1.2-amp (Radio Shack 273-1505 or equiv.)
Loudspeakers—Oval car speakers, 4-in. x 6-in. or 6-in. x 9-in. multi-impedance units, 10, 20, 40 ohms, if required—see text (Radio Shack 401-222, or 40-1336 or equiv.)
Misc.—Fuse holder (Radio Shack 270-739 or equiv.), AC line cord and plug, car radio antenna plug obtainable at radio parts suppliers).

CB NEW PRODUCTS

e/e puts together in one neat package some of the newest CB rigs, antennas and accessories for you to use in CB contacts this year!

Low Priced SSB/AM Base

Midland has a new full-power, all-channel, single sideband/AM base station. The 13-976 base station operates on all 23 AM channels, as well as on all upper and lower sidebands. The transceiver puts out 4 watts on AM, or 12 watts P.E.P. on single sideband. Though it is the lowest-priced single sideband base station in the Midland line, this sleek, low-profile unit includes such features as RF gain control, switchable noise



CIRCLE 73 ON READER SERVICE COUPON

blanker, and hi/lo tone switch. In addition, there are clarifier and squelch controls, a large, lighted instrument-style signal-power meter, and a PA switch. The 13-976 can be operated on either 115-volt AC or 12-volt negative ground DC. It comes complete with a push-to-talk microphone with coiled cord, AC and DC power cords, and an owner's manual. Price is $387.95. For more information, write to Midland Communications Division, P.O. Box 19032, Kansas City, MO 64141.

TV Filters

If you've ever had a neighbor "get on your back" because your transmitting interfered with his TV reception, you'll be glad to know about these two new Avanti filters. If the problem is caused by the transceiver radiating harmonics of the same frequency

CIRCLE 66 ON READER SERVICE COUPON

as those assigned to a TV channel, installation of the Low-Pass TV interference Filter on the transceiver should clear up the problem. If the problem is with the TV receiver, due to front-end overloading, installing the Avanti 27 MHz CB Signal Rejection Filter on the TV set lead-in should do the job. The Low-Pass TV interference Filter (AV-800) sells for $24.95. For more information, write to Avanti, 340 Stewart Ave., Addison, IL 60101.

Two New CB Antennas

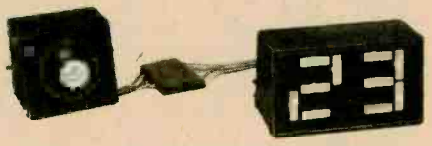
Anixter-Mark has two new CB antennas. The **Champ** ($20.50) is the first CB antenna designed not to look like a CB antenna. It's top-loaded with the loading coil wound on a high quality fiberglass whip, which is attached to a heavy chrome-plated metal mast and sturdy spring. It is designed for easy installation. The mount and cable pig-tail Install on the trunk lip simply by tightening two set screws. The **Champ** is ready for new

CIRCLE 68 ON READER SERVICE COUPON

channels as they are released. Maximum height: 54 inches. Tuning range: 26.9—27.5 MHz, which is enough range for 50 plus channels. In addition to the **Champ**, Anixter-Mark is also introducing a new Tunable Stainless Steel Antenna, ($14.50), which is base loaded and can easily be adjusted to cover all present channels. A simple turn of the frequency adjustment screw brings in clearly the channel you want. It is also capable of tuning in all new channels as they become available. It has a long lasting stainless steel whip and deluxe mount with coaxial cable, and mounts easily to any trunk lip with no drilling needed. Maximum height: 60 inches. Tuning range: 26.9—27.5 MHz. Get all the facts direct from the maker by writing to Anixter Bros., Inc., 4711 Golf Road, Skokie, IL 60076.

CB Billboard

A new accessory for mobile CB operators, featuring a digital display for twenty-three CB channel numbers, makes CB monitoring much more fun. The CB Billboard Channel Advertiser indicates the selected channel in bright, 2-in. digital-type numerals which are visible both day and night. By advertising the channel in this way, the mobile CB operator invites contact from other CBers on the road, thus increasing his enjoyment of



CIRCLE 70 ON READER SERVICE COUPON

CB radio. It is especially practical when regular channels are overcrowded. The Billboard package comes complete with display box, flat-lying cable, connector, control box, mounting brackets, mounting hardware, and installation instructions. The number display mounts easily in the back window or any visible location. The control box, installed next to the CB radio, turns the Billboard on or off, and selects the channel number to be displayed. The Billboard is powered by 12 VDC from any car or truck. The Billboard sells for $39.95. The unit is available at CB retail outlets, or write Controls/Inc., Box 522, Consumer Sales, Dept. 17, Logansport, IN 46947.

CB Converter

Mount the **Roadmate** under your dashboard, plug the car's CB antenna into the unit and the unit's antenna connector into the car radio; then, hook up the unit to your 12-volt car battery, and you're all set to use your car radio as a CB monitor. The radio's tuning dial lets you select any of the 23 channels that CBers use. You'll hear all the traffic conditions, the smokey reports, and

CIRCLE 72 ON READER SERVICE COUPON

the road and driving information that truckers exchange over the air. A simple flick of the switch, and your car radio becomes its self again, bringing you the news and music that you are accustomed to hearing. The **Roadmate** fits unobtrusively under the dashboard. The EICO CBC-1 features pushbutton on/off control, and an LED to indicate that the unit is on and operating. The new con-

CB NEW PRODUCTS

verter permits any motor vehicle operator to enjoy most of the benefits of CB without having to pay $150.00 to install a two-way system! Although you cannot transmit with a converter, most of the information you might require is available by listening. **Roadmate**, priced at $29.95, comes complete with installation and operating instructions. For further information, contact EICO, Inc., 283 Malta Street, Brooklyn, NY 11207.

CB Base Station

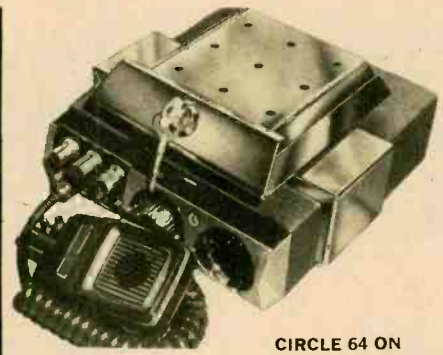
Many features required for continuous heavy-duty, two-way radio operation are built into SBE's Trinidad citizen band AM base station. It features a double-conversion receiver, adjustable squelch and volume controls, standing-wave-ratio sensitivity, and delta tuning. Its transmit mode delivers maximum legal power, high AM modulation for optimum efficiency, and it synthesizes all 23 channels, requiring no additional crystals. The Trinidad, identified as Model SBE-11CB, comes ready to plug into any 117 VAC circuit. Among its many special features is an emergency power "fail-safe" circuit, which automatically switches the SBE-11CB from

CIRCLE 71 ON READER SERVICE COUPON

117 VAC to 13.8 VDC battery operation in the event of a power failure. Other convenience features include an illuminated triple function front-panel meter which monitors power output, relative strength of incoming signals and voltage standing wave ratio. The SBE Trinidad is housed in a walnut-finished cabinet. The unit measures 5.75-in. high, 17.75-in. wide and 8.75-in. deep. It comes complete with dynamic microphone and four-conductor coiled cord with plug. It sells for $269.95. For complete information and specifications, write to SBE, Inc., Dept. P, 220 Airport Blvd., Watsonville, CA 95076.

Anti-Theft CB Brackets

Theft of mobile citizens band radios and car stereo equipment can be thwarted with CB Lok, a locking, mounting bracket introduced by Colar Systems. CB Lok consists of two basic parts; a support plate that bolts to the inside of a car or truck, and a slide plate with mounting brackets that bolts to the CB or stereo equipment. By using hinged mounting brackets on the slide plate, CB Lok hides all bolts and screws, leaving them inaccessible to potential thieves. And when CB Lok is in place in a car the bolts used to attach the support plate are also impossible to reach. And, as an extra safety precaution the key to the multi-tumbler lock cannot be removed unless the mounting

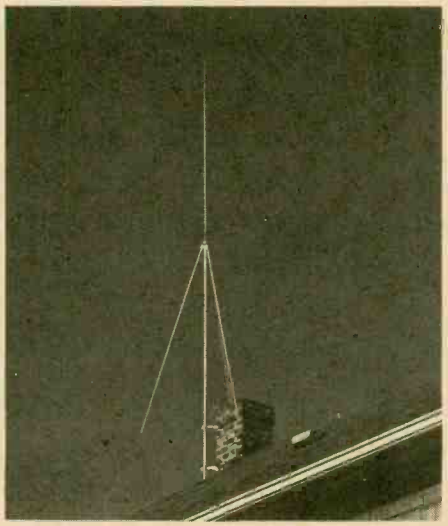


CIRCLE 64 ON READER SERVICE COUPON

bracket is secured. An optional feature of CB Lok—a welded-link chain that attaches to the support plate and the vehicle's firewall—presents an additional obstacle to the thief who pries loose the CB rig and bracket. CB Lok comes in two sizes, one for units 4½ to 8-in. wide ($19.95), and another for units 8- to 12-in. wide ($21.95). Brushed nickel or flat black. More information may be obtained from Colar Systems, Box 3576, Scottsdale, AZ 85257.

Fiberglass Base Antenna

Military grade fiberglass and high quality construction of Pacer's Sunburst base station antenna will open doors to the 10-20's of value minded CBers. Radiating elements totally enclosed in tough white fiberglass make the omni-directional 5-dB gain Sunburst antenna untouchable by weather and give it a consistently low SWR reading with



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no maintenance. The Sunburst can be assembled in minutes and mounted in the desired location with a minimum of effort. No coils or matching devices to rob power. The Sunburst will reach across the new 40 channel spectrum. Sells for $54.95. For more information on the Sunburst and other Pacer antennas, write to: Progress, Inc., 3321 N.W. 79th Avenue, Miami, FL 33122.

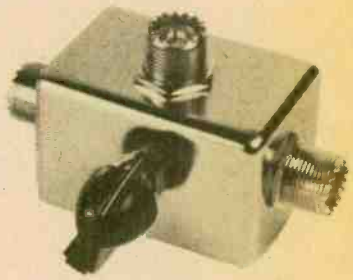
Mini CB Transceiver

Zodiac's newest addition to their product line is the highly compact Model M-5023, a full 23-channel CB transceiver measuring only 8¼ x 2¼ x 6½-in. Its small size permits it to be used anywhere, in trucks, boats, or in industrial applications. It can be installed in a car's glove compartment as a means of minimizing theft. Although small, its rugged construction makes it suitable for either mobile or permanent base operation. The Model M-5023 can be connected to 12-volt batteries having either positive or negative terminal ground. Weighing only 2 pounds and housed in a durable dustproof and dampproof pressed sheet steel container, the M-5023 is delivered with crystals for all channels on 27 MHz. A microphone, microphone holder, mounting bracket with screws, antenna plug, and power supply cable are

CIRCLE 67 ON READER SERVICE COUPON

a standard PL-259 connector. For more information on the Hy-Gain Hellcat Z citizens band two-way mobile antenna, contact Department MM, Hy-Gain Electronics Corporation, 8601 Northeast Highway Six, Lincoln, NE 68505.

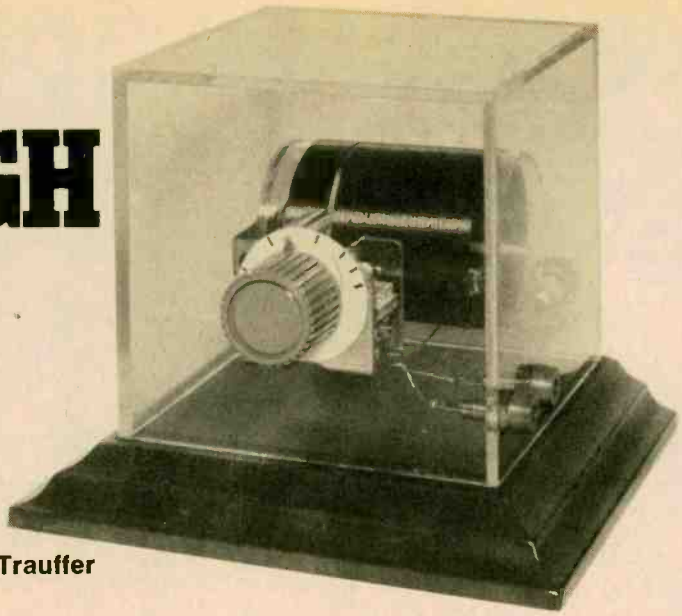
Amphenol has a new two-position CB antenna switch that allows switching one rig between two antennas or one antenna between two rigs. Designated Amphenol Model 83-2SW, the new device also permits switching an antenna between a CB rig and a monitor or scanner. A dummy load or power output indicator can also be incorporated into the system by using position 1 of the switch for the station antenna and position 2 for the dummy load.



CIRCLE 65 ON READER SERVICE COUPON

This provides maximum operating convenience, and allows checking of transmitter performance without illegal and annoying interference with other stations. Rated for maximum legal CB power, Model 83-2SW also can handle a ham kilowatt (2 KW PEP, SSB), and is designed to match both 52 and 75 ohm transmission lines. Frequency range is 0-108 MHz, and voltage rating is 500 V peak. The switch mates with standard PL-259-type connectors. Priced at $6.95. For additional information about the new Amphenol Model 83-2SW CB switch, contact: Bunker Ramo RF Division, 33 E. Franklin Street, Danbury, CT 06810. ■

Build the SEE-THROUGH CRYSTAL RADIO RECEIVER



by Art Trauffer

☐ Have you ever wanted to recreate those old days of listening to AM radio on a crystal set and headphones? No tubes, no batteries, no hum, no nothing but pure clean sound drifting out of the ether into your headset? If you have the yen to get a crystal set which has the advantage of using a crystal diode instead of the old unreliable cats-whisker and galena crystal, this radio is the one for you to build. In addition to being about as good a power-supplyless AM receiver as you can make, it's also a pleasure to look at.

It closely resembles the beautiful glass-enclosed radio receivers that were custom-built by manufacturers for display in radio exhibitions in the 1920's. Manufacturers of radio receiver kits mounted and wired their kits in glass cabinets so the visitors could see the "works" from all angles instead of lifting the lid to look inside. Those glass cabinet radios are now rare collectors items.

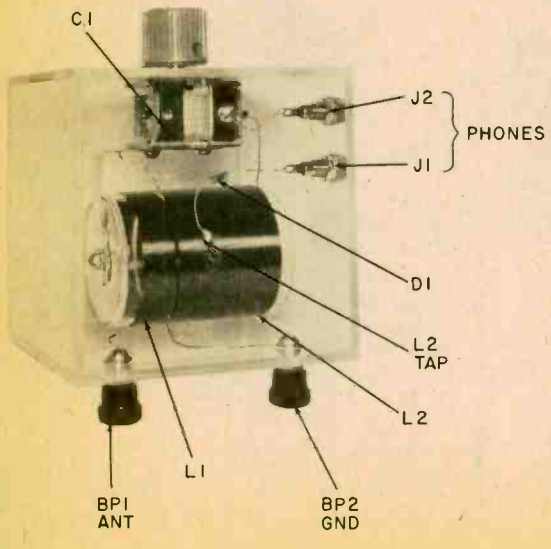
This crystal radio also saves you the work and expense of making a wood cabinet, and it is low-loss for radio frequencies because the cabinet and coil form are made of styrene plastic which is a good dielectric material. The cabinet is simply a clear plastic 4-in. square photo display cube, and the coil form is a clear plastic pill container about 2-in. in diameter.

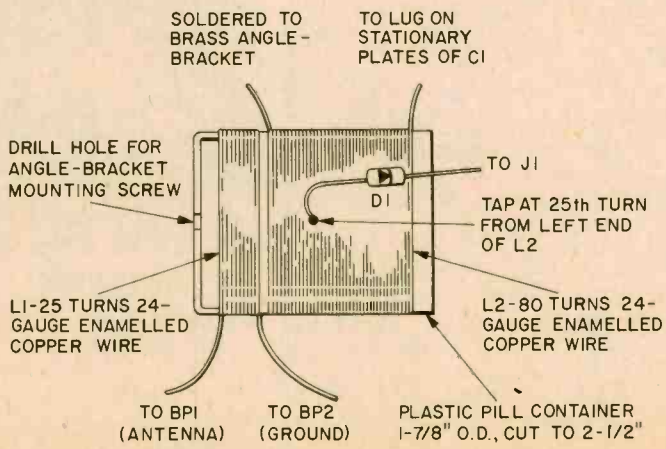
Circuit Description. The simple schematic diagram shows a time-tested hookup which is still widely used, but it's improved here by connecting one side of the crystal diode to a tap on the secondary, L2. This greatly increases the receiver's selectivity and helps you separate the powerful local stations.

Making the Coil. To make coils L1 and L2 the four ends of the coils are anchored in small holes drilled through the wall of the plastic container and spotted with Duco cement. You can also make small holes by pushing a hot sewing needle through the plastic. To make the tap on the coil, simply twist a small loop in the coil and spot it with Duco cement. Scrape the enamel insulation off the loop, and solder to it.

Build Your Own or Ours. The plastic cube makes a very attractive enclosure, as you can see in the photographs. However, the parts layout isn't at all critical, and you can breadboard this radio any way you want, so long as it's wired correctly. If you want to have a beautiful-looking radio you can show off you'll follow the model I made which is shown in the photographs.

Mounting The Parts. The photograph shows how the parts mount inside the plastic box. The coil form is mounted to the rear of variable capacitor C1 by means of a brass angle-bracket. Use lockwashers wherever needed to hold the screws, binding posts, and phone tip jacks securely to the plastic material.



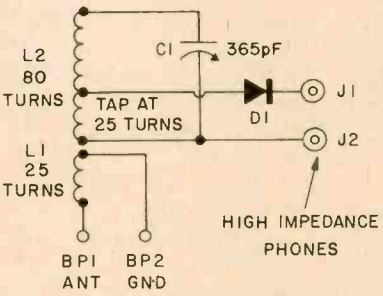


Apart from getting hold of the parts, construction of the See-Through Crystal Set should take you less than two hours in all. You can use any kind of box you want, but the lucite box shown will make it into a real showpiece.

When assembling and wiring this receiver be careful not to scratch the plastic, and keep the soldering iron well away from the plastic. If you use rosin core solder, protect the plastic by covering it with pieces of paper taped in place to keep the rosin from splattering on the plastic.

