HOME COMPUTERS ARE HERE! Buying Facts on Page 54

Elementary Electronics

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elementary Electronics

JULY-AUGUST
1977
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FOR BEGINNERS

HOW TO USE SIGNAL GENERATORS

OUR BASIC COURSE

Build PET

Precision electronic thermometer tames Mother Nature

The Programmables –

- ✓ Intercept, Jr. Microcomputer
- ✓ Bearcat 210 FM Scanner
- ✓ Jerrold TRC-82 TV Remote Control

SIMPLE-SYN

Manufacture your own music with our easy-to-build IC Synthesizer

Tune In –

the shortwave war of words in the orient. DX the Two Chinas!

Kathi checks out President Grant CB with SSB

A DAVIS PUBLICATION

BUILD A FUTURE IN ELECTRONICS INSTEAD OF JUST TINKERING AROUND.

Now you can give yourself the advantages of a college degree in electronics. Without the disadvantages of spending years at college or night school.

We're the ICS Center for Degree Studies. Authorized by the Pennsylvania Department of Education to help you earn, at home, an associate degree that ordinarily takes two years of full-time classes.

Our electronics program gives you practical, career-oriented training in everything from computers to microwave systems. Radio and TV to radar. Analog devices to servomechanisms.

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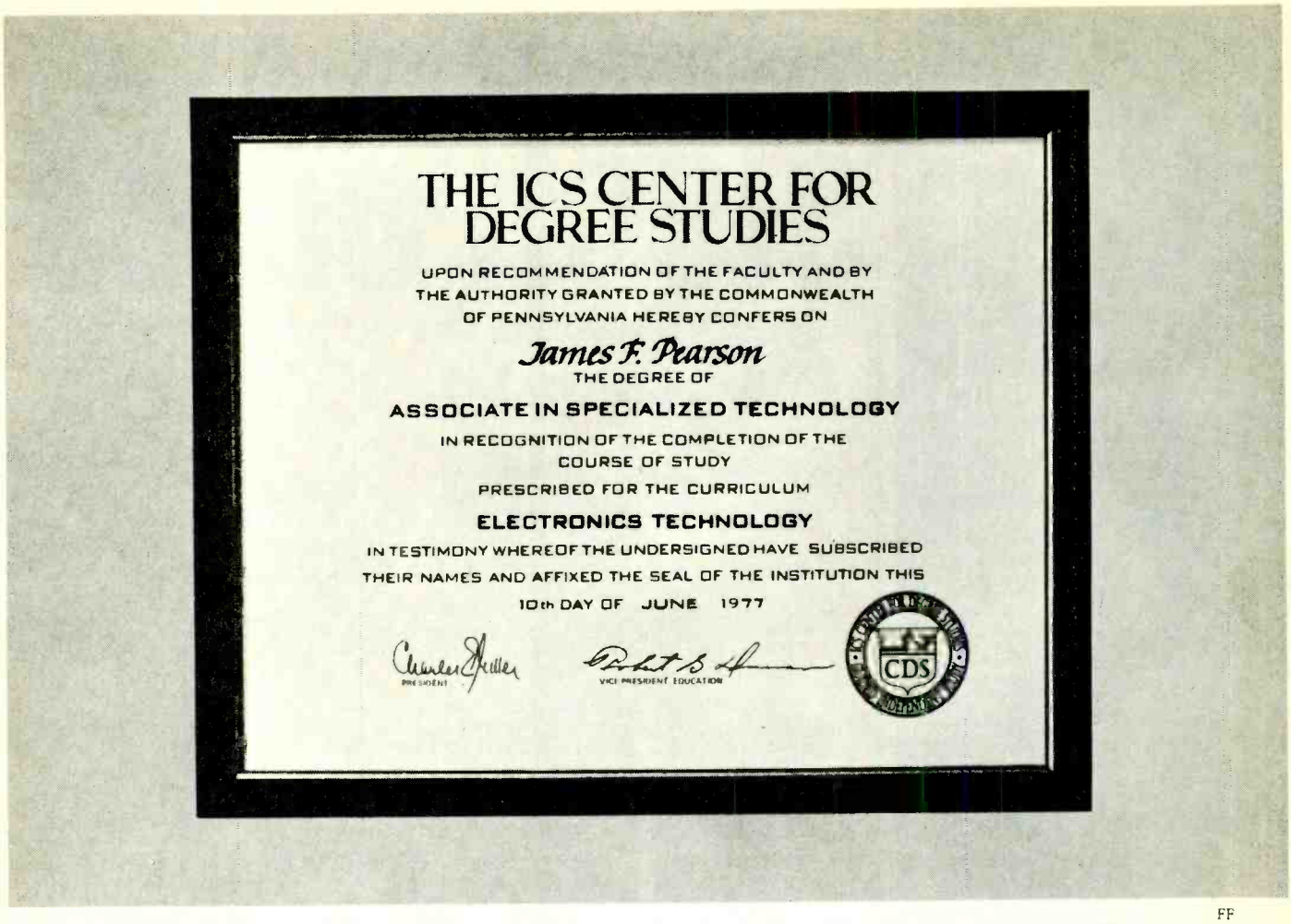