The completed crystal radio is mounted on a fancy walnut base purchased from a woodworking shop. The plastic box is secured to the wood base by spotting the four corners of the bottom of the box with Duco cement. The dial for the pointer knob is simply a small disc of white double-weight paper held to the plastic box with a spot of Duco cement. Make pencil marks at the places where your local stations come in.

Use a pair of sensitive high-impedance magnetic or crystal earphones, a good connection to a cold water pipe, and a long outdoor antenna (for best results, put up a long-wire, random-length antenna. Details for this sort of antenna are given on page 63 of ELEMENTARY ELECTRONICS, January/February 1976. If you're in an apartment and can't put one on the roof, see the article in our May/June 1976 issue page 52.) Even if you don't use your crystal radio every day, you'll have a real showpiece for your friends to admire! ■



PARTS LIST FOR CRYSTAL RADIO

BP1, 2—Binding posts for antenna and ground connections; may be any convenient type (Radio Shack 274-661 or equiv.)

C1—365-pF variable tuning capacitor, single-gang (Radio Shack 278-1344 or equiv.)

D1—Small-signal, general purpose diode, similar to 1N34 (Radio Shack 276-821 or equiv.)

J1, 2—Jacks for headphones (dependent on phone(s) selected.

Misc.—Headphone(s), high impedance. May be crystal or magnetic, or small earphone as supplied with transistor radios and portable tape machines; plastic photo display cube, approx. 4-in. each dimension; plastic pill container, 1 7/8-in. diameter, for use as coil form; 1/4-lb. 24-gauge enamelled copper magnet wire (Radio Shack 278-C04 or equiv.); brass mounting strip, assorted screws, nuts and lockwashers

BY CHRISTINE BEGOLE, KFC3553

☐ Break break—you got your ears on? You got Buzzin Bee again and, land sakes alive, those CB waves have sure been buzzin' since I last put pen on paper to let you know what I been hearin' from my good CB buddies.

Pickle City, USA.

Got a note from a CB friend in Knoxville, Tennessee, who had her camera handy when the Bicentennial Wagon Train made a stopover in her hometown. Karen Carden writes, "Even cowboys need ears! I caught those boys while

they worked hard attaching a CB antenna to an Arkansas wagon. (They're authentic, honest-to-goodness pioneer ears, of course.)" Thanks for the pic, Karen. Now, all I want to know is what town in Arkansas is called Pickle City?

Uncle Charley's Been Busy.

The fact that 40 channels will be available for CBers' use starting January 1, 1977, isn't all that's been going on with the FCC.

As we go to press, Channel 11 has been opened up for general use, and is no longer a "calling-only channel." Every CB rig sold after Jan. 1, 1977 will come with a copy of Part 95 and a copy of both Form 505 and Form 555B, the two FCC Forms you need to apply for your permanent CB license and to write your own temporary operating permit.

Also, the use of add-on devices that would expand the frequency capabilities of present 23-Channel rigs is strictly prohibited. I asked Morgan Godwin, my fellow editor, to give me some details on what's going to happen to all those 23-channel rigs on dealers' shelves. I thought maybe they could be modified. Here's the word from Morgan:

As a practical matter, any modification of 23-channel transceivers to cover the new channels will be limited to manufacturers who wish to do so. Even so, any modification will undoubtably be confined to 23-channel sets that have PLL circuitry and that meet or have the potential of meeting the new, more stringent rules for transmitters and receivers. The individual CBer who has a 23-channel set would have to take it to a licensed technician or engineer to have it modified and then have it submitted to FCC for approval. FCC would charge a couple of hundred dollars to check the unit and chances are very remote that it would pass unless it was literally rebuilt from the chassis up. So, don't look for any individual CBers (except for perhaps a handful of die-hards who don't want to give up their faithful ole radio and who have the time, money and patience to indulge themselves) to have their transceivers updated. Maybe a few of the biggies like Pearce-Simpson et al will recycle PLL radios, but that will probably be it. If anyone does buy a re-manufactured set they should be sure to obtain at time of purchase some sort of documentation that the radio meets the new requirements and has FCC approval.

Also, none of us should be at all surprised to hear call signs consisting of four letters followed by four digits. That's the way the FCC is issuing call signs at the moment. One more flash thought: those of you planning to operate your CB rig while traveling in Canada would be well-advised to keep your eye on new developments in Canadian regulations. There may well be some important changes.

ALERT Helps Kids Celebrate.

Another letter, from ALERT Headquarters in Washington, D.C. and a photo from the U.S. News Service, let me know about a Trans-Atlantic friendship operation. With the help of the Share Your Birthday Foundation and the

Norwegian Embassy, a group of school children in Oslo, Norway, sent 350 pounds of birthday presents to kids in Decorah, Iowa. After the presents arrived in Maryland by boat, the presents traveled across the country via ALERT relay teams. That's a lot of traveling, a lot of pounds, and a lot of cooperation, communication and coordination! A big ten-four to one and all!

Locking Backward.

Last month waiting around at the library for a friend to check out a book, I got looking

(Continued on page 105)

40 Channels News Notes -We Clear the Air!!!

CB CHANNEL EXPANSION is here! FCC has authorized 17 new CB channels for use effective January 1, 1977, providing a total of 40 channels for the Class D Citizens Radio Service. In another change, Channel 11 ceases to be reserved exclusively as a "calling" channel and becomes available for general CB communications. Channel 9 remains the emergency channel.

CBers will share the new channels with stations in other radio services until December 31, 1979. Both AM and single sideband (SSB) will be legal on all channels and sidebanders may use either upper or lower sideband on all 40 channels.

All transceivers sold after January 1, 1977 must be supplied to purchasers with a CB license application (FCC Form 505), a Temporary Permit (FCC Form 555-B), and a copy of Part 95 of the FCC Rules and Regulations. In addition, the serial number of all new sets sold after January 1, 1977 must be engraved on the unit's chassis.

Add-on devices designed to extend frequency coverage of 23-channel transceivers to 40 channels are strictly prohibited. However, *re-manufacture* of 23-channel units to cover the new channels is permitted if the reworked sets are submitted for type acceptance and approved by the FCC as meeting their new, stricter standards.

New Suppression Standard. There are tougher rules on harmonic radiation, with the suppression requirement being increased to 60 dB for all new transmitters no matter how many channels. If a CBer's operation causes interference to TV reception because of harmonic radiation he may be required to insert a low pass filter between the transmitter RF output terminal and the antenna feedline. It makes sense.

The FCC considers the channel expansion on 27 MHz only an interim measure. While interference on the present frequencies is minimal at this time it is expected to become severe during the next several years as we approach a solar cycle peak. Studies are now underway to explore the area of personal communications, including the possibility of new frequency assignments for CB in other parts of the radio spectrum such as the 220 MHz and 900 MHz ranges.

Two Proposals Nixed. A proposal to lower the age requirement for a Class D CB License from 18 to 16 years of age was not approved, the FCC pointing out that the recent tremendous influx of license applications (500,000 or more each month) has rendered the Commission unable to spare the manpower necessary to process additional applications. Further, present rules permit all persons under the age of 18 living in the same household to operate under a license held by a parent.

The Academy of Model Aeronautics (AMA) strongly opposed a proposal to combine the privileges of Class C and D licenses and it was not adopted. That makes sense, too!

Makers To Re-manufacture. A number of companies have announced plans to re-manufacture at least some of their 23-channel sets to meet the new 40-channel specifications.

Hy-Gain will offer re-manufacture of certain of their Phase-Lock Loop (PLL) equipped units, including the Hy-Gain 1, 2, 3, 4 and 9 models, as well as the Hy-Range Ia and IIa. The re-manufacture of those sets will begin after January 1, 1977 and after the new 40-channel designs have received type acceptance approval from the FCC.

Pearce-Simpson informs us that it will remanufacture most of its 23-channel Citizens Band Radios purchased after August 20, 1976 to FCC type-approved 40-channel units at the customer's option and will allow authorized dealers and distributors to exchange sets for the new models after January 1, 1977.

"Consumers desiring the additional channels may ship their Pearce-Simpson radios to one of several designated factory service centers after January 1, 1977. The remanufacturing will be accomplished by factory technicians at a prepaid cost of $25 if proof of purchase date is included.

"Dealers and distributors may exchange 23-channel transceivers purchased after August 20 and remaining in their inventory in original cartons after January 1 for remanufactured sets at the same cost of $25 per unit.

"Pearce-Simpson's authorized distributors and dealers will be given a priority on 40-channel transceiver shipments."

Sharp Electronics Corporation has announced a program that will enable owners of its 23-channel transceivers to exchange them for new 40-channel models as soon as they become available at a cost to the consumer of $30.

According to the company, "Purchasers of Sharp's 23-channel models CB-750, CB-760, or CB-800 are eligible to participate. The program applies to all purchases made since July 26, 1976, the announcement date by the FCC authorizing manufacturers to increase to 40 channels. The exchange privilege will be offered to purchasers of the three models until January 31, 1977, by which time dealers are expected to have inventories of the 40-channel models.

"Purchasers of these 23-channel models will receive a registration certificate, entitling them to return their used units to participating dealers for an immediate exchange. A comparably featured, new 40-channel model will be given to the consumer right on the spot for $30. The certificates can be redeemed through April 30, 1977.

According to a Sharp company spokesman, "The consumer can purchase a 23-channel unit now at a lower price than expected for 40-channel models. He can use the model for several months, gain personal experience with it, and then decide for himself whether he wants a 40-channel model.

(Continued on page 94)

Electronic Reactionaries: Inductance and Capacitance

How these two combine with resistance to make electrons go around and around

by Norman Crawford

THE LOWLY RESISTOR is the solid citizen of electronics. It can be relied upon to behave with the same, predictable performance, whether confronted with AC or DC. Unruffled by excursions into the higher frequencies, it continues to live by the guiding rule —Ohm's law—and declares that, no matter what, the current (I) it permits to flow shall depend solely on the applied voltage (E) divided by its own resistance (R).

However, the resistor's component cousins—the inductor and the capacitor —are by no means so stolid in the face of changing frequencies. The inductor, for example, grouchily shuts off more and more of the current flow as the applied frequency gets higher and higher, while the capacitor reacts to higher frequencies in just the opposite manner —it happily allows more and more current to flow as the frequency rises.

Fortunately, the reactionary behavior of these components is just as predictable as is the single-mindedness of their resistive cousin. If we study the strange conduct of these apparently erratic citizens, we not only discover the rules which govern their odd behavior, but also perceive that ultimately, they too, are faithful to Ohm's law—in their fashion—just as are all electronic components and circuits.

Reactionaries in the Lab. To begin our study, let's set up the lab experiment shown in Fig. 1.

Here, we have an audio oscillator set to produce an output of 60 Hz, and a power amplifier to amplify that signal to the 100-volt level. The power amplifier drives a load consisting of a large (25-watt) 390-ohm resistor connected in series with an ordinary 1½-volt (0.25-amp) flashlight bulb. An AC meter reads the output voltage from the power amplifier.

Turning on the equipment, we set the audio oscillator to 60 Hz, and gradually turn up the amplifier gain till 100 volts appears at the output. (Note: The ordinary hi-fi amplifier won't do this—you will need a public address amplifier with a high-voltage (70-volt, or 500-ohm) auxiliary output if you actually want to carry out this experiment.) At this point, the bulb will light to its normal brightness, indicating that the 100 volts is pushing about 0.25 ampere through the combined resistor/light-bulb circuit. Using Ohm's law, we can easily check this:

$$I = E/R$$
$$= 100 \text{ volts}/(390 \text{ ohms} + 6 \text{ ohms})$$
$$= 0.252 \text{ amperes}$$

Note that the light bulb's resistance, R, is

$$R = E/I$$
$$= 1\frac{1}{2} \text{ volts}/\frac{1}{4} \text{ ampere}$$
$$= 6 \text{ ohms}$$

Please also note that it's the 390-ohm resistor, not the bulb, which is the chief authority in establishing the current. The lamp current will change very little, whether the bulb is 6 ohms, 12 ohms, or zero ohms.

Next, let us vary the frequency of the audio oscillator; first, down to 30 Hz, and then, up to 120 Hz. We notice that the bulb stays at the same brightness, indicating that the 390-ohm resistor is behaving in its normal, stolid fashion—that is, it is steadfastly ignoring frequency changes, and permitting its current flow to be determined solely by Ohm's law. Even if the frequency were zero (which is another way of saying DC), the bulb's brightness would remain the same, if we applied 100 volts to it.

Enter the First Reactionary. Now, let's go to our parts supply bin, pick up a 1-henry inductor, and make a few preliminary measurements on it. Using an inductance bridge, we discover that its real value is 1.05 henry. We next connect it to an ordinary ohmmeter as shown in Fig. 2, which informs us that the inductor has a resistance of 45 ohms.

Now, let us replace the 390-ohm resistor of Fig. 1 with this 1-henry inductor as shown in Fig. 3, and predict what will happen when we turn on the equipment. Since the ohmmeter said "45 ohms" we can predict that the current will be

$$I = E/R$$
$$= 100 \text{ volts}/45 \text{ ohms} + 6 \text{ ohms}$$
$$= 1.96 \text{ amperes!}$$

Fig. 1. Practical laboratory setup to demonstrate Ohm's law. Power amplifier must have a 70-volt output or a 500-ohm output transformer tap.

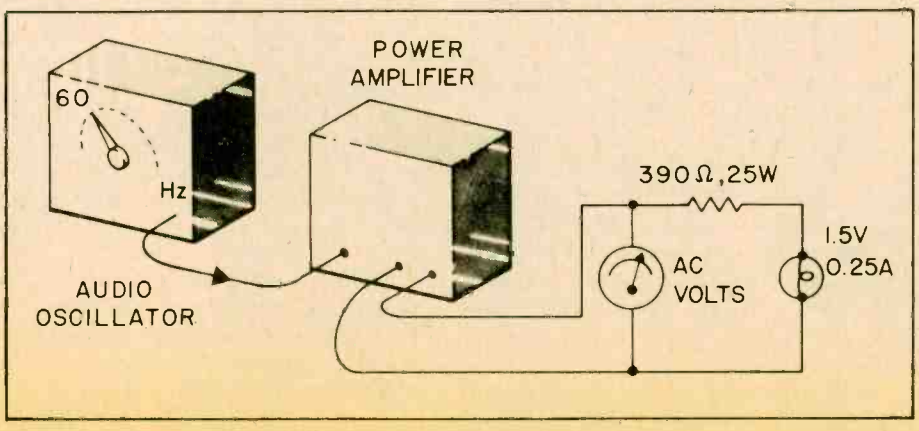
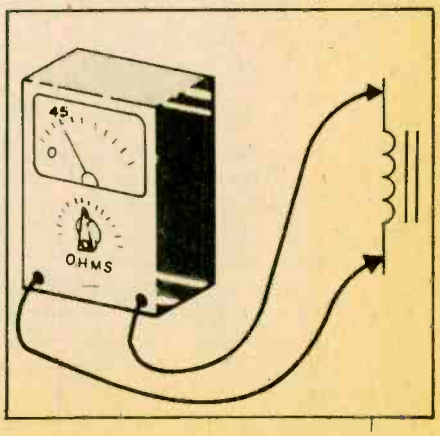


Fig. 2. Measuring the DC resistance of a one-henry inductor (choke coil) shows it has 45 ohms of resistance.



With this large current—nearly 8 times normal—the light bulb should burn out almost instantly! However, when we apply 100 volts of 60 Hz to the inductor-plus-bulb, we are surprised to see that the bulb lights to normal brightness! This means that the inductor is behaving like a 390-ohm resistor, and is establishing a ¼-ampere flow of current—not the nearly-2 amperes calculated from the above ohmmeter measurement.

To compound the mystery, let us now vary the frequency of the oscillator: first, up to 120 Hz—and the bulb gets dimmer!—and then gingerly, down, just a little, to 50 Hz—and the bulb gets uncomfortably brighter. Here, in the lab, is the actual behavior forecast by theory—the inductor grouchily shuts down the current flow for high frequencies, causing the bulb to go dim at 120 Hz, but it is willing to let low frequencies through, thus allowing the bulb to get brighter for 50-Hz input.

A Little Compassion for the Reactionary. To understand this "reactionary" behavior, we must understand how an inductor "feels" about an alternating current. An inductor is, after all, an electromagnet. If a steady direct current flows through it, it fills the space in its vicinity with a magnetic field. If we attempt to cut down the inductor's current, it reacts, quite understandably, by collapsing its magnetic field. But this collapsing field moves across the inductor winding in just the same way that a dynamo or generator field moves through the generator windings to make an output voltage. The inductor, then, reacts to any attempt to change its current by *acting as its own generator*, generating a new voltage of the correct polarity *to try to keep its own current from changing*. So, in its own way, the inductor is a solid, but *conservative* citizen—a citizen who tries to maintain the status quo.

Furthermore, the faster we try to change its current, the harder the inductor works to keep the current from changing. Therefore, the inductor sees a high frequency as an attempt at rapid changes—a threat to the status quo—so it works very hard to generate an opposing voltage (a 'counter-EMF' or 'counter-electro-motive-force') to keep its current from changing. This internally-generated voltage opposes the applied voltage more and more as the frequency rises; hence the actual current which flows drops lower and lower as the frequency rises. *This means that the apparent resistance of the inductor rises with frequency.* But this apparent resistance is not called *resistance*—since it is the inductor's reaction to the frequency applied to it, it is called *inductive reactance.*

A Resistance by Any Other Name. But whether you call it "apparent resistance" or "inductive reactance", it is still measured in ohms, and can be used as a part of the familiar Ohm's law formula. Where a simple resistive circuit answers to the expression

$$I = E/R$$

A similar circuit with resistor replaced by an inductor (coil) is described by the formula:

$$I = E/X,$$

where X is the symbol for reactance. But, since the amount of reactance (X) changes according to frequency, we must have a way to calculate its value at the frequency we are using. The following simple formula does that for us:

Inductive Reactance = $2 \times \pi \times$ frequency $\times$ inductance or, in the familiar algebraic shorthand,

$$X_L = 2\pi fL$$

where L is the inductance in henrys, and the subscript L following the X indicates we are talking about *inductive* reactance. Therefore, the current in an inductive circuit is:

$$I = E/X_L,$$
$$= E/2\pi fL$$

For Example. Let's take the 1.05-henry inductor and calculate its reactance at 60 Hz:

$$X = 2\pi fL,$$
$$= 2 \times \pi \times 60 \times 1.05$$
$$= 395.8 \text{ ohms.}$$

which, as you can see, is very close to the 390 ohms of the resistive circuit of Fig. 1. This explains why the bulb lit to about the same brightness for the inductor as for the resistor.

When we cranked the audio oscillator up to 120 Hz, the inductive reactance became

$$X_L = 2\pi fL,$$
$$= 2 \times \pi \times 120 \times 1.05$$
$$= 791.7 \text{ ohms.}$$

The new current becomes, ignoring, for the moment, the 6-ohm bulb:

$$I = E/X$$
$$= 100 \text{ volts}/791.7 \text{ ohms},$$
$$= 0.125 \text{ ampere.}$$

which is about half the rated current of the bulb. Hence, it would be dim at this frequency. You can easily calculate that at 50 Hz, the X becomes 329.9 ohms and the current rises to the excessive value of .303 amperes; any further lowering of frequency could burn out the bulb!

Reactionary No. 2: The Capacitor. Returning to the parts-supply bin, we now take a large, *oil-filled* (—Don't try this with an electrolytic!) capacitor, and, measuring it on a capacitance bridge, find that its true value is 6.8 mfd. An ohmmeter placed across the capacitor's terminals registers an upward 'kick' of the needle as the ohmmeter's internal battery charges the capacitor, but the ohmmeter then settles down to indicate that, as far as *it* is concerned, the capacitor is—as it should be an open circuit.

We now replace the 390-ohm resistor of Fig. 1 with the 6.8 uF capacitor, as shown in Fig. 4.

Again set the oscillator to 60 Hz, and turn on the equipment. Since the capacitor is really an open circuit—according to the ohmmeter—one might expect no current flow at all. We are surprised, then, when the light bulb blithely ignores our oil-filled open circuit, and proceeds to glow as serenely and confidently as it did for the inductor and resistor! When we *drop* the frequency to 30 Hz, the bulb goes dim—when we gingerly raise the frequency to 70 Hz, the bulb gets brighter. This is just the opposite of the inductive effect, where the bulb got dimmer for higher frequencies.

Capacitive Reactance. We are obviously dealing with another type of reactance, this time arising from the presence of the capacitor in the circuit, and known as *capacitive reactance.* Its behavior in the face of changing frequency is exactly the opposite of that shown by inductive reactance. A capacitor's apparent resistance goes *down* as frequency goes up, and goes *up* as frequency goes down. This inverse relationship is seen in the expression for capacitive reactance, which is

$$X_C = \frac{1}{2\pi fC}$$

where X is *capacitive* reactance, and C is the capacity in *farads,* (not microfarads.)

Mathematically speaking, by placing f (frequency) in the *denominator* (bottom) of the fraction, we are saying that as f gets *larger,* the answer (X) gets *smaller,* which is exactly what we observed in the lab experiment above.

Just as in the inductive case, we can plug X right into the Ohm's law formula and have a way to calculate current or voltage for a capacitive circuit:

$$I = \frac{E}{X}$$

More Examples. As examples of how the above formulas can be used, let's calculate reactances and currents of our 6.8-uF capacitor at various frequencies at 60 hz,

$$X_C = \frac{1}{2\pi fC}$$

$$= \frac{1}{2\times\pi\times60\text{Hz}\times6.8\text{uF}}$$
$$= 390.1 \text{ ohms.}$$

(Note that 6.8 *micro*farads must be expressed as 6.8×10^{-6} farads, since the formula is always written for C in *farads*. Alternately, you could write 6.8 microfarads as 0.000 006 8 farads, but that's a little more awkward to handle.)

At 30 Hz, a *lower* frequency, the capacitive reactance *increases:*

$$X_C = \frac{1}{2\times\pi\times30 \text{ Hz } (6.8\times10^{-6})} \text{ farads,}$$
$$= 780.2 \text{ ohms,}$$

and at a *higher* frequency, say 70 Hz, the capacitive reactance becomes *less:*

$$X_C = \frac{1}{2\times\pi\times70 \text{ Hz } (6.8\times10^{-6})} \text{ farads,}$$
$$= 334.4 \text{ ohms.}$$

The current, in any case, can be found by Ohm's law. At 70 Hz, the current is

$$I = E/X,$$
$$= 100 \text{ volts}/ 334.4 \text{ ohms,}$$
$$= 0.299 \text{ ampere,}$$

while at 30 Hz the current is:

$$E/X = 100 \text{ volts}/780.2 \text{ ohms,}$$
$$= 0.128 \text{ ampere.}$$

So, in their way, both inductors and capacitors are obedient to Ohm's law. Their reactances–X_L and X_C, respectively–can replace the R in the familiar Ohm's law expression, $I = \frac{E}{R}$ enabling us to calculate current flow for ac circuits which include inductors or capacitors.

Adding Apples and Oranges. But, what of circuits which *combine* an inductor and a resistor? Or an inductor and a capacitor? Can we simply add the two 'ohms' together? Do resistance and reactance add like apples and apples?

Unfortunately, this is not the case. Consider, for example, the circuit of Fig. 5. Here, our 1.05-Henry inductor and a 150-ohm resistor are connected in series across the 100-volt, 60-Hz source. What is the current flow?

Obviously, we need an Ohm's-law-like expression–something like:

I = E, divided by the apparent "resistance" of R and L, combined.

We know from our previous work that a 1.05-henry inductor has an X inductive reactance of about 396 ohms. We wish that we could simply add the 396 ohms of reactance to the 150 ohms of resistance to get 546 ohms–but reactance and resistance simply don't add that way. *Instead, they add at right angles!* And how, you ask, does one *add* at *right angles?*

A Journey at Right Angles. To understand how resistance and reactance can add at right angles, consider another type of problem: If I travel 150 miles due east, and then 396 miles north, how far am I from my starting point? See Fig. 6.

You obviously cannot get the answer to this problem by adding 396 to 150, because you're certainly not 546 miles from home. But notice that the figure is a right triangle–a shape which that old Greek, Pythagoras, solved long ago. He said that if you *square* 150, and *square* 396, add the squares, and then take the square root, you will get the length of the longest side:

$$\sqrt{(150\times150) + (396\times396)},$$
$$\sqrt{179{,}316},$$
$$= 432.5 \text{ miles.}$$

This, then, is a way of adding two quantities that act at right angles to each other. Since inductive reactance is a kind of "north-bound resistance", operating at right angles to the "east-bound resistance" of an ordinary resistor, we combine the two by adding at right angles, just as the two right-angle distances were added in the above mileage problem. The effective resistance of the 396-ohm reactance and the 150-ohm resistor is therefore:

$$\sqrt{(150\times150) + (396\times396)},$$
$$= 432.5 \text{ ohms.}$$

What do we call this combination? It is obviously neither resistance nor reactance, but a combination of both. Since it represents a *general* way that a circuit can impede the flow of electrons, it is called *impedance,* and is represented by the symbol Z. The general formula for impedance is, therefore:

$$Z = \sqrt{R^2 + X^2}$$

Another Candidate for Ohm's Law. Impedance is measured in *ohms,* just as are reactance and resistance. If we know the impedance and voltage in a circuit, we can find the current by plugging Z into the familiar Ohm's Law expression:

$$I = E/Z,$$
$$= E/\sqrt{R^2 + X^2}.$$

Using this expression we can calculate the current in the example of Fig.5:

$$I = E/Z,$$
$$= 10 \text{ volts}/423.5 \text{ ohms,}$$
$$= 0.326 \text{ ampere.}$$

Southbound Capacitors. The knowledge that inductive reactance adds at right angles to resistance leads immediately to the question, "What about *capacitive* reactance? Does it also act as a 'northbound' resistance?"

As you might except, two circuit elements as different as inductance and capacitance could never agree on the 'direction' of their reactances. If inductive reactance is 'northbound', the capacitor obstinately declares that *its* reactance is *'southbound'*, acting in direct opposition to the inductive direction, as shown in Figs. 7 and 8.

However, this makes no difference in the equation for impedance, which is still given by

$$Z = \sqrt{R^2 + X^2},$$

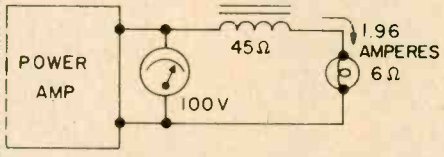


Fig. 3. Substituting the one-henry inductor in place of the 390-ohm resistor of Fig. 1 lowers the opposition of the circuit to AC, hence more current flows.

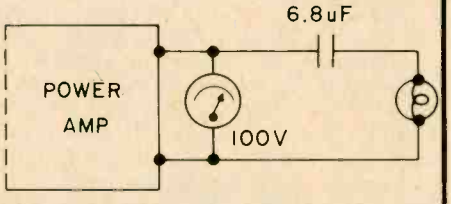


Fig. 4. A 6.8 uF capacitor substituted in the test circuit for the inductor. If the capacitor acted as an open (as it would for DC) no current would flow.

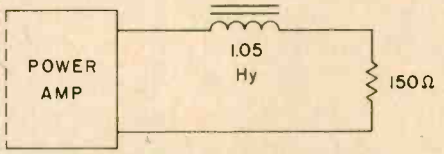


Fig. 5. Test circuit load is now combination of inductor (1.05 henry) and resistor (150 ohms). As the text explains, their combined reactance is computed by adding them at right angles!

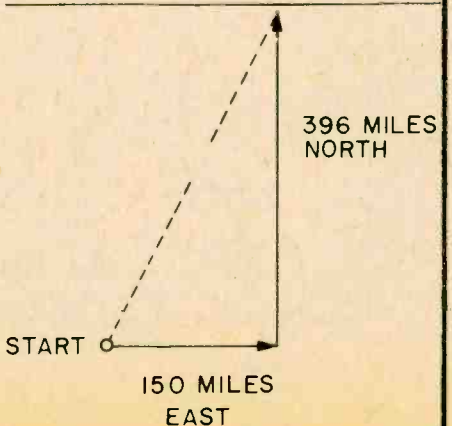


Fig. 6. Adding traveling distances in different directions yields resultant which is the diagonal (the shortest distance between the two points), also a right triangle. Back to the Pythagorean theorem!

where X is, in this case, X_C, capacitive reactance.

As an example, let's calculate the impedance of the circuit of Fig 9.

$$Z = \sqrt{R^2 + X^2}$$
$$= \sqrt{(150)^2 + (200)^2}$$
$$= \sqrt{62{,}500} = 250 \text{ ohms}$$

As a further calculation, let us determine the current which will flow if 50 volts is applied to the terminals at the left of Fig. 10:

$$I = E/Z,$$
$$= 50/250$$
$$= 0.2 \text{ ampere.}$$

All Together, Now. The final question is this: If a circuit includes resistance, inductance and capacitance, all at once, what is its total impedance?

An example of such a series circuit is shown in Fig. 10.

Here, 100 volts at 70 Hz is applied across a series circuit of 150 ohms resistance, 1.05 henry inductance (X_L = 462 ohms), and 6.8 uF capacitance (X_C = 334 ohms).

As a first step in determining the total impedance, we can draw the 'directions' of the resistance and the two reactances, as shown in Fig. 11.

The first thing that strikes us about the illustration in Fig. 11 is that the effect of the 'northbound' (inductive) 462 ohms is partially cancelled by the 'southbound' (capacitive) 334 ohms. The *net reactance* of this circuit is therefore:

$$X = X_L - X_C,$$
$$= 462 \text{ ohms} - 334 \text{ ohms},$$
$$= 128 \text{ ohms.}$$

This combining of X_L and X_C by simple subtraction reduces the problem to a simpler one, resembling a problem we've already solved. This is graphically shown in Fig. 12.

Applying the formula for impedance

$$Z = \sqrt{X^2 + R^2},$$
$$= \sqrt{(128)^2 + (150)^2},$$
$$= 197.2 \text{ ohms.}$$

The current flow is:

$$I = E/Z,$$
$$= 100 \text{ volts}/197.2 \text{ ohms},$$
$$= 0.51 \text{ ampere.}$$

North vs. South. In the above problem, we saw that the 'northbound' inductive reactance (462 ohms) was very nearly cancelled by the 'southbound' capacitive reactance (334 ohms). It's pretty obvious that by changing some values, or by changing the frequency, we could make X_L *exactly equal to* X_C, and they would cancel each other completely, leaving the circuit with no net reactance whatsoever—just 150 ohms of simple resistance. This condition, where $X_L = X_C$ exactly, is called *resonance*, and that's an interesting story, too—but it's a story for another day. ■

Circuits which include capacitance and inductance as well as resistance are only slightly more complicated than circuits with just pure resistance. Once the AC frequency is known the reactance of inductors and capacitors is figured, added (subtracted) and inserted into the formula for impedance (see text above on this page).

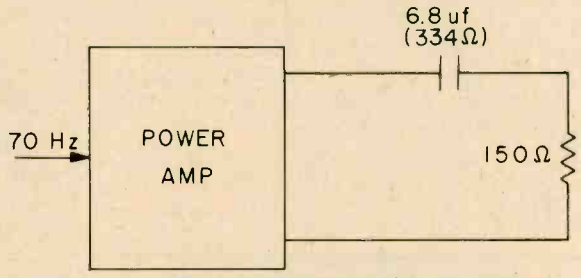


Fig. 7. The reactance of the capacitor at this frequency (70Hz) is 334 ohms. This may be combined with the pure resistance, 150 ohms, by using the formula discussed in the text.

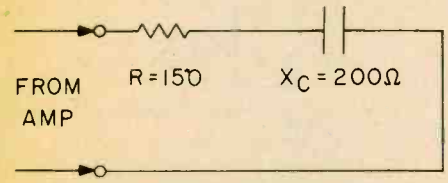


Fig. 9. Schematic showing reactance of capacitor. The two reactances add according to the formula, to yield a combined reactance (at the particular frequency used) of 250 ohms.

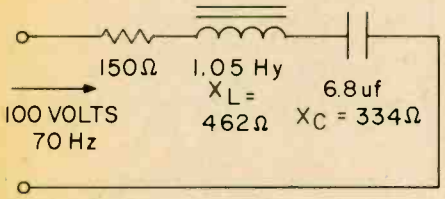


Fig. 10. Combining capacitive reactance and inductive reactance is also handled. Reactance of each at 70 Hz is computed, they are added together, and the difference is put into the formula with the pure resistance.

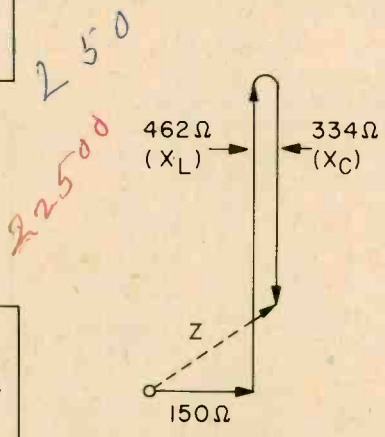


Fig. 11. The relative "directions" of capacitive and inductive reactances along with that of the pure resistance. Z (the diagonal) is the resultant of the 150-ohms resistance plus the difference between the two reactances.

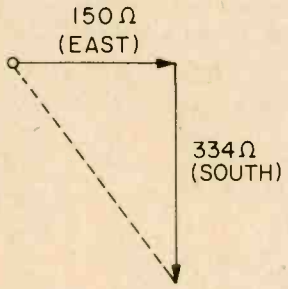


Fig. 8. This drawing shows how the two reactances are added, as also shown in Fig. 6 and, described in the text.

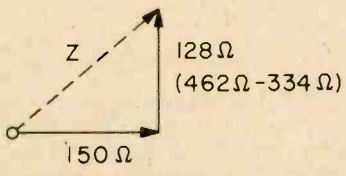
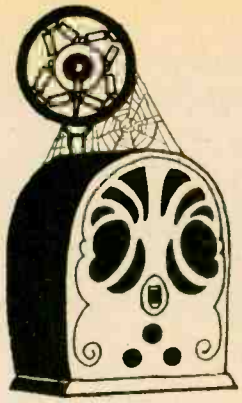
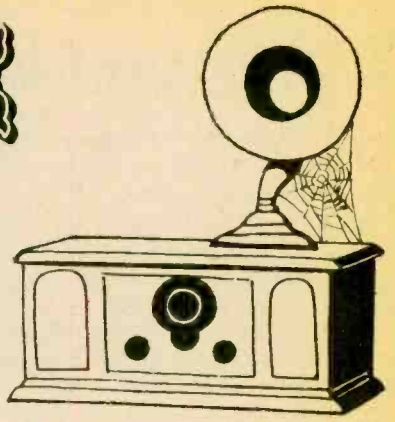


Fig. 12. Combining the reactances leaves a difference of 128 ohms and provides a directional diagram similar to that of Fig. 6. Such directional drawings are called "vector" diagrams.



ANTIQUE RADIO CORNER



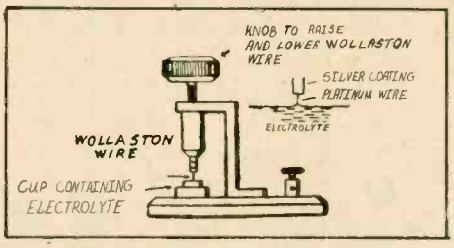
by James A. Fred

☐ Hello out there in radio land! We are entering the Fall-Winter season when interest in collecting radios begins to pick up. Since we have never discussed early radio receivers we will start at the beginning, in the early 1920s. Crystal receivers were the first low-cost radios that many people started to listen with, and they are fascinating things to build and tinker with. They also provided the clearest radio reception imaginable. Just put a crystal set together and listen with a good pair of headphones, and you'll find Hi-Fi doesn't have a thing on a crystal set. There is no hum, no cutting off of high frequencies, just pure music and speech.

If you have ever seen a display of crystal radios you were probably as amazed as I to see the many different sizes, shapes, coil configurations, and even the different kinds of detectors used.

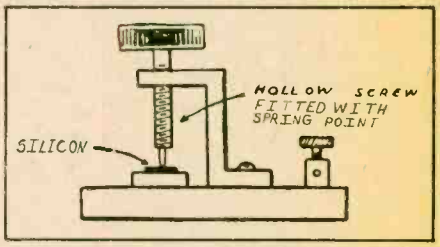
Early Detectors. We might as well start at the beginning and discuss the different kinds of detectors that have been used, excluding of course the modern semiconductor germanium and silicon diodes. This discussion will be confined to pre-1930 materials.