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A high-school diploma or the equivalent. Beyond which you get academic credit for previous education or experience, if it meets our standards.

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Mind you. We can't guarantee you a job or raise. No school can. And independent study takes motivation and plain old-fashioned self-discipline.

But we do suggest you send for our free career booklet and demonstration lesson, with no obligation. Today.

Because while we may not be right for everybody, we may just be perfect for you.

FF

Please mail me, with no obligation, the free career booklet and demonstration lesson in the field I've checked below.

Associate in specialized technology degree programs:

- ☐ Electronics
- ☐ Civil eng.
- ☐ Mechanical eng.
- ☐ Electrical eng.
- ☐ Chemical eng.
- ☐ Mechanical design

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- ☐ Automotive mechanics
- ☐ Business management
- ☐ TV service & repair
- ☐ Interior decorating
- ☐ Construction electrician
- ☐ Appliance service & repair
- ☐ Income tax
- ☐ Motel/restaurant mgt.
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Center for Degree Studies
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Scranton, Pa. 18515

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July/August 1977
Volume 17, No. 4

elementary electronics

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

SPECIAL CONSTRUCTION PROJECT
☆ 41 PET—*this precision electronic thermometer lets you measure temperature accurately anywhere, even under water*

PROGRAMMABLE NEW PRODUCTS
☆ 65 e/e checks out the—*Bearcat 210 FM Scanning Receiver*
☆ 77 e/e checks out the—*Jerrold TRC-82 All-Channel TV Remote Control*

CONSTRUCTION PROJECTS FOR SUMMER FUN
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☆ 59 Simple-Syn, The Music Machine—*this simple IC project does more, better, than many professional devices of a generation ago*
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AUTHORS IN THIS ISSUE

Thomas R. Fox, James Fred, Don Jensen, Charlene Babb Knadle, Kathi Martin, Harry Miller, Norman Myers, George X. Sand, Hank Scott, Walter Sikonowiz, C. M. Stanbury, II, and the ELEMENTARY ELECTRONICS Editorial Staff.

Cover Illustration by Ron Macarty

The 40-channel Cobra 29XLR. From the sleek brushed chrome face to the matte black housing, it's a beauty. But its beauty is more than skin deep. Because inside, this CB has the guts to pack a powerful punch.

The illuminated 3-in-1 meter tells you exactly how much power you're pushing out. And pulling in. It also measures the system's efficiency with an SWR check. In short, this Cobra's meter lets you keep an eye on your ears.

The Digital Channel Selector shows you the channel you're on in large LED numerals that can be read clearly in any light. There's also switchable noise blanking to reject short-pulse noise other systems can't block. The built-in power of DynaMike Plus. Automatic noise limiting and Delta Tuning for clearer reception.