The first drawing shows the mechanical layout of the Electrolytic Detector. From the picture you can see that it consists of a fine platinum wire (called Wollaston after its inventor) dipping into a cup of dilute nitric acid just far enough to touch the surface of the liquid. The telephone receivers (headphones) are connected to the detector, in series with a battery. The current from the battery causes bubbles to form on the end of the wire and insulates it from the liquid so the current quits flowing. When a voltage is induced into the antenna by a radio wave, the small alternating current breaks down the bubbles and permits a pulsating current to flow, producing a sound in the telephone receivers. The Electrolytic Detector was used during the early days of wireless to detect arc gap transmissions.



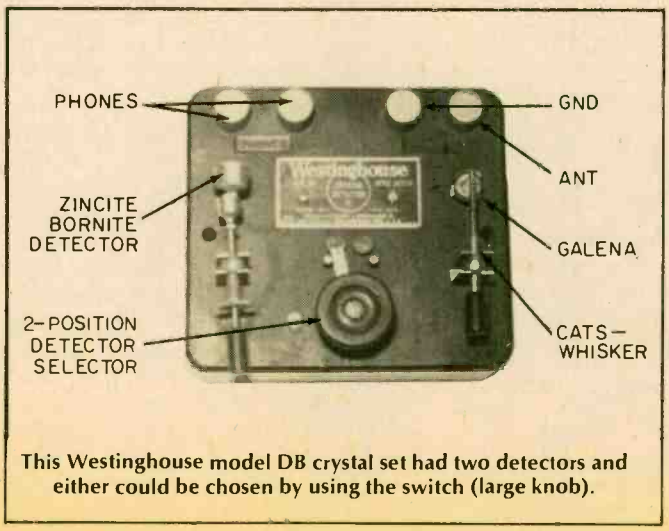
Electrolytic Detector developed by Wollaston was used in the very earliest days.

The magnetic detector (not shown) was a very sensitive device utilizing the changes in the magnetic state of iron. If a core of iron wires is placed in a varying magnetic field, the magnetization of the iron will lag behind the magnetizing force on account of hysteresis or magnetic friction. But if a rapidly oscillating current is passed through a coil surrounding the iron a sudden change in magnetization occurs. This is sufficient to induce current in the secondary winding of the coil.

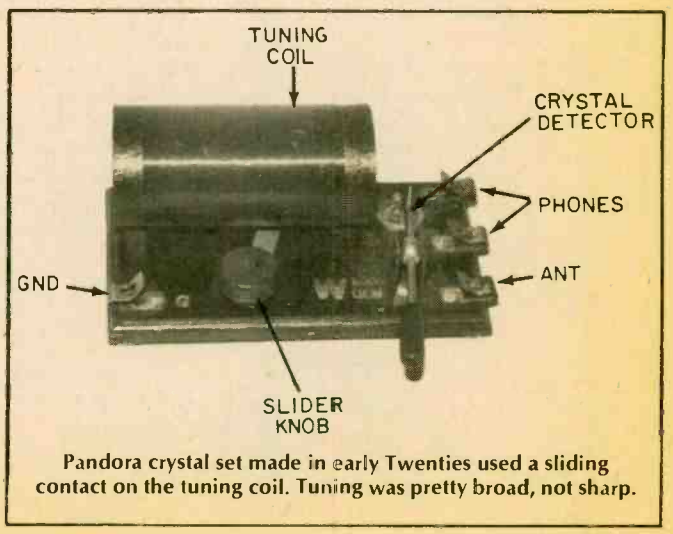


Early silicon detector had a brass screw instead of the subsequent spring-loaded wire.

The two detectors above described were difficult to use and were soon replaced by the mineral (rectifying) type. Nearly everyone tried different ma-



This Westinghouse model DB crystal set had two detectors and either could be chosen by using the switch (large knob).



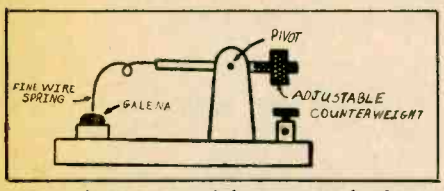
Pandora crystal set made in early Twenties used a sliding contact on the tuning coil. Tuning was pretty broad, not sharp.

terials so there were soon several mineral detectors available. The silicon detector shown consisted of a flat surface of highly polished silicon upon which rested a brass point. I suppose we should consider this the forerunner of the present day silicon diode.

The Pyron detector was a crystal of iron pyrite imbedded in a cup of low melting-point metal for contact. A small wire spring pressed against the surface of the iron pyrite. The Pyron detector was difficult to adjust, but remained in a sensitive condition much longer than the silicon type.

Another type, the Perikon detector, consisted of a piece of the mineral Zincite imbedded in a low melting-point metal. Another cup containing Bornite was held in a similar cup fastened to the end of a rotating rod. The Bornite was brought into contact with the Zincite and the pressure adjusted by means of a spring.

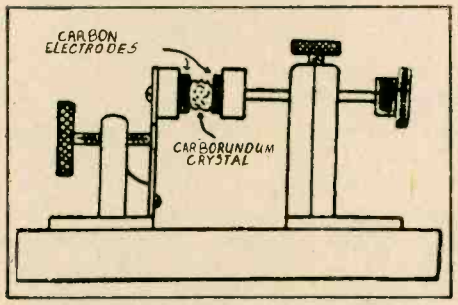
The Galena Crystal. Now we come to the most-often-used mineral galena. Galena is a mineral found in connection with lead mining in southeastern Kansas, northern Oklahoma, and southern Missouri. A piece of rough galena is imbedded in a cup filled with a low melting point material such as lead, a fine spring wire called a "catswhisker" is used to probe the surface of the galena for a sensitive spot The mineral detectors were most often called crystal detectors.



This primitive crystal detector used galena rectifier, which survives even today!

Crystal detectors act as rectifiers to change the alternating radio frequencies to pulsating (audio) DC which can activate the headphones. Minerals used for this purpose possess unilateral conductivity—in other words, they conduct current much better in one direction than they do in the other. This is called rectification.

Another mineral having unilateral conduction is a man-made material, carborundum. When properly adjusted this form of detector is very sensitive. It consists of a small crystal of carborundum clamped tightly between two carbon electrodes and it is more sensitive if used with a small battery. This detector was used for a number of years in all the offices of the United Wireless Telegraph Company.



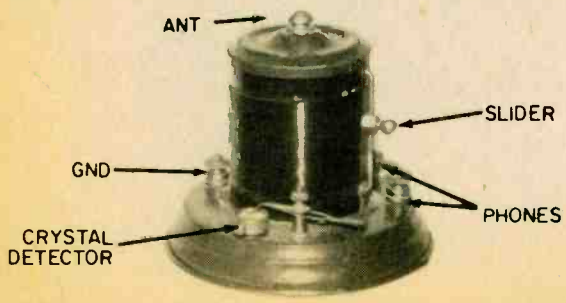
Carborundum detector was popular with shipboard "Sparks" (operators) for years.

One problem encountered in wireless installations in ships at sea was the unstable conditions during rough weather. A galena or pyron detector that depended on a catswhisker to contact the mineral could be jarred or accidentally moved from its sensitive spot and could lose the signal at a critical time. This is the reason the carborundum detector was popular in the radio shacks aboard ships.

Now that we know what materials were used as detectors of wireless signals let's see how they were used in the circuits.

The Simplest Receiver. First, in Fig. 1, we see the simplest type of crystal radio receiver. It consists of a tuning coil, a crystal detector, an RF bypass condenser, and a pair of headphones. This receiver will not separate stations well because it tunes very broadly and the loudest station will crowd out the weaker ones.

In Fig. 2 we have added a variable condenser that enables us to tune (separate) the stations. The tuning coil may be wound on a 2 or 2½-in. insulated tube. Wind 250 turns of no. 26 enameled wire in a single layer on this form. Along one side sandpaper or scrape the enamel off the wire in a path about ½-in. wide, the whole length of the coil. Install a sliding contact to rub on the clean wire. To tune in a station use the coil for broad tuning and the variable condenser for the fine tuning.



Another early-Twenties crystal set which also used a slider on the tuning coil. It had limited selectivity, which could be improved by adding a tuning capacitor across the coil—an improvement which was soon incorporated into most receivers.

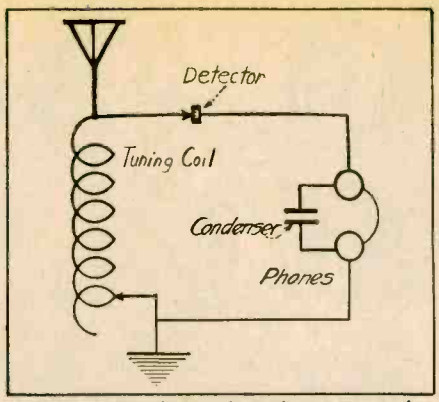


Fig. 1. Minimal crystal receiver tunes only broadly, using the coil slider to tune.

To further increase the selectivity of a crystal receiver we can use a *loose coupler.* This is shown schematically in Fig. 3. The loose coupler is made up of two tuning coils, one sliding inside the other. One is the primary, to which the antenna and ground are connected. The secondary slides into the primary so that the coupling between the two coils can be varied. To further improve the tuning a slider may be put on the coil, as shown in Fig. 4.

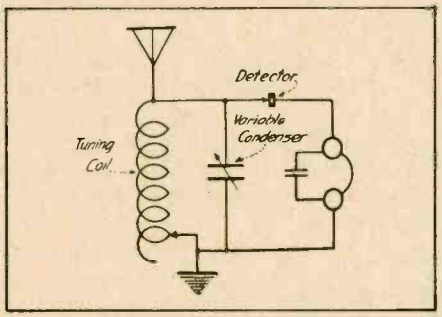
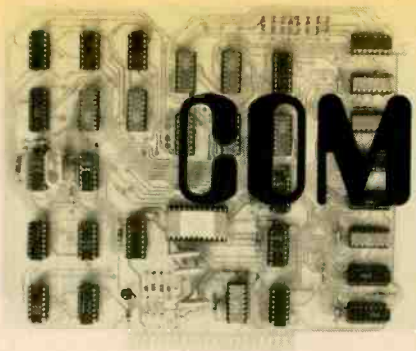


Fig. 2. Adding variable condenser across coil improves tuning the stations somewhat.

One more improvement can be made, and that is to install another tuning condenser in the primary circuit. This is shown in Fig. 5. This improves the selectivity—the ability to separate stations. By now the crystal radio has four or five tuning controls which is beginning to make it hard to tune in a station. When this point is reached most experimenters are ready to build a vacuum tube radio.

Commercial Sets. Now that we are familiar with mineral detectors and the different tuning arrangements used in crystal receivers let us look at some

(Continued on page 99)



COMPUTER READOUT

by Norman Myers, Computers Editor

How a Microcomputer Works

☐ In the last two issues we talked about the Altair 8800 which is a microcomputer based on the Intel 8080 microprocessor. The Altair, with its 65,536 words of memory, typewriter interface capability, and full complement of software packages, is a complex and powerful machine.

The microcomputer we will describe this time is different. It is small enough to fit in your coat pocket yet it is programmable, accepts over 40 instructions, has a small alpha-numeric readout, and can be used for many things from playing computer games to controlling external electrical devices. With some imagination you could make it control your model railroad or your holiday lights.

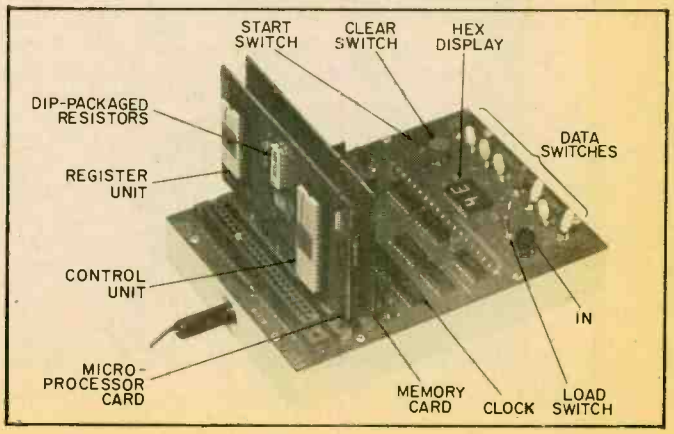
A New Smaller Computer. This unit is called the *Microtutor*, is made by RCA, and comes assembled and ready to go. The integrated circuits (ICs) are neatly fitted into the printed circuit layout on the three boards in this computer. The base, about 5 by 6 by one inches, overall, contains the clock, power supply, logic circuits, switches for inputting information, and a two-digit LED display for visual output all on one board. In addition there are two smaller boards containing components. These boards are called cards, and they have pin connections on one end that plug vertically into sockets on the base. One card contains the microprocessor, the other the random access memory (RAM). There is an empty socket on the base which provides electrical access to the data lines and other portions of the microprocessor. This access permits testing as well as control of external devices. The Microtutor Manual explains in humorous style the basics of what the unit can do and how to write programs for it. A program that I call Password is shown later in this article. First though, let's look at the Microtutor hardware, the *hexadecimal* code which it uses, and a block diagram operation of the unit.

Basics. Microtutor is an 8-bit computer whose heart is the RCA CDP1801 microprocessor. It's made up of two plug-in ICs; the control IC and the register IC, both of which are mounted on the same plug-in card. RCA also has a CDP1802 which can handle more instructions than the 1801, and is on a single chip, but the basics of the 1801 and 1802 are the same. The control chip of the 1801 receives control signals from the clock and in turn controls the movement of instructions and data through the register chip and into the RAM. There are 256 memory locations available in Microtutor although an 1801 can address up to 65,536 locations.

There are four control switches and eight data switches. Let's look at the four control switches: *Clear, Start, Load,* and *In*. The *Clear* button returns the microprocessor to the first instruction of your program and lets it sit there. The Start button begins execution of the prorgam. The Load toggle-switch is turned up when the program steps are entered and down when the program is to be run. The In button is pressed once for each instruction or data word to be loaded. An instruction or data word is selected with the 8 "data" switches (these are toggles) and then In is pressed. Each press of In causes the instruction or data word to be entered into the next available memory location in the RAM. Also, as In is pressed, the values set on the data switches are displayed on the two digit LEDs.

What's Hexadecimal Counting? How can these 8 switches (corresponding to 8 bits—a bit being either 0 or 1 in computer language) give a two-digit alphanumeric readout? Simple—the eight are divided into two groups of four each. With this arrangement, setting the 8 switches to 0001 0010, for example, would cause 1 and 2 (that's 1, 2—not twelve) to show on the LEDs. All is well, you say, until 1001 1010 is set on the data switches. The value of this setting, when converted from binary to decimal, is "nine, ten." How can we show "ten" on a single LED? Bring in the letters A through F: Letter A is ten, B is eleven, etc. This form of counting is known as hexadecimal, which means sixteen in Greek. (Apparently it was invented by programmers with sixteen fingers!) The Altair microcomputer in our Sept.-Oct. issue used *octal* code—groups of three bits are used. Here, the Microtutor uses hexadecimal—groups of four bits are used. Octal is a little easier for the user to work with, but "hex" simplifies the computer hardware because the RAM is readily set up to take four bits at a time.

Loading The Memory. An analogy helps to explain what Microtutor (as well as most other computers) does in storing and executing instructions. Imagine the computor's memory to be an office mail box made of pigeon holes—lots of little, stacked, square boxes. There are 16 "pigeon holes" in this memory down the side and 16 along the top, a total of 256. To address the hole designated as 0, 0 (first row, first column) you push the *Load* switch up and set the data switches at 0000 0000. Now in that pigeon hole you put the



RCA's Microtutor is a learning tool which can control external devices as well. It has 256 memory locations, four control switches, and eight data-input switches. Completely assembled, with its manual, Microtutor costs $349.

blank instruction "0 0" which happens to be needed to start all Microtutor programs. Then move to the 0 1 hole and place an instruction in there, such as "F8" (more on instructions in a minute). Then move on to the 0 2 hole and put an instruction in there. Continue in this fashion, and when you have finished loading the pigeon holes with a sequence of instructions, you have written a program and placed it in memory.

To run this program, push the *Load* switch down, press *Clear* to get back to the 0 0 hole, and then press *Start*. The processor goes from one hole to the next, doing as the instruction in each hole directs—such as, "add 5 to the number in the next hole, and store the result in hole 2 1."

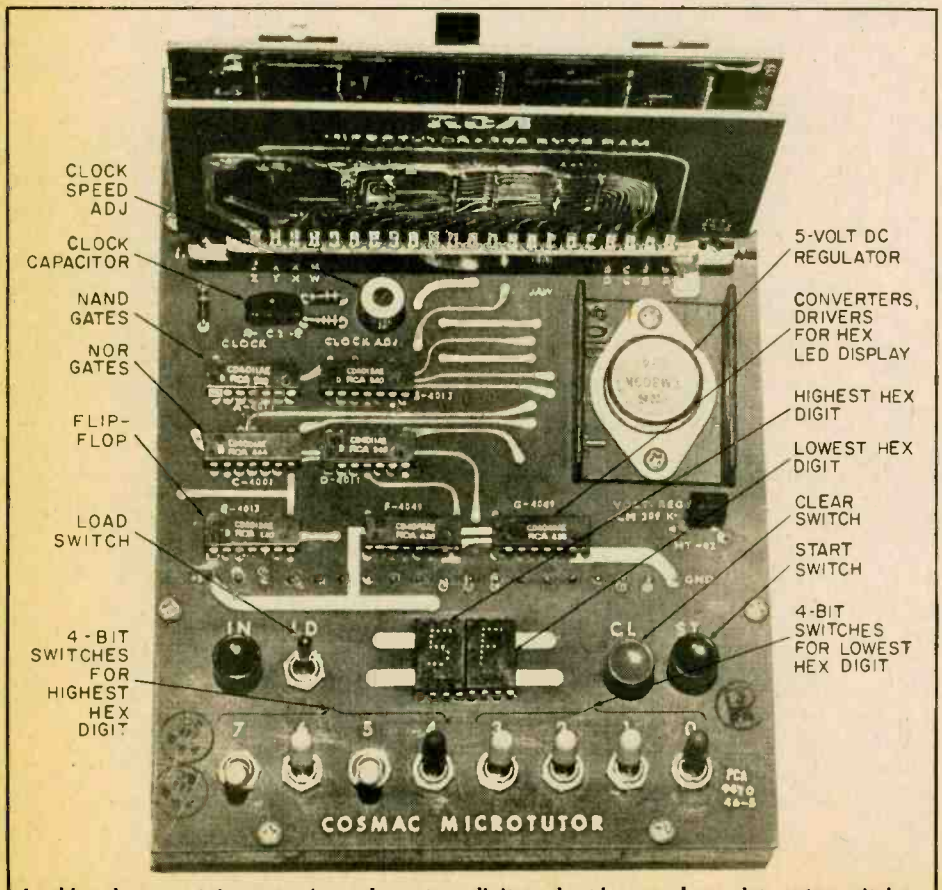
Block Diagram. If we now look at a block diagram of the Microtutor we can understand some of the instructions that we can put into the "pigeon holes," and then we can write a useful (and fun) program. Remember, however, that block diagrams are like stamp collections. That is, they're really dull until you get into them, and then you're stuck. Too, block diagrams don't answer detailed questions—they just supply general, over-all ideas.