And the added protection of Cobra's nationwide network of Authorized Service Centers with factory-trained technicians to help you with installation, service and advice.

The Cobra 29XLR. It has 40 channels. And it has what it takes to improve communications by punching through loud and clear on every one of them. That's the beauty of it.

Cobra

Punches through loud and clear.

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CIRCLE 8 ON READER SERVICE COUPON

PUNCH AND BEAUTY

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Fighting a fire takes tough men. And tough equipment. Equipment like the Motorola® 2-way radios carried by so many fire fighters.

Today you can own a 2-way radio with many of the engineering principles that go into Motorola professional radios.

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When you've made 2-way radios as long as Motorola, the result is a radio with a difference you can hear.

Whether you're fighting a fire. Or fighting the traffic home.

Motorola CB

From the voice of experience in 2-way radio.

To find the dealer nearest you, write: Customer Relations Manager, Motorola Inc., Automotive Products Division, 1299 East Algonquin Rd., Schaumburg, Illinois 60196. Motorola is a registered trademark of Motorola Inc.

CIRCLE 13 ON READER SERVICE COUPON

Hey, look me over

Showcase of New Products

Compact CB Tester

The new Hickok Model 388 CB In-Line Tester provides digital readout of SWR, power, % modulation and frequency. Contained in the small lunch-box size module, the Model 388 is digital power meter, digital SWR meter, digital % modulation meter, 7-digit CB frequency meter and a 7-digit 80 MHz frequency counter with 10 Hz resolution. The SWR and % modulation functions of this unique instrument incorporate the exclusive "dynamic ratio technique" which permits accurate SWR and % modulation measurements without a cal/set adjustment and regardless of power level. The "dynamic ratio" feature allows continuous monitoring of either SWR or % modulation as output power is adjusted or fluctuates without troublesome recalibration steps, thus saving valuable service time. Model 388 may be switched between any of the functions without recalibration while maintaining rated accuracies. One-step connection of the rear-panel coax connectors in-line between transmitter and antenna or dummy load provides full function capability with single-control mode selection. Using previously available equipment the service technician had to contend with multiple connects and disconnects wasting time, and multiple instruments occupying valuable bench space. The Model 388 costs just $349.00. For further information on the Model 388 or other Hickok Communications Test Instruments, contact Marketing Services, Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, OH 44108.

CIRCLE 66 ON READER SERVICE COUPON

Calculator for Consumers Finances

Consumers can make faster and smarter decisions in their everyday financial transactions with a new electronic calculator called the TI Money Manager from Texas Instruments Inc. The TI Money Manager has several programmed financial routines which significantly reduce the amount of keying a user has to do to solve problems. It is useful to those who want fast answers when figur-

(Continued on page 12)

CIRCLE 70 ON READER SERVICE COUPON

Shakespeare's Black Knight™ Antenna. Ride with this graphite beauty. And the word gets out.

Never before has there been such an outstanding performer for the 40 channel era as Shakespeare's new Black Knight. The graphite antenna. And the champion of the Knights of the Road.

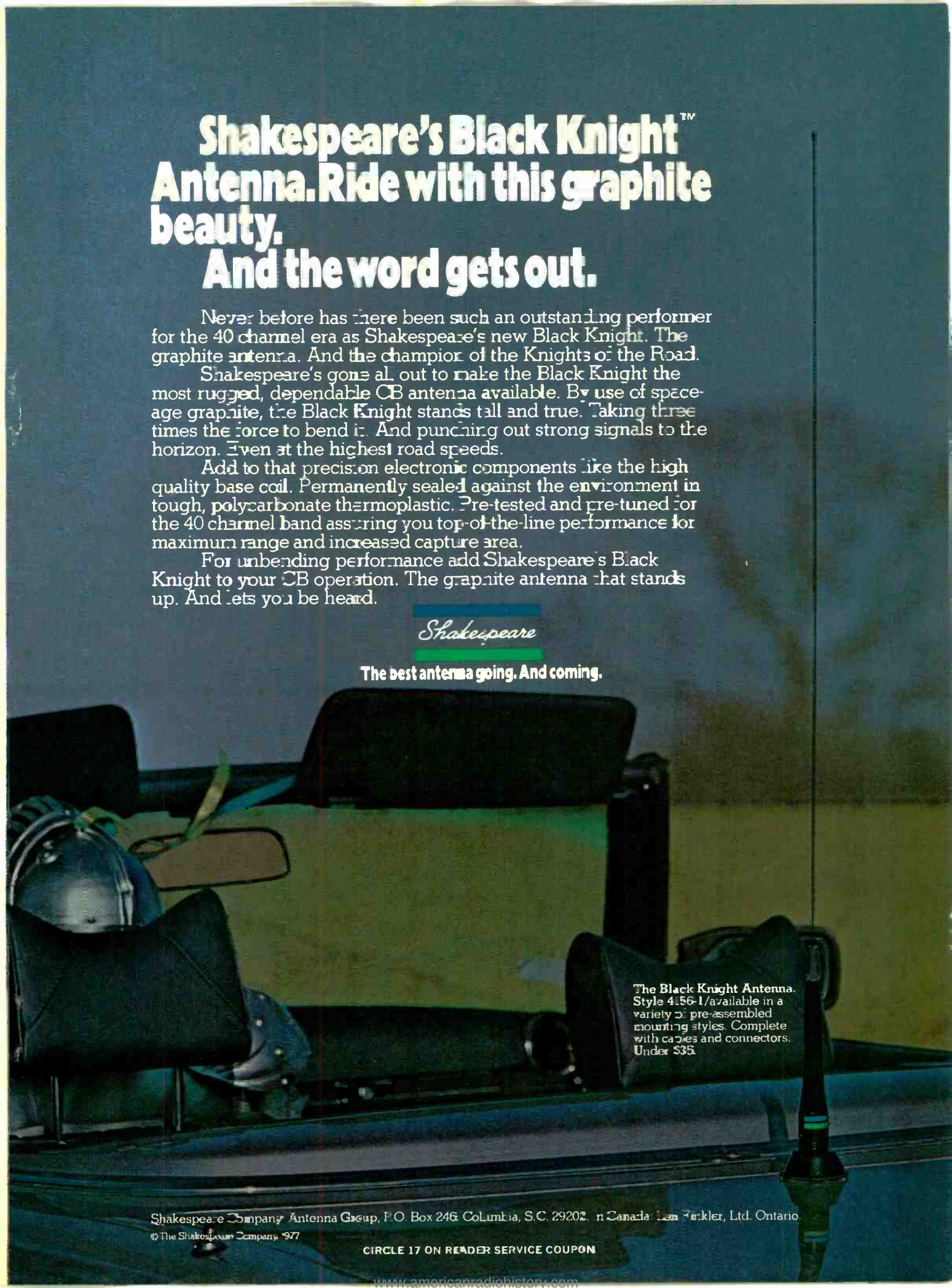
Shakespeare's gone all out to make the Black Knight the most rugged, dependable CB antenna available. By use of space-age graphite, the Black Knight stands tall and true. Taking three times the force to bend it. And punching out strong signals to the horizon. Even at the highest road speeds.

Add to that precision electronic components like the high quality base coil. Permanently sealed against the environment in tough, polycarbonate thermoplastic. Pre-tested and pre-tuned for the 40 channel band assuring you top-of-the-line performance for maximum range and increased capture area.

For unbending performance add Shakespeare's Black Knight to your CB operation. The graphite antenna that stands up. And lets you be heard.

Shakespeare

The best antenna going. And coming.



The Black Knight Antenna. Style 4156-1/available in a variety of pre-assembled mounting styles. Complete with cables and connectors. Under $35.