Looking at the block diagram you can see the eight data switches and four control switches that are inputs to the Microtutor. The two LED digits provide the visual output. The arithmetic logic unit (ALU) performs simple arithmetic (add, subtract, logical AND, etc.) on two 8-bit words. One word comes from the D register, which in turn got the word handed to it under some program control, and the other word is sent to the ALU by means of a memory location supplied by the program.

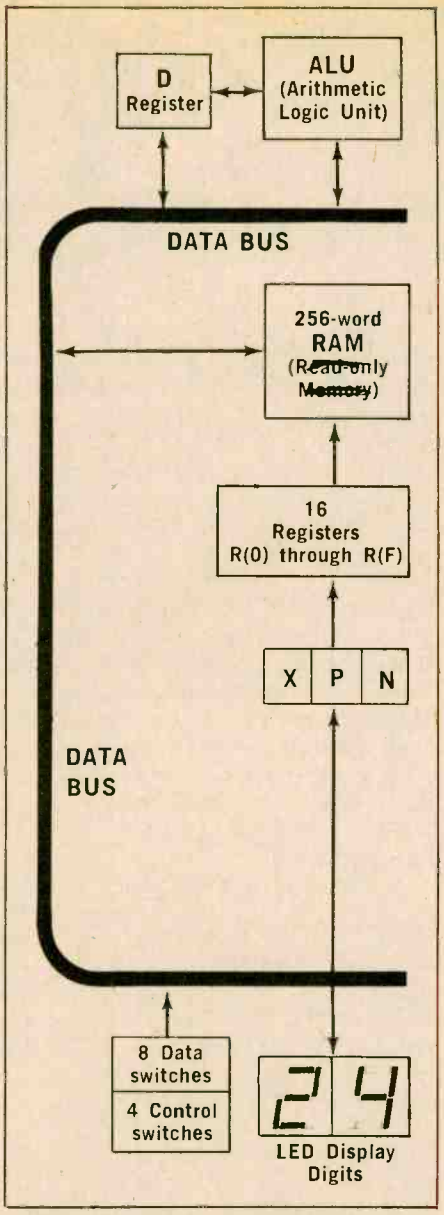
More Operation. The 16 general purpose registers R(O) through R(F) each hold an 8-bit word. (In the 1801 and 1802 microprocessors, these registers actually hold 16 bits, but Microtutor is designed on a smaller scale). These registers can be selected under program control either to hold data or to hold the location of a specific memory slot, like 0001 0010. One register is called the *program counter*. This counter directs the microprocessor to the memory location containing the instruction that is to be executed next. Normally, this counter just keeps incrementing (increasing) by one as each instruction is performed. But if a special *branching* condition is encountered during execution of the program, the program counter can skip over as many memory locations as it is directed and pick up an instruction many "pigeon holes" away. The register chosen to be the program counter is determined by the value in register P. If P contains 0101, then register 5—written R(5)—will be the program counter. When *Clear* is activated it automatically sets P to zero, so register R(0) is normally the program counter, and *Clear* makes the value value in R(0) equal to 000 0001. Thus the program starts at the top of the memory.

Register X is important. Pay close attention, now, because this is a bit tricky. Any 4-bit value contained in

(Continued on page 100)



Looking down on Microtutor from above two-digit readout is seen above data entry switches.



Block diagram shows relations of major parts. Entering commands and data on switches gives results on two digits.

e/e BASIC COURSE IN ELECTRICITY & ELECTRONICS

RECOMMENDED THEORY FOR ALL CB OPERATORS

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CATHODE-RAY TUBES IN TV SETS AND OSCILLOSCOPES

WHAT YOU WILL LEARN. When you have finished reading this article you will have learned how the cathode-ray tube, which is the display device for oscilloscopes, as well as for all television receivers, works. In addition you will know what the differences are between cathode-ray tubes used in 'scopes and those used in TVs.

THE CATHODE-RAY TUBE

The cathode-ray tube (which we'll refer to as CRT from here on) is a large vacuum tube which has three main parts. They are, first, the **electron gun**, which produces a steady stream of electrons and aims them at the large, flat end of the tube, second, **deflecting** devices, which move the electron beam in accordance with the signal to be observed, and third, the chemical coating on the large flat end of the CRT, commonly called the **screen.**

The oscilloscope displays electrical signals on the screen to show what's going on in electrical or electronic circuits. The TV set shows pictures transmitted from the TV station. In both cases the CRT used in the 'scope or the TV set are almost exactly the same.

The main difference in the picture tube in TV sets and the CRT in scopes today is that the electron beam is moved back and forth in the TV set *electromagnetically,* by coils of copper wire placed around the neck of the tube, while the electron beam in a 'scope is moved about by the changing *electrostatic* voltages between small deflection plates inside the neck of the tube. In fact, the earliest TV picture tubes were electrostatic-deflection CRTs, and during the Korean War, when copper for the magnetic deflection coils was scarce, TV set makers stopped making electromagnetic-deflection picture tubes and went back to the earlier, electrostatically-deflected tubes!

THE CRT IN OSCILLOSCOPES

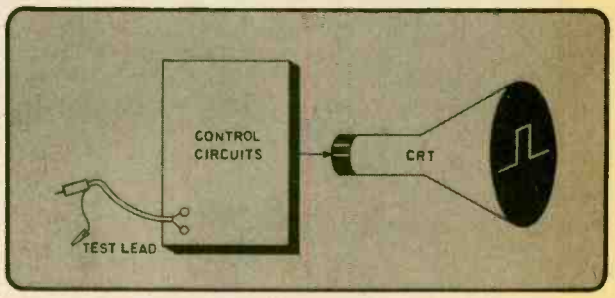
The oscilloscope is really a not-very-exact *measuring* instrument for voltages and waveforms which also shows what the voltages or signals *look* like. Although it *can* be pretty exact in its measurement of signals, only the most expensive 'scopes are nearly as precise as even cheap meters, so their main purpose is usually to show what the signals look like.

The oscilloscope contains, in addition to the CRT, a power supply which generally provides 2,000 volts or more, and some control circuits which take the signal voltage(s) to be displayed, amplify and the otherwise process them and feed them to the CRT for display.

'Scope CRTs have a screen usually made of phosphorescent (give off light when struck by electrons) chemicals which create a green display. Some very expensive 'scopes use CRTs with blue, or even purple-emitting phosphor-coated screens. TV sets of course have screens with white light-emitting screens (in black and white sets).

The CRT in oscilloscopes uses electrostatic deflection, with the deflecting voltages applied to the vertical-deflecting plates and to the horizontal deflecting plates, as shown in the diagram.

SIMPLIFIED OSCILLOSCOPE



The signal voltage size is indicated by the *amplitude* (height, up-and-down dimension) of the beam movement on the screen. The *time period* (duration) is shown by the distance the beam travels across the screen horizontally, from left to right.

By relating the time a signal takes to its amplitude (size) and its shape, we can get a very accurate idea of what's going on in most circuits at any desired point.

QUESTIONS

Q1. A waveform can be described in terms of its vertical and horizontal dimensions. What are these dimensions? a_____, t_____.

Q2. A cathode-ray tube can display a picture on its face, or screen. What causes the picture to appear?

Q3. An oscilloscope is made up of a cathode-ray tube and a group of control circuits. What is the function of the control circuits?

ANSWERS

A1. The vertical and horizontal dimensions of a waveform are **amplitude** and **time.**

A2. The picture on a CRT is developed by a **moving electron beam** that strikes and illuminates a chemical coating on the inside face of the tube.

A3. The function of the oscilloscope control circuits is to process, amplify, and deliver the **signal** to the CRT.

THE CRT IN TV SETS

The cathode-ray tube is the display device in the television set. The CRT operates by moving a controllable beam of electrons across the inside face of the tube. The number of electrons in the beam is determined by the blacks, grays, and whites of the scene the TV camera is viewing. White is produced by a large number of electrons striking a chemical coating on the inside of the tube. The electrons cause the coating to give off light. Black is achieved by stopping the electron flow, and shades of gray are obtained by varying the amount of electrons between the amounts required for black and white.

The picture is "painted" on the screen by the narrow electron beam moving back and forth across the tube many times a second. This movement is due to varying magnetic fields produced by a set of horizontal and vertical deflection coils around the neck of the CRT.

The principle of putting a picture of a waveform on the screen of an oscilloscope is similar. The movement of the electron beam in the 'scope is controlled *electrostatically* so that the beam traces out the pattern of the waveform being measured. As in the TV tube, the electron beam illuminates a coating on the inside of the tube.

Electrostatic Fields

To understand how the CRT operates you must know that an electrostatic field is a space in which electric forces act.

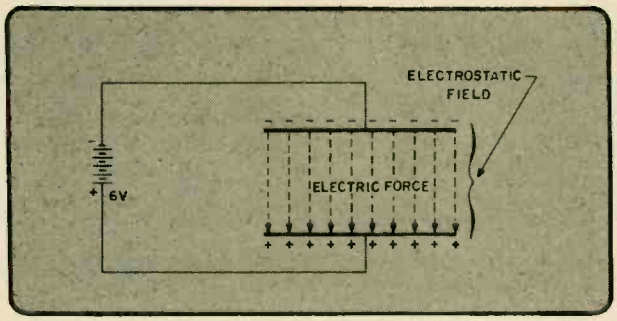
An electrostatic field can be developed between two charged plates. If one plate is negative with respect to the other, the direction of the electric force can be determined.

In the drawing shown, lines of electric force take a direction from negative to positive. This means a negatively-charged body entering the field would be moved downward (from negative to positive). A positively-charged body, however, would be moved upward (positive to negative). (Like charges repel, and unlike charges attract). How do you think an electrostatic field is formed?

An electostatic field is formed with a voltage source and a pair of metallic plates to hold the charges.

If a 6-volt battery is connected to the plates in the manner shown, the battery will draw electrons from the bottom plate and deposit them on the top plate until the difference in potential between the plates equals the battery voltage. The potential of the plate having an

ELECTROSTATIC FIELDS



excess of electrons will be negative. The other plate, being deficient in electrons, will be positive.

QUESTIONS

Q4. What is an electrostatic field?

Q5. What causes an electrostatic field to exist between two metallic plates?

ANSWERS

A4. An electrostatic field is a region in which **electric forces** are acting.

A5. An electrostatic field is formed when one plate has an excess of and the other a deficiency of electrons.

Electrostatic Forces Between Circular and Tubular Plates

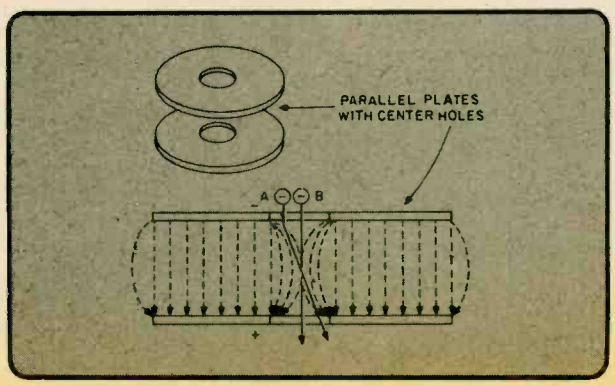
In the drawing shown an electrostatic field between two plates having center holes is shown. Observe the curvature of the force lines under the holes.

PRODUCING AN ELECTROSTATIC FIELD

Since its path is parallel to the force lines, electron B will pass straight through the axis (center line) of the holes. Electron A starts in the same direction as electron B. When electron A enters the feld, it turns in the direction of the force lines. Just before it leaves the field, it is turned even further and in the direction of the curvature of the force lines.

Suppose a small and a large cylinder, both charged with a positive potential, are placed so the electrons must pass through them. Also suppose the larger cylinder has a more positive charge. The distribution of

ELECTROSTATIC LENS I

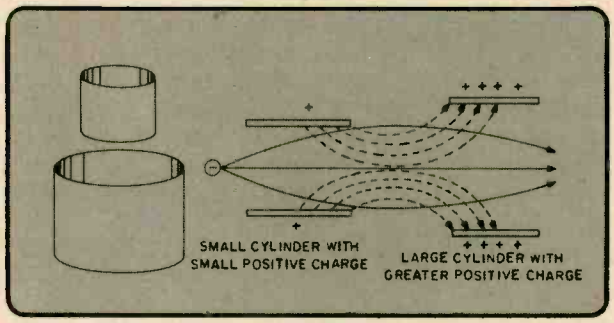


the lines of force would look like the next illustration.

An electron in the space at the left of the small cylinder would be attracted toward the cylinder by the positive charge. If the electron was traveling along the axis of the cylinder, it would pass through without crossing a line of force. As it approached the larger, more positively charged cylinder, the velocity of the electron would increase.

An electron entering the small cylinder at an angle will cut the lines of force and be turned in their direction as shown by the top and bottom electron paths in the figure.

ELECTROSTATIC LENS II



ELECTROSTATIC FOCUS

As it approaches the larger cylinder, the electron will be accelerated by the higher positive potential. Because of the higher electron velocity, the force lines in the larger cylinder will have a smaller turning effect on the electron. If the difference of potential between the cylinders is adjusted properly, the electrons will unite at a given distance after passing through the second cylinder. This action of the electrons as they pass through the influence of the two cylinders provides a convenient method of focusing the electron beam.

QUESTIONS

Q6. As an electron approaches the larger cylinder, the velocity of the electron will - - - - - - - - .

Q7. Why is the above statement true?

ANSWERS

A6. As an electron approaches the larger cylinder, the velocity of the electron will **increase.**

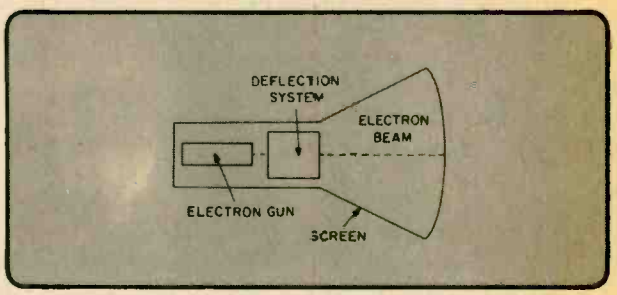
A7. The above statement is true because the larger cylinder is **more positively charged.** It will attract the electron with a greater force, thereby increasing the velocity of the electron.

ELECTRON GUN

Cathode-ray tubes used in oscilloscopes consist of an *electron gun,* a *deflection system,* and a *florescent screen.* All elements are enclosed in an evacuated container, usually glass. The electron gun generates electrons and focuses them into a narrow beam. The deflection system moves the beam across the screen in the manner desired. The screen is coated with a material that glows when struck by the electrons.

An electron gun has a cathode to generate electrons, a grid to control electron flow, and a positive element to accelerate electron movement. The control grid is cylindrical in shape and has a small opening in a baffle at one end. The positive element consists of two cylinders, called anodes. They also contain baffles (or plates) having small holes in their centers. The main purpose of the first anode is to focus the electrons into a narrow beam on the screen. The second anode speeds up the electrons as they pass.

BASIC CATHODE-RAY TUBE



Cathode and Grid

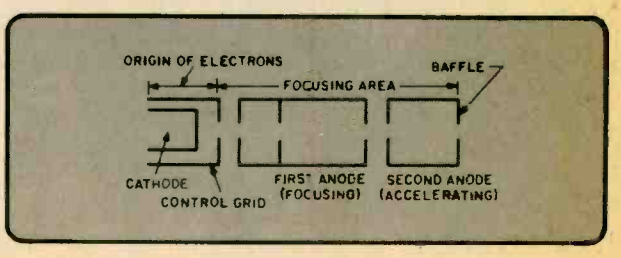
The cathode is indirectly heated and emits a cloud of electrons. The control grid is a hollow metal tube placed over the cathode. A small opening is located in the center of a baffle at the end opposite the cathode. The grid is maintained at a negative potential with respect to the cathode.

A high positive potential on the anodes pulls electrons through the hole in the grid. Since the grid is near the cathode, it can control the number of electrons that are emitted. As in an ordinary vacuum tube, the negative voltage of the grid can be changed to vary electron flow or stop it completely. The brightness of the image on the fluorescent screen is determined by the number of electrons striking the screen. Intensity (brightness) can, therefore, be controlled by the voltage on the control grid.

Focus Control

Focusing is accomplished by controlling the electrostatic fields that exist between the grid and first anode and between the first and second anodes. Study the diagram. See if you can determine the paths of electrons through the gun.

DIAGRAM FOR Q8 and Q9



QUESTIONS

Q8. Which element controls the number of electrons

striking the screen in the drawing titled *electrostatic fields?*

Q9. Which element controls the focus of the beam?

ANSWERS

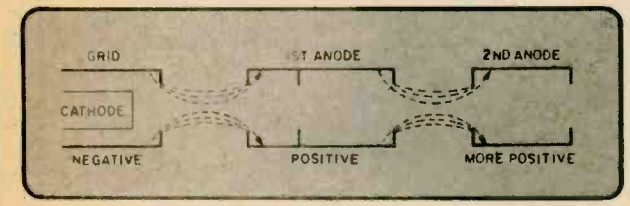
A8. The **control grid** controls the number of electrons striking the screen.

A9. The **first anode** controls the focus of the beam.

Electrostatic Lenses

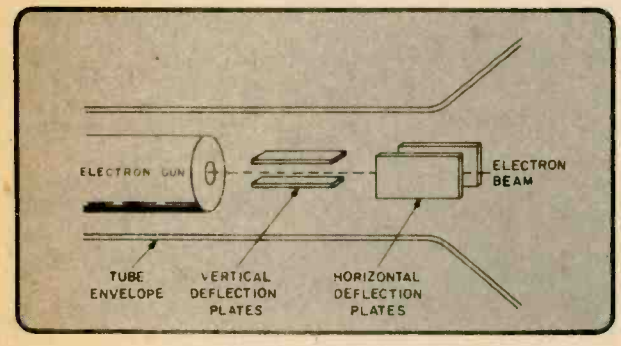
The next diagram shows electrons moving through the gun. The electrostatic field areas are often referred to as *lenses*. The first elctrostatic lens causes the electrons to cross at a focal point within the field. The second lens bends the spreading streams and returns them to a new focal point.

ELECTRON GUN "LENSES"



The diagram also shows the voltage relationships on the electron-gun elements. The cathode is at a fixed positive voltage with respect to ground. The grid is at a variable negative voltage with respect to the cathode. A fixed positive voltage of several thousand volts is connected to the second (accelerating) anode. The potential of the first (focusing) anode is less positive than the potential of the second anode. It can be varied to place the focal point of the electron beam on the screen of the tube. Control-grid potential is established at the proper level to allow the correct number of electrons through the gun for the desired screen intensity.

ELECTRON GUN AND BEAM FORMATION

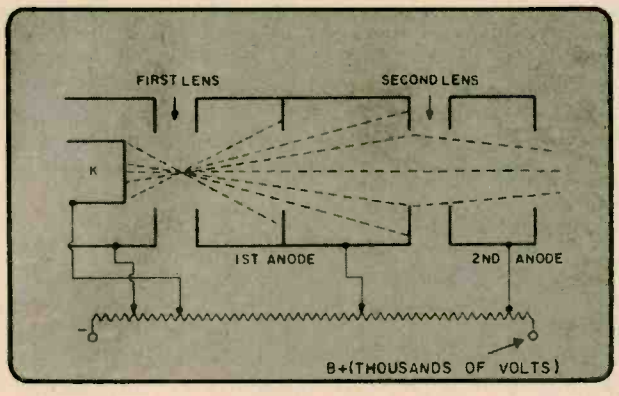


ELECTRON-BEAM DEFLECTION SYSTEM

The electron beam is developed, focused, and pulled toward the screen by the electron gun. It appears on the screen of the CRT as a small, bright dot. If the beam were left in one position, the electrons will soon burn away the illuminating coating in that one area. To be of any use, the beam must move. As you have learned, an electrostatic field can bend the path of a moving electron.

Assume the beam of electrons passes through an electrostatic field between two plates. Since electrons are negatively charged, they will be deflected in the direction of the electric force (from negative to positive). The electrons will follow a curved path through the field. When the electrons leave the field, they will take a straight path to the screen at the angle at which they left the field. Although the beam is still wide (the focal point is at the screen), all the electrons will be traveling toward the same spot. This is assuming, of course, that the proper voltages are existing on the anodes which produce the electrostatic field. Changing the voltages changes the focal point of the beam.

ELECTRON GUN FIELDS



QUESTION

Q10. Why are the electrostatic fields between electron-gun elements called lenses?

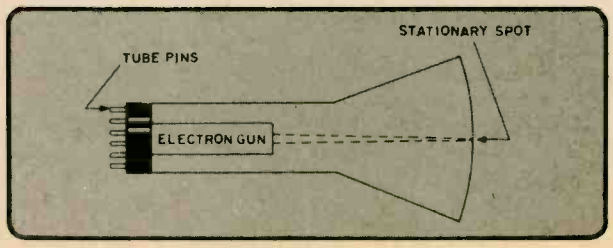
ANSWER

A10. They are called lenses because the fields **concentrate and focus** the electron streams in the same manner that optical lenses bend light rays.

Vertical and Horizontal Plates

If two sets of deflection plates are placed at right angles to each other inside a CRT, the electron beam can be controlled in any direction.

CRT WITHOUT DEFLECTION



By varying the voltage between the two vertical-deflection plates, the spot on the face of the tube can be made to move up and down. The distance will be

proportional to the change in voltage between the plates. Changing the voltage difference between the horizontal-deflection plates will cause the beam to move a given distance from one side to the other. There are directions other than up-down and left-right. The beam must be deflected in all directions.

Note the double diagram. You can see that the beam may be moved to any position on the screen simply by moving it both vertically and horizontally.

In the top diagram, position A of the beam is in the center. It can be moved to position B by going up two units and then right two units. Movement of the beam is the result of the simultaneous action of both sets of deflection plates. The electrostatic field between the vertical plates moves the electrons up an amount proportional to two units at the screen. As the beam passes between the horizontal plates, it is moved to right an amount proportional to two units at the screen.

QUESTION

Q11. In the right figure, how many units and in which direction will each set of deflection plates move beam A′ to B′?

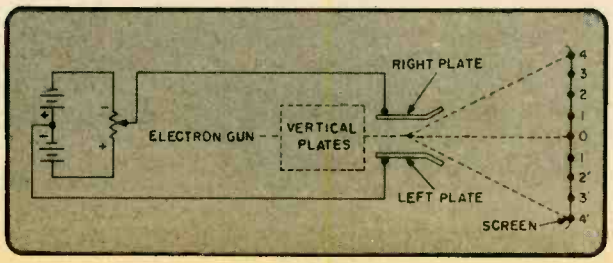
ANSWER

A11. The vertical plates will move the beam **down three units.** The horizontal plates will move the spot **one unit to the left.**

Voltage Control of Horizontal Plates

Assume that the resistance of the potentiometer in the figure is spread evenly along its length. When the arm of the potentiometer is at the middle position, there is the same potential on each plate. Since here is zero potential between the plates, an electrostatic field is not produced. The beam will be at zero on the screen. If the arm is moved downward at a uniform rate, the right plate will become more positive than the left. The electron beam will move from 0 through 1, 2, 3, and 4 in equal time intervals. If the potentiometer arm moves at the same rate in the other direction, the right plate will decrease in positive potential. The beam returns to the zero position when the potential difference between the plates again become zero. Moving the arm toward the other end of the resistance will cause the left plate to become more positive than the right. The direction of the electric force reverses, and the beam moves from 0 through 4′. If the movement of the potentiometer arm is at a linear (uniform) rate, the beam will move at a steady rate.

HORIZONTAL PLATES—TOP VIEW

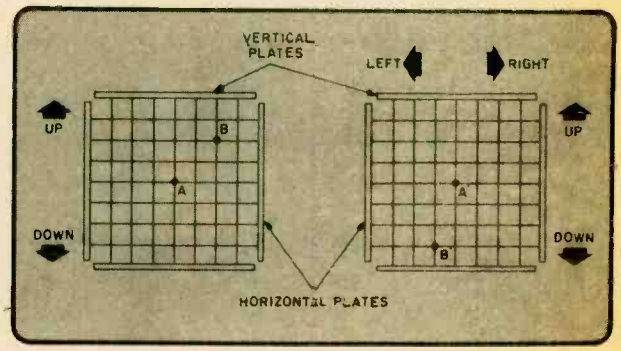


AMPLITUDE VERSUS TIME

Do you recall the statement made earlier that waveforms could be described in terms of amplitude and time? You have just seen how the movement of the CRT beam depends on both potential (amplitude) and time.

From zero time to 1 second the waveform in the diagram is at zero volts. In the CRT the vertical plates remain at the same potential difference while the potential difference between the horizontal plates increases 1 unit in the direction necessary to move the beam toward the right. When time is equal to 1 second the waveform rises to +2 volts. The potential difference between the vertical plates increases enough to move the electron beam 2 units in the positive direction. From 1 to 4 seconds, the waveform remains at +2 volts and then decreases to −2 volts. As the horizontal-plate potential difference increases by 3 units, the vertical potential remains the same (+2 units) and then drops sharply 4 units. For the next 3 seconds the waveform remains at −2 volts. In the CRT, the potential difference between the vertical plates remains unchanged as the horizontal potential increases uniformly by three units.

DEFLECTION OF CRT BEAM



The vertical-plate potential difference follows the *voltage* of the waveform. The horizontal-plate potential follows the passage of time. Together they determine the *trace* (image produced on the screen by the moving beam).

QUESTIONS

Q12. Waveforms can be described in terms of a_____ and t_____.

Q13. The horizontal-deflection plates are used to reproduce the a_____ t_____. (choose one)

Q14. The vertical-deflection plates are used to reproduce the a_____ t_____. (choose one)

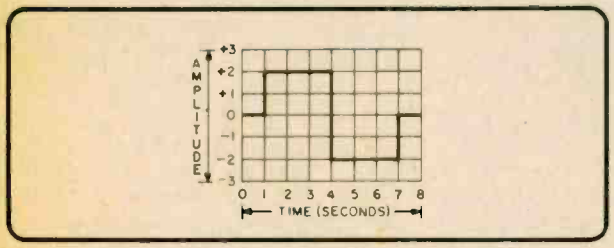
ANSWERS

A12. Waveforms can be described in terms of **amplitude** and **time.**

A13. The horizontal-deflection plates are used to reproduce the **time component.**

A14. The vertical-deflection plates are used to reproduce the **amplitude component.**

DEFLECTION OF CRT BEAM



CRT TYPE-NUMBER DESIGNATION

Cathode-ray tubes are designated by a tube number, such as 2AP1, 2BP4, 5AP1A, etc. The first number identifies the diameter of the tube face. Typical diameters are 2 inches, 5 inches, and 7 inches. Tubes can have diameters up to 24 inches or more. The first letter designates the order in which a tube of a given diameter was registered. The letter-digit combination indicates the type of phosphor (glowing material) used on the screen. Phosphor P1, which is used in most oscilloscopes, produces a green light at medium **persistence.** P4 provides a white light and has a short persistence. Persistence refers to the length of time the phosphor glows after the electron beam is removed.

CRT Safety

Handle all cathode-ray tubes with great caution. Because of its size and vacuum condition, a tremendous amount of pressure is exerted inward all over the CRT's surface. A bump may weaken the glass, causing it to **implode** (opposite of explode but with the same results). Pieces of glass and parts will fly in all directions. When replacing a CRT, store the old tube in the box which the new one came in for safely disposing of it later.

WHAT YOU HAVE LEARNED

An electron gun contains a cathode (to emit electrons), a control grid (to control the intensity of the trace on the screen), a first anode (to develop the electric lenses that focus the beam on the screen), and a second anode (to accelerate the electrons toward the screen). Deflection plates in vertical and horizontal pairs are used to position the beam on the screen. If a waveform is applied to the scope, the plates deflect the beam according to the amplitude and time characteristics of the waveform.

This series is based on material appearing in Vol. 4 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. @ $22.50. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

DX Central Reporting

(Continued from page 16)

"With best wishes for all gud DX, 73, Garry Hart, United States Senator."

For those of you who aren't too sure about the countries in which the *VOA* operates shortwave relay transmitters, there are facilities in Colombo, Sri Lanka; Kavala, Greece; Monrovia, Liberia; Munich, Germany; Okinawa; Poro, Philippines; Rhodes, Greece; Tangier, Morocco; Tinang, Philippines and Woofferton, England.

A current *VOA* schedule with list of hours and frequencies, plus locations of the transmitters, may be had by writing to the *Voice of America*, U.S. Information Agency, Washington, DC 20547.

A Further Look at Radio Swan. Some months back, in ELEMENTARY ELECTRONICS, we ran a feature article on a Latin American broadcaster known as *Radio Swan*.

This station, which went on the air in mid 1975, was rather mysterious and appeared to be trading on the name of a strongly anti-Communist broadcaster of the 1960's. The original *Radio Swan*, we explained, broadcast from a tiny island in the Gulf of Mexico, Swan Island, claimed by both the U.S. and Honduras. *Radio Swan* programmed avowedly anti-Castro programs beamed to Cuba and reportedly involved itself in cloak-and-dagger broadcasts just prior to the Bay of Pigs invasion. Later it was widely reported that *Radio Swan* was controlled by the Central Intelligence Agency.

So it was a surprise when the new *Radio Swan* took to the air on 6,185 and later 6,000 kHz on the SWBC 49-meter band. Like the original version, this *Radio Swan* was openly anti-communist and seemed to be claiming a link with the station of the past. But its president, one Rafael Nodarse, in QSL replies to DXers did not really answer many questions about his station, which in its reincarnation broadcast from San Pedro Sula, Honduras, not from Swan Island.

In that article we even suggested that the president's name, Nodarse, might be fictitious.

It's Really Real! The article apparently stung Sr. Nodarse who, after ignoring earlier letters seeking information about *Radio Swan*, finally replied. He had more than a few objections to our feature story.

Among his complaints—and one where I owe him an apology—was my suggestion that the name Nodarse might simply be a nom-de-guerre. Indeed, Nodarse is his real name, apparently a well-known Cuban family. Rafael Nodarse, himself, was a member of the parachute battalion that landed at the Bay of Pigs during the disasterous Cuban invasion.

Sr. Nodarse admitted that, except for the name, there was no connection with the original *Radio Swan*. Both are, of course, anti-communist in tone. He also stresses that the present day *Radio Swan* has no connection with the CIA. He said the station was duly licensed by the government of Honduras. But, in the end, he never really did explain much about his station. He, in fact, denied there was any mystery about *Radio Swan* at all.

It's Still A Mystery. In fact, though its links appear to be unrelated to those of the original *Radio Swan*, the new station remains quite mysterious. In fact, a few months ago the station's radio tower in a suburb of San Pedro Sula was toppled by a bomb explosion. Nodarse blamed the "Communists" for this attack on the station.

My investigation is continuing into this puzzling station. I would suggest, however, that the powers behind the station are more apt to be Honduran than CIA agents. Sr. Nodarse is related by marriage to powerful military officers in the Honduran government, I am told.

BANDSWEEP. (Times in GMT, frequencies in kHz) **3,930**—Here's a nice one that is being heard lately

around 2330. The station is *Voz de Sao Vicente* and is located on one of the Cape Verde Islands off Africa's west coast . . . **6,105**—Though an economy drive cut out the foreign service, *Radio New Zealand* still survives on shortwave. Today, however, the programs you hear are the same as those heard on the domestic stations by New Zealanders. Listen in between about 0830 and 1030 GMT . . . **9.585**—*Radio Japan*, Tokyo, has been reported with an English language commentary program at 1430. The signal is a good one too!

(Credits: Dan Henderson, MD; Bob Zilmer, WI; John Hancock, AL; North American SW Association, Box 13, Liberty, IN 47353).

GLOSSARY OF DX TERMS

DXer—A radio listener who hunts distant stations as a hobby.

Domestic—A home service program or station operated for the benefit of persons living in a certain country—the opposite of foreign service, which is intended for listeners outside the country.

GMT—Greenwich Mean Time (universal time), a standard time reference for broadcasters and DX listeners, equivalent to EST+5, CST+6, MST+7 or PST+8 hours.

kHz—Kilohertz, a measure of a station's frequency; also kilocycles per second.

MHz—Megahertz; similar to kHz but equals 1,000 kHz.

QSL—A verification, a card or letter sent by a station, in response to a listener's report of reception, confirming that the report is correct.

Shack—The place where a DXer does his listening. It might be a den, a bedroom or the basement.

SWL—Shortwave listener, a DXer who tunes the shortwave frequencies between about 1605 kHz and 30 MHz (30,000 kHz).

VHF—Very High Frequency, the frequencies between 30 and 300 MHz, above the shortwave frequency range.

VLF—Very Low Frequency, the radio frequencies on the bottom end of the spectrum, even below the regular AM radio band, which is 540-1600 kHz.

UHF—Ultra High Frequency, frequencies above 300 MHz. ■

Newscan

(Continued from page 26)

ing geography and spelling with the help of a made-at-home computer that was put together by his dad, Ron Herff.

"I can foresee a computer in every household within the next five years," said Herff, who last year was instrumental in organizing Cleveland Digital Group, a computer hobbyists association with a current roster of some 150 members.

Father and son have fun playing "Moon Landing" with "homemade" computer system. The heart of the system is an Altair 8800 microcomputer.

Besides the educational value of having a computer in his home, Herff said it is helpful with Christmas card lists, bills and housekeeping systems. He plays computer games such as checkers, monopoly, and bridge with his family and neighbors, and has made up special programs such as spelling lessons, a medieval war game and a moon landing simulation.

"I guess I always wanted my own computer," Herff said, "but was never able to afford one. Now that technology is becoming so advanced, the equipment is priced within reach of the average person. It's possible to buy the parts and assembly instructions together in "kits" for as little as $400. Of course, for more sophisticated units, the costs can run into several thousand dollars."

He pointed out that home computer systems such as the one he built can be as small as a shoe box or as large as a stereo system.

Herff is enthusiastic about plans being made by the Cleveland Digital Group, which has been a model for the formation of similar groups across the country, and this year sponsored a Midwestern Regional Conference in Cleveland.

The group, which is now in the process of being incorporated as a nonprofit institution, holds monthly meetings in an old railroad station at the corner of Harvard and Broadway.

Continually exploring new ideas for his computer, Herff says it is an integral tool for both work and play.

"My son, Michael, and I have a great time playing 'Moon Landing,'" he said. "We choose arbitrary speeds and positions for our space craft. Then the computer tells us such things as, 'Sorry, your craft came down too fast. Condolences will be sent to your next of kin. The craft is now buried in moon dust at a depth of 60 feet. Reprogram. . . . reprogram. . . .'"

Quad Op Amps

Looking for economy? Well, here is a quad op amp, which combines four popular standard op amps on a single chip and yet consumes less power than one. It consists of four independent, high gain, internally compensated, low-power operational amplifiers. Two versions are available and each is designed to provide functional characteristics identical to those of the familiar 741 Op Amp. The total supply current for all four amplifiers is comparable to the supply current of a single 741 type op amp. These new op amps are made by National Semiconductor.

Compared to the standard 741, however, the input offset current is lower (4 nA) and the input bias current is less (30 nA). The new series also features low supply current drain (0.6 mA/amplifier), low input offset voltage (1 mV), and overload protection for both inputs and outputs. Also, a high degree of isolation between amplifiers has been achieved by independently biasing each amplifier and using a layout technique which minimizes thermal coupling.

Two versions of the quad op amp, the LM 148 and LM 149, are available. The LM 148 is compatible with the older LM 124 quad op amps and can be used anywhere that the 741 or 1558 amps are used. It is designed for applications where amplifier matching or high packing density are required.

The LM 149 series has the same features as the LM 148, plus a gain bandwidth product of 4 MHz at a gain of 5 or greater. The LM 148D, manufactured in DIP made from Epoxy B, is priced at $8.50 each when purchased in lots of 100. We forecast that at this time next year, the price will be much lower and the LM 148 and LM 149 will be standard fare for experimenters.

Checkbook With a Brain

CheckMaster, a personal *computerized banking center in a case*, is the world's first pocket computer that never forgets what is in its memory, not even when turned off. A checkbook holder with a built-in computer, CheckMaster will keep your checkbook in perfect balance for every check you write. A push of the button eliminates those

hours spent in search of dollars that just don't add up.

Developed by Mostek Corporation after years of research, under the "Corvus" trade name, the CheckMaster computer comes in a tan-and-cream-colored plastic case, which measures ⅞-in. x 3⅝-in. x 6¾-in., and is only slightly larger than a personal check. The entire unit weighs eight ounces and holds standard-sized personal checks, check

CheckMaster is a small computer/memory system that is very helpful to modern consumer check writers. The built-in calculator retains a bank balance memory, even when turned off for one year.

register, credit cards and other documents. The computer, which fits into the top of the case, has keys for *check*, *deposit*, *balance* and *clear*, in addition to the standard 10 digit keys.

The CheckMaster was designed to solve the problems of checkbook balancing, but can also be used as an aid to supermarket shopping.

The CheckMaster—being offered at the national introductory price of $39.95—is the latest in a series of space-age consumer products currently marketed by the JS&A National Sales Group. Their address is 42 Dundee Rd., Northbrook, IL 60062. ■

555 Tester

(Continued from page 51)

ready to go.

I have yet to find a surplus 555 that isn't in a DIP package, but even those 555s that come in transistor-style TO-5 or TO-99 cases usually follow the same lead arrangement. So identify pin 1, plug your 555 in and turn it on.

If both LEDs come on, your 555 is open. If only one comes on, or if neither comes on, your 555 is either open or shorted. If there are no visible solder bridges between pins and no pins are missing, the open or short must be internal. Perhaps you could use a 555 that tests bad as an ornament; you sure can't use it for electronics.

A good 555 will always flash both LEDs. It's that simple.

Your handy tester even provides a bonus. With a good 555 in place, you can use the pin 3 output as a clock pulse to drive TTL circuitry. You can use the pulse directly, but a small resistor or capacitor will help keep things safe. Remember to use pin 1 for *ground*.

By the way, it probably took you longer just to read this article than it will take you to build your tester. ■

40 Channels

(Continued from page 78)

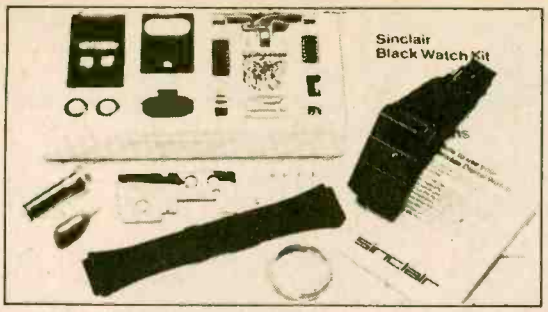
And, if he does, he can get that new model for only an extra $30, which is the anticipated price difference between 23- and 40-channel models."

Other Makers' Plans. So there you have three CB manufacturers' approach to the transistion from 23 to 40 channels. A check with a number of other companies resulted in a wide range of responses. Many will be following the lead of Hy-Gain, Pearce-Simpson and Sharp, others will not be re-manufacturing 23-channel radios, some will be offering various rebates, discounts and other deals.

CBers can look forward to some excellent buys during the coming weeks and months but they should shop carefully and be sure just what they will be getting for their money. Now, more than ever, the old saying of "Buyer Beware" applies! Some manufacturers and dealers will be offering substantial price cuts on 23-channel units. Others, such as Sharp, will be offering 40-channel sets in exchange for 23-channel models plus a relatively small cash payment in the range of $25 to $50. Now *is* a good time to buy, but be absolutely certain what you will be getting for your money.

Remember, your 23-channel transceiver is *not* obsolete. Channel 9 remains the designated emergency channel, the truckers will tend to stick to 19, boaters will continue using 13, and with 23 channels available at the flick of the channel selector you should be able to find a spot to carry on your communications between channels 1 and 23. ■

The Black Watch Kit $19.95



The Black Watch Kit by Sinclair is unique. Controlled by a quartz crystal...powered by two hearing aid batteries. Styled in understated elegance the Sinclair way. No knobs no buttons. To see the exact time or date just touch the face of the case. A re-set control is on the back.

(Actual Size)

THE KIT CONTAINS

1. printed circuit boards
2. integrated circuits
3. encapsulated quartz crystals
4. trimmers
5. capacitors
6. LED displays
7. 2-part case with window in positions
8. batteries
9. battery-clip
10. black strap (black stainless-steel bracelet optional extra — see order form.)
11. full instructions for building and use.

All you provide is a fine soldering iron and a pair of cutters.

Dimensions:	1-1/2" X 1" X 3/10"
Weight:	1/2 ounce
Strap:	3/4" wide
Case:	Specially designed unbreakable black matte plastic. Water resistant.
Batteries:	Mallory RM41H
Accuracy:	On a built watch we guarantee accuracy within a second a day. In building it yourself you may be able to adjust the trimmer to achieve an accuracy within a second a week.

sinclair

Scientific Calculator Kit $14.95

KIT COMPONENTS

1. Coil
2. LSI chip
3. Interface chips
4. Printed circuit board
5. Keyboard panel
6. Electronic components pack
7. Battery assembly and on/off switch
8. Case moldings, with buttons windows and light-up/display in position. Soft carrying case
9. Comprehensive instructions
10. Assemble time is approximately 3 hours.

Designing the Sinclair Scientific was no small feat of engineering, but you don't have to be an engineer to assemble it with our kit.

You can put together the world's most remarkable scientific calculator from eight groups of components, using only a soldering iron and a pair of cutters. (Complete instructions are included.)

Less than 3/4-inch thin and 3-3/4 ounces light. British-made Sinclair Scientific isn't just portable, it's pocketable.

All parts are tested before shipment — and we guarantee any correcly assembled calculator for one year.

Features of the Sinclair Scientific

FUNCTIONS SUMMARY –

Algebraic logic
Five function memory
Sine, cosine, tangent, arcsine, arccosine, arctangent
Degrees/radians switch
Ln and e^x
Square root, pi and reciprocal
8 digit mantissa, plus 2 digit exponent
Automatic constant
Pocket-sized. 4-1/3" X 2" X 11/16".
Weight: 4 ounces.
Battery life. Low-cost, disposable AAA batteries (not included) operate for around 25 hours of continuous use.

1. FREE TRIAL OFFER If you decide not to keep and assemble your kit, you may return it undamaged within 10 days for a refund of its purchase price.

2. SERVICE If a problem arises in building your kit, Sinclair Service Department will fix it for you at a nominal charge.

3. WARRANTY Your correctly assembled kit will be repaired or replaced by Sinclair if it fails to operate within one year of purchase free of charge (except in the case of misuse).

4. To order your kit, just use the coupon and mail it with your check or money order to: GFN Industries, Inc., 6 Commercial Street, Hicksville, New York 11801.

To: GFN INDUSTRIES, INC., 6 Commercial Street, Hicksville, New York 11801

___Black Watch Kit(s) at $19.95 ..... $_____
___Black Watch Kit(s) with stainless steel band at $24.95 ..... _____
___Scientific Calculator Kit(s) at $14.95 ..... _____
___Assembled Black Watch(es) with stainless steel band at $39.95 _____
___Assembled Scientific Calculator(s) at $19.95 ..... _____
___Sales Tax (N.Y. Residents) ..... _____
___Shipping and handling ($2.00 PER UNIT) ..... _____
Enclosed is check/MO (payable to GFN Industries Inc.)
TOTAL ..... $_____

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

Quantity discount: For 6 or more units, the total shipping and handling charge is $5.00.

KEY # EE-11WC

LITERATURE LIBRARY

301. Get acquainted with the new *EICO* products, designed for the professional technician and electronics hobbyist. Included in brochure are 7 IC project kits, *EICO's* "Foneaids," security products and many varied kits.

302. *International crystal* has illustrated folders containing product information on radio communications kits for experimenters (PC boards; crystals; transistor RF mixers & amplifiers; etc.).

303. See brochures on *Regency's* 1977 line-up of CB transceivers & scanner receivers (for police, fire, weather, & other public service emergency boadcasts).

304. *Dynascan's* new *B & K* catalog features test equipment for industrial labs, schools, and TV servicing.

305. Before you build from scratch, check the *Fair Radio Sales* latest catalog for surplus gear.

306. Get *Antenna Specialists'* catalog of latest mobile antennas, test equipment, wattmeters, accessories.

307. Want a deluxe CB base station? Then get the specs on *Tram's* super CB rigs.

308. Compact is the word for *Xcelite's* 9 different sets of midget screwdrivers and nutdrivers with "piggyback" handle to increase length and torque. A handy show case serves as a bench stand also.

310. *Turner* has two booklets on their Signal Kicker antennas. They give specifications and prices on their variety of CB base and mobile line. Construction details help in your choice.

311. *Midland Communications'* line of base, mobile and hand-held CB equipment, marine transceivers, scanning monitors, plus a sampling of accessories are covered in a colorful 18-page brochure.

312. The *EDI (Electronic Distributors, Inc.)* catalog is updated 5 times a year. It has an index of manufacturers literally from A to X (ADC to Xcelite). Whether you want to spend 29 cents for a pilot-light socket or $699.95 for a stereo AM/FM receiver, you'll find it here.

313. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

315. *Trigger Electronics* has a complete catalog of equipment for those in electronics. Included are kits, parts, ham gear, CB, hi fi and recording equipment.

316. Get the *Hustler* brochure illustrating their complete line of CB and monitor radio antennas.

317. *Teaberry's* new brochure presents their complete lines of CB and marine transceivers and scanners for monitoring police, fire and other public service frequencies.

318. CBers, *GC Electronics'* 16-page catalog offers the latest in CB accessories. There are base and mobile mikes and antennas; phone plugs; adaptors and connectors; antenna switchers and matchers; TVI filters; automotive noise suppressor kits; SWR power and FS meters; etc.

319. *Browning's* mobiles and its famous Golden Eagle base station, are illustrated in detail in the new 1977 catalog. It has full-color photos and specification data on Golden Eagle, LTD and SST models, and on "Brownie," a dramatic new mini-mobile.

320. *Edmund Scientific's* new catalog contains over 4500 products that embrace many sciences and fields.

321. *Cornell Electronics'* "Imperial Thrift Tag Sale" Catalog features TV and radio tubes. You can also find almost anything in electronics.

322. *Radio Shack's* 1977 catalog colorfully illustrates their complete range of kit and wired products for electronics enthusiasts—CB, ham, SWL, hi-fi, experimenter kits, batteries, tools, tubes, wire, cable, etc.

323. Get *Lafayette Radio's* "new look" 1977 catalog with 260 pages of complete electronics equipment. It has larger pictures and easy-to-read type. Over 18,000 items cover hi-fi, CB, ham rigs, accessories, test equipment and tools.

327. There are *Avanti* antennas (mobile & base) for CB transceivers and scanner receivers, fully detrated in a new full-color catalog.

328. A new free catalog is available from *McGee Radio*. It contains electronic product bargains.

329. Semiconductor Supermart is a new 1977 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors—all from *Circuit Specialists*.

330. There are over 400 electronic kits described in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo & 4-channel, hi-fi, etc.

331. *E. F. Johnson* offers their CB 2-way radio catalog to help you when you make the American vacation scene. A selection guide to the features of the various messenger models will aid you as you go through the book.

332. If you want courses in assembling your own TV kits, *National Schools* has 10 from which to choose. There is a plan for GIs.

333. Get the new free catalog from *Howard W. Sams*. It describes 100's of books for hobbyists and technicians—books on projects, basic electronics and related subjects.

334. *Sprague Products* has L.E.D. readouts for those who want to build electronic clocks, calculators, etc. Parts lists and helpful schematics are included.

335. The latest edition of *Tab Books'* catalog has an extensive listing of TV, radio and general servicing manuals.

337. *Pace* communications equipment covers 2-way radios for business, industrial and CB operations. Marine radiotelephones and scanning receivers are also in this 18-p. book.

338. "Break Break," a booklet which came into existence at the request of hundreds of CBers, contains real life stories of incidents taking place on America's highways and byways. Compiled by the *Shakespeare Company*, it is available on a first come, first serve basis.

342. *Royce Electronics'* new full-color catalog updates information on their CB transceivers (base, mobile, handheld). It also describes new product lines—CB antennas and a VHF marine radiotelephone.

344. For a packetful of material, send for *SBE's* material on UHF and VHF scanners, CB mobile transceivers, walkie-talkies, slow-scan TV systems, marine-radios, two-way radios, and accessories.

345. For CBers from *Hy-Gain Electronics Corp.* there is a 50-page, 4-color catalog (base, mobile and marine transceivers, antennas, and accessories). Colorful literature illustrating two models of monitor-scanners is also available.

350. Send for the free *NRI/McGraw Hill* 100-page color catalog detailing over 15 electronics courses. Courses cover TV-audio servicing, industrial and digital computer electronics, CB communications servicing, among others. G.I. Bill approved, courses are sold by mail.

352. Send for the free descriptive bulletin from *Finney Co.* It tells all about their new auto FM radio signal booster (eliminates signal fading).

353. *MFJ* offers a free catalog of amateur radio equipment—CW and SSB audio filters, electronic components, etc. Other lit. is free.

354. A government FCC License can help you qualify for a career in electronics. Send for information from *Cleveland Institute of Electronics*.

355. New for CBers from *Anixter-Mark* is a colorful 4-page brochure detailing their line of base station and mobile antennas, including 6 models of the famous Mark Heliwhip.

356. Send for *Continental Specialties* new breadboarding prototest devices. They vary in prices from a mini-budget kit at $19.95. Featured is the new logic monitor, giving information on what it does, how it works, and how to use it.

357. *Dage Scientific Instruments* offers a 16-page booklet on how to build an electronic thermometer with control. Included is an introductory course on thermocouples, schematics and many applications.

358. *PixTronics* announces its new Model 200 Super Sensitive Electronic Darkroom Exposure Meter, used to determine the correct exposures of all black-and-white and color negatives. Useable with any enlarger.

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November/December 1976
Void After April 19, 1977

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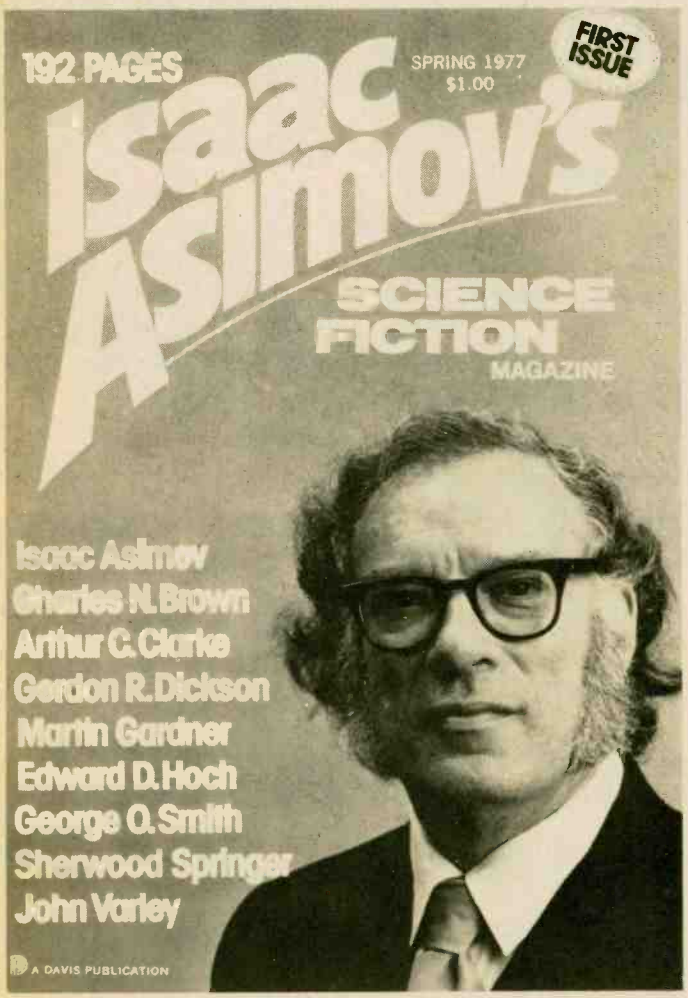

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EEN6

Eliminate Record Noise

(Continued from page 64)

stantial, it may be far from ideal if the sound source is excessively noisy. Relative to discs, the denoisers generally do a good job in terms of *inherent* noise; but they can do little to remove *acquired* noise such as clicks and pops associated with scratches and stylus gouges in phonograph records, and noise associated with accumulations.

Correct adjustment of the five different denoising systems is a key to happy operation. Each approach is affected to some degree by what is called the "breathing" action of the denoising processes, including expansion/contraction of the signal. This is manifest as a kind of "whooshing" or "swishing" sound that varies with the music. According to some equipment testing sources, the dbx and Phase Linear systems are virtually free of the above phenomenon.

Despite the caveats, there is no reason to hold back, to wait for the *perfect* noise reduction system. Any one of the above could be of great value *now* in extending your listening experience to greater heights of pleasure.

Of considerable portent is the recent announcement by Teac Corp., major tape recorder manufacturer, that it had signed a licensing agreement with dbx, Inc., producers of the dbx system of noise reduction, to sell recorders with dbx built into them. This move, say industry crystal-ballers, is likely to be emulated by other major tape recorder suppliers and will encompass reel, cassette, and cartridge units.

dbx has what was called a "loose" licensing agreement under which a company can buy the dbx system in circuit-board form from dbx, Inc., or produce its own for inclusion in an audio product. An industry source close to the company said that the price differential between regular equipment and equipment fitted with dbx would be "about the same as the price differential between Dolbyized and non-Dolbyized equipment, or slightly greater." He explained that the dbx system requires more circuitry than Dolby. Relative to costs, Dolby circuitry adds from $50 to $75 to the retail price of a cassette deck, and from $150 to $200 to the cost of a reel recorder. These prices are estimates at this time.

Burwen has embarked on a licensing program under which manufacturers can build Burwen circuitry into their cassette, reel, or cartridge recorders. The circuit, somewhat different from that incorporated in the firm's DNF 1201, offers from six to nine dB of noise reduction. Manufacturers can provide this system as a built-in at a retail increment of $25 to $30—regarded as a reasonably low figure for such a feature.

In short, it's a good time to say goodbye to hiss. The price is right and there are several ways to stomp most of it out forever. ■

CB XCVR Checkout

(Continued from page 54)

Input Level for S9	100 μV
Transmitter Test Section:	
RF Output	3.5 watts
Modulation to 85%	yes
Relative Sensitivity for 85% Modulation	—25 dBmax. (user adjustable)
Modulation Limited to 100%	yes

Editorial Remarks: The Regency CR-142 has an S-meter that reads 6 dB per S-unit, internal transmitter tuning, double conversion, external and PA speaker jacks, S/RF/Modulation meter. ■

Antique Radio Corner

(Continued from page 84)

commercially made sets. The three sets shown were made around 1920 to 1924. The first one shown is the Westinghouse type DB, number 307216. This detector was designed to be used with the RA tuner. In the photo you can see two types of detectors are

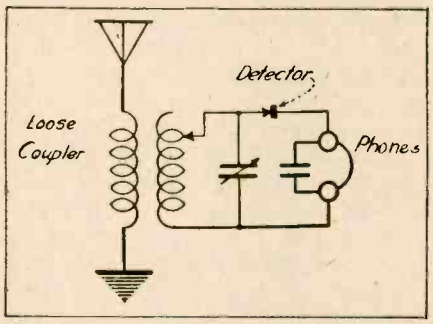

Fig. 3. Loose coupler set tuned better using two coils, one moveable inside the other.

mounted on the base. One is the pressure type in which two carefully-selected mineral are pressed tightly together. The original catalog published by Westinghouse titled, *Radio Enters the Home* printed in June 1922, doesn't identify the minerals used. We believe that they were Zincite and Bornite. The detector on the right side is probably galena with its catswhisker. A two-position switch, between the detectors, is used to select the one you wish to use. Binding posts for antenna and ground would be connected to the tuner if you were using one. The other binding posts are for the headphones. A bypass capacitor is connected across the headphones. It is interesting to note that the complete detector originally cost $6.50. The spare crystals were $1.00 each.

The second crystal receiver shown is named the *Pandora*, and it includes a tuning coil, binding posts, and the detector. The crystal is a mineral type with a stiff metal stamping with a sharp

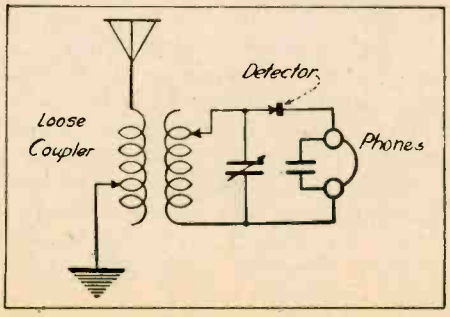

Fig. 4. Loose coupler is further improved by adding a sliding contact to primary coil.

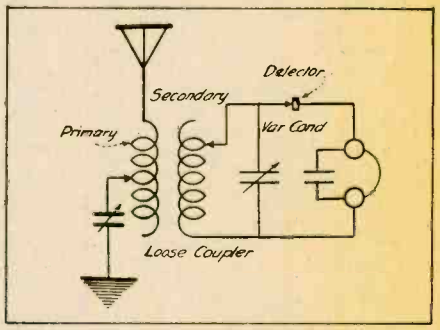

Fig. 5. Final improvement to circuit was made when another variable condenser was added.

point used to probe the galena crystal for a sensitive spot. The parts are mounted on a metal base that resembles an inverted miniature tin pie pan with the coil form mounted vertically in the center, with a sliding contact for tuning. As pointed out previously this gives rather poor tuning.

The third crystal radio shown is also complete, with the name *Weeco Gem* stamped on the base. This set has a black wooden base, a horizontally-mounted tuning coil with slider, and a detector with a catswhisker. There are spring clips for antenna, ground, and headphones. The coil has a slider which contacts the bare wire. This receiver would also have broad tuning.

ELEMENTARY ELECTRONICS INDEX TO ADVERTISERS—E.E.

Where To Find 'Em. There are many home-made crystal radios to be found in flea markets, antique, and second hand stores. At present I have three of these sets and one commercial set which has no identification. If you want to have a beautiful conversation piece which also *works*, go out and find one. If you want to have a receiver which will give you many hours of pleasure, and no electric bills, you can build one!

So long for now. We will be back with you next time with more news and information for radio collectors. In the meantime, keep those cards and letters coming! ■

Computer Readout

(Continued from page 86)

register X for example, 1000, which is the binary for decimal 8 will be the number of the general register (like register R(8) in this example) which will contain the location in memory (like 0001 0010 could be in register R(8)) of some data that is to be retrieved for use in the ALU or elsewhere. And that arrangement is a very good example, although a very *simple* one, of what computers go through as they run programs. It also shows machine-level programming requires a lot of steps to do one task. All those steps lend a lot of flexibility to the program making it easy to get in to make little changes without upsetting the whole apple cart. Finally, there is register N. It can be used, for example, to specify that an R register is to receive a data word, or to specify, indirectly, that a particular memory location is to receive a data word.

Writing A Program. Let's write a program we'll call "Secret Password" so that we can get to know some of the Microtutor instructions. Imagine that Microtutor is connected to your personal bank vault. To open the bank vault you set the 8 data switches to your secret password and press *Start* to run the program. When the proper password is selected, "0 0" will light on the LED display—which will stand for "open, open". If a thief tries his hand at the combination and gets it wrong (his chance of getting it right just by guessing is one out of 256), "A A" will light—which will stand for "Alarm, Alarm!"

Looking at the program listing you can see that the program is 15 steps long and uses memory locations 0 0 to 0 E. Location 0 0 contains code 0 0 as required by all Microtutor programs. The program is loaded by setting the Load switch up, setting the data switches to the first code, E3, pressing *In*, and continuing right on with F 8, etc. Let's go through each step of the program which is really quite simple. First the value 3 is put in register X with the instruction E 3. (If we had used E A, then A would have been placed in register X.) Remember that the value in the X register points to a specific general register to set it up for special work. In this case, R(3) has been chosen by using just one command, E 3. Now the program is going to put the value 2 0 into the R(3) register. This is done by F 8 followed by 2 0, which puts 2 0 in the D register, and then with instruction A 3, which puts the contents of D into R(3). Now comes a very important instruction—6 8. If you say 6 8 to a friend, probably nothing worthwhile will happen. But if you say 6 8 to Microtutor it will take the value set on the 8 data switches and enter that value into its memory at the location given by the value in register R(X). So in this case the memory location is 2 0.

Are You Still With Us? Now for the big question: Does the value set on the switches equal the secret password? The password in this sample program listing has been designed to be C B, and it is placed by instruction F 8, into register D. The program now compares C B with the switch values by using instruction F 3. To accomplish this the F 3 instruction does an *exclusive-OR* operation (0+0 = 0, 0+1 = 1, 1+1 = 0) on the first bit of the password in register D with the first bit you have just put into memory via the data switches. The result of that exclusive-OR operation is put into a position in register D, and then instruction F 3 goes on to the second bit and does the same thing, continuing through all eight bits. If the value set on the switches is C B, register D will contain 0 0.

Now we are almost done because step 0 9 in the program contains the instruction 3 2 which says "Hey, if D contains zeros, jump on down to step 0 D." And there at step 0 D and 0 E the value in register D (value 0 0) is put on the LED display to say "open, open!". Returning to step 0 9, if the value in register D is not 0 0, that is, the value on the data switches is not exactly C B, the program goes to steps 0 B through 0 E which cause A A to be put on the display.

Flexibility. This program demonstrates a really key feature of microcomputers: Flexibility. For example, if

TABLE OF BINARY-TO-HEXADECIMAL NUMBER CONVERSIONS

Binary Code	Hexadecimal Code	Decimal Number
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	A	10
1011	B	11
1100	C	12
1101	D	13
1110	E	14
1111	F	15

you, as owner of the bank vault, want to change the password, you do not have to go through a massive rewiring effort. All you do is change C B at step 0 7 to something else. Also, if you want to make the password harder for a thief to crack, the program can be rewritten to require, for example, C B to be entered, *followed by B C*. This demonstrates the tremendous flexibility of these programmable microcomputers.

How To Get Started. The Microtutor Manual contains a list of tweny application ideas for the Microtutor, many of which use the control pins on the back which allow the 1801 microprocessor to operate relays, lights, motors, etc. Imagine your model railroad controlled by this microcomputer. Instead of seeing the train go from one circle to another in a repetitious way, Microtutor could make all sorts of things happen! You fill in the ideas! But of course, to make it work, you would have to add external relays and maybe some logic circuits, and write your own program.

PROGRAM FOR SECRET PASSWORD

M	CODE	
00	00	
01	E3	
02	F8	Data switch values put in *Memory*
03	20	
04	A3	
05	68	
06	F8	
07	CB	"CB" put in *Register*
08	F3	*Memory*
09	32	equal to
0A	0D	*Register?*
0B	F8	
0C	AA	
0D	53	Yes: show "OO"
0E	60	No: show "AA"

A good way to start is to order the Microtutor Manual for $2.00 plus a shipping charge of $1.00. It contains wiring diagrams and software ideas. There are no large projects in the manual, just basic instructions, several short programs, and lots of ideas. Write to Microprocessor Marketing, RCA, Solid State Division, Somerville, New Jersey 08876. The Microtutor Manual is designated MPM-109 on the RCA price list. The Microtutor itself is designated as CDP 18S011 and the price is $349. Of course forming a club would let you share the cost of microcomputers with others. This is an idea that is catching on rapidly across the country.

Next Time. In the next issue you will get more hands-on computer experience when we take a look at yet another breed of microcomputer. Stay with us in future issues as we take off our shoes and wade through the micromuck. We will review books and look at applications, trying to keep you abreast of this fast-changing field. And remember, your comments and ideas are welcome. Let me know if there is a topic you want to have covered in this column. ■

Prevent CB Theft

(Continued from page 68)

a dollar extra to cover mailing, you can purchase it from Shur-Lok Mfg. at 413 North Main Street, Hutchins, Texas 75141, if you can't get it at your local CB store.

The Flip-Flop installs inside the trunk on the left or right side so that it can goose-neck up through the crack between the trunk lid and car body. Where the goose-neck protrudes there's a small platform for mounting an antenna. The unique thing about this mount is that it's equipped with a hinge which allows you to open the trunk lid and lay the antenna down inside without removing it from the mount. Close the lid and the antenna's completely out of sight and safe from theft.

There are other advantages in mounting an antenna like this, but the greatest is that you can conceal the evidence that your car's equipped with CB radio. Most thieves look for the antenna first, before they strike.

It's Up To You. Don't place all of your confidence in anti-theft mounting devices. They'll give you protection up to a point. Beyond that it's up to you to develop and exercise good habits that'll complement whatever devices you choose.

You can learn a lot from friends who've had CBs stolen. Talk with them and find out what they'd do differently if they had to go through it again. Also, your local police department is a good place to go for advice. They can tell you what the current CB theft rate is in your area, what to expect in coming months, where and when most thefts take place, and what precautions to take.

The Toledo police reported that most thefts in their area were confined to large parking areas with minimum security, such as, shopping centers, bowling alleys, churches, etc. Ft. Worth police have reported the same, plus high incidence of theft to cars parked on back streets and in driveways at homes during the late hours of night.

Now, these precautions are the good habits you are to develop and exercise.

So, the habit you'll want to get into when you park in areas like these is that of removing your radio and either placing it in the trunk of your car or carrying it with you.

The Toledo and Ft. Worth police and the Nebraska Crime Commission offer these recommendations for combating CB theft:

(Continued on page 105)

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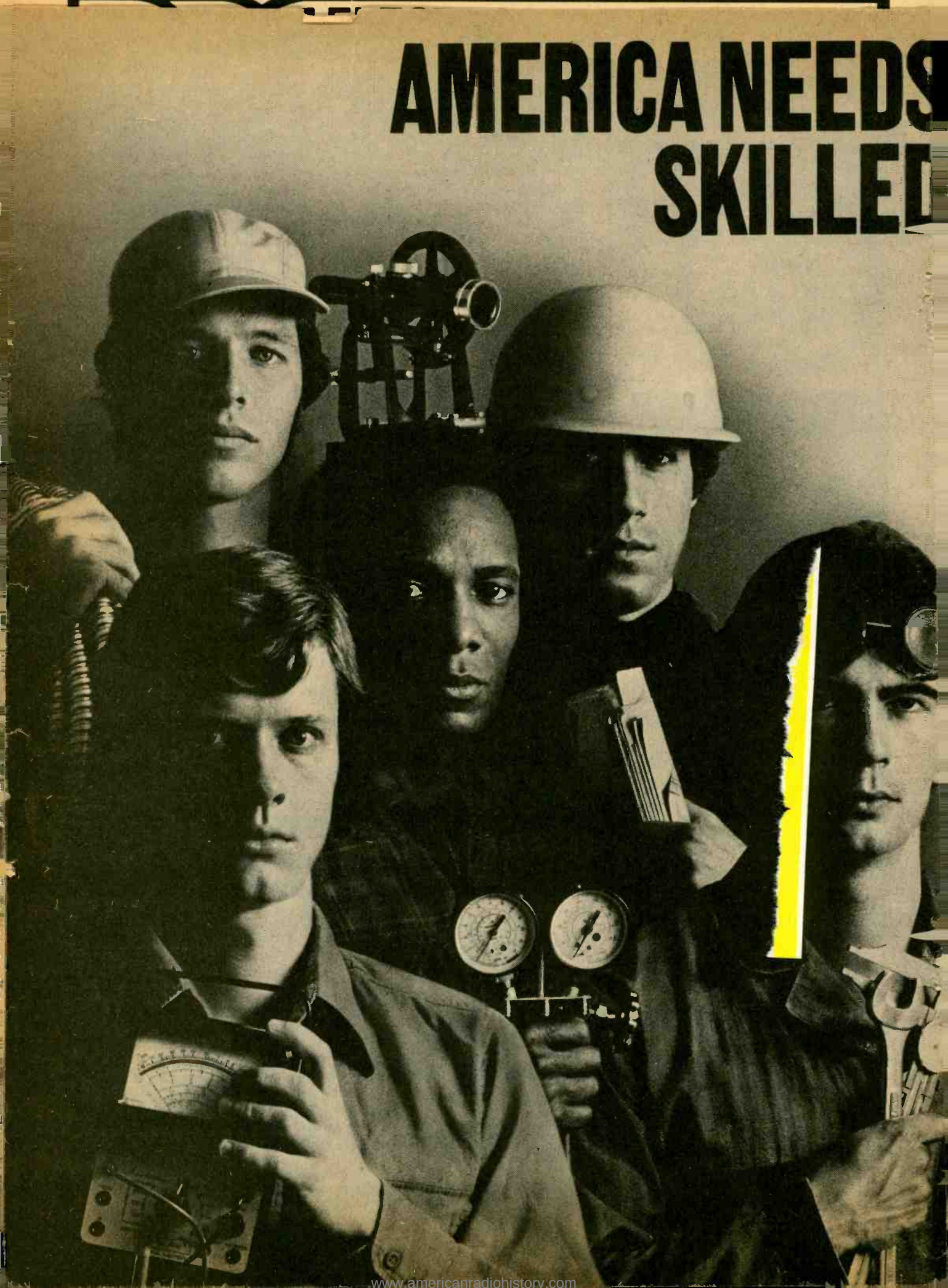

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Electricians (Construction and Maintenance)	20,900	30.0%
Engineering and Science Technicians	39,600	48.9%

*Source: U.S. Office of Education publication, "25 technical careers you can learn in 2 years or less."
†Source: 1974 U.S. Dept. of Labor *Occupational Manpower and Training Needs*

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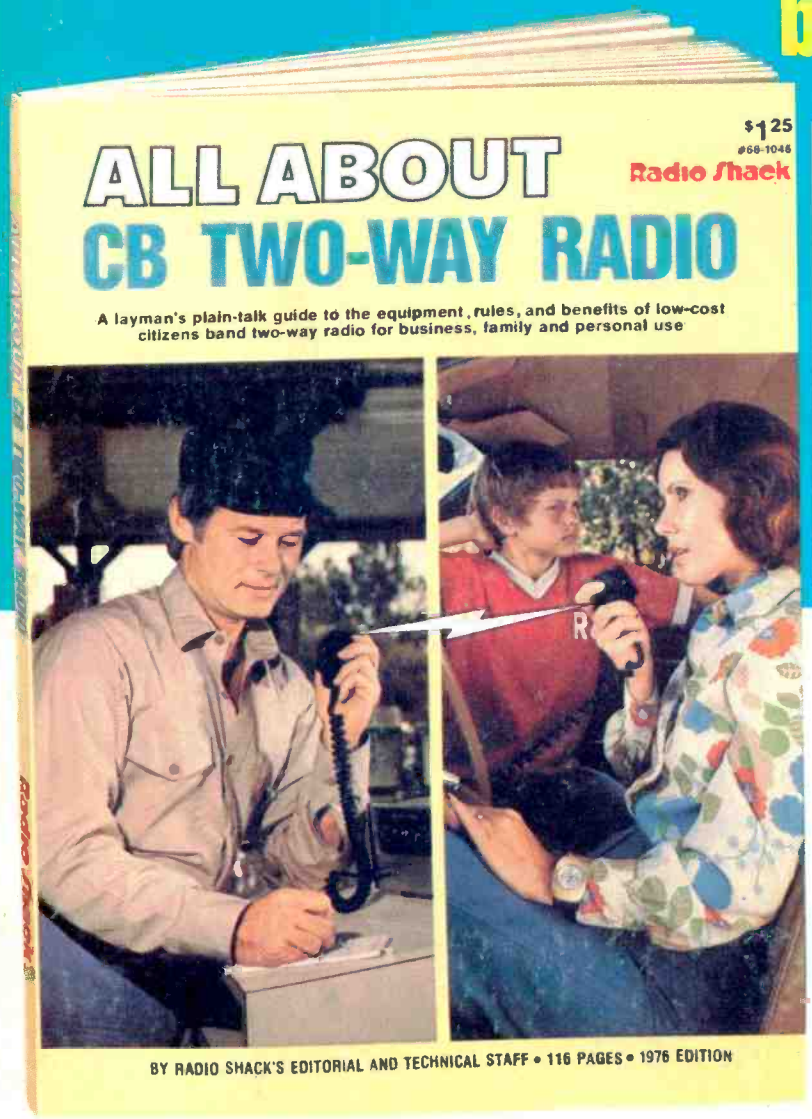

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