Shakespeare Company, Antenna Group, P.O. Box 246, Columbia, S.C. 29202. In Canada: Len Finkler, Ltd. Ontario.

CIRCLE 17 ON READER SERVICE COUPON

HUSTLER

"Hustloff"

STOP RIP-OFF
—three models—

Instant mount or dismount—store out of sight in trunk

Instant mount or dismount—store out of sight in car

New Hustle-away CB antenna eliminates faulty grounds-erratic SWR of magnetics and hinged flip-outs!

Outsmart the rip-off, quick and easy! Turn the knob and store your antenna out of sight. To remount, slip the antenna back in place and spin the knob. It's that quick, that easy! And most important, you get complete freedom from erratic grounding, questionable SWR that can cause CB radio failure. The Hustler design is positive, definite and equal in electrical and mechanical performance to the best permanently mounted mobile antennas.

TRUNK LIP MOUNT "HUSTLOFF"
Stainless steel 48" antenna and mount—
Model HT-27.
Heavy duty 55" antenna and mount—
Model HHT-27.

RAIN GUTTER MOUNT "HUSTLOFF"
Fiberglass 42" antenna and mount—Model RFG
All versions include cable, connectors attached, ready to operate.

THIS HUSTLER COVERS 40+ CHANNELS

"the home of originals"

HUSTLER

Available from all distributors who recognize the best!

new•tronics corporation
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AVAILABLE IN CANADA FROM
superior
SUPERIOR ELECTRONICS INC.

CIRCLE 14 ON READER SERVICE COUPON

THE GREAT UPRISING!

HUSTLER®

"HOMING PIGEON"™

the first all-indoor CB base antenna with all-out performance.

Model HP-27

THIS HUSTLER COVERS 40+ CHANNELS

The "Homing Pigeon" is your antenna answer to operating CB from any location, condominium, office, home, apartment, motel etc. No installation required; antenna is supported between floor and ceiling like a pole lamp. Communications range is equal or superior to better mobile installations. The "Homing Pigeon" incorporates a unique method of easily and quickly adjusting SWR. One setting covers all channels for outstanding performance with any 23 or 40 channel CB radio, AM or SSB. Antenna is supplied complete with 17′ coax, connectors attached, ready to use. Model HP-27.

"the home of originals"

HUSTLER®

AVAILABLE FROM ALL DISTRIBUTORS WHO RECOGNIZE THE BEST!

Patent for "Homing Pigeon" applied for by New-Tronics. Other Hustler antennas are protected by one or more New-Tronics patents: 3287732, 3513472, 3327311, 3419869, 3599214, 3873985, 3582951.

new-tronics corporation

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AVAILABLE IN CANADA FROM
superior
SUPERIOR ELECTRONICS INC.

CIRCLE 48 ON READER SERVICE COUPON

HEY, LOOK ME OVER

(Continued from page 8)

ing compound interest, doing mortgage and installment loan calculations, dealing with annuities and insurance and in numerous other personal finance situations. To do a new car financing calculation, a user enters the loan amount, interest rate and number of payments, for example, 36. He gets his monthly payment amount and decides he wants to see what the financing would be over 42 months. To do this, he need only enter the new number of payment periods (42) to compute the monthly payments for the longer time period. The TI Money Manager can also help consumers shop for the best credit terms. While installment contracts specify annual percentage interest rates, smart shoppers can save money if they figure in advance the effects of such items as "add-on interest" and "balloon" charges on installment purchases. These can be done in seconds with the new TI calculator. Besides having preprogrammed financial functions, the TI Money Manager is also a powerful general purpose calculator with memory and percent functions. For greater versatility, the calculator has additional math functions, some of which are reciprocals, squares, square roots, linear regresssion, powers and roots, natural logarithms and parentheses. The calculator has an eight digit LED display board and operates on a nine volt transistor battery which is not included. It sells for $26.95. For more information, write to Texas Instruments, Inc., P.O. Box 5012, Dallas, TX 75222.

Calculator Charts Biorhythms Cycles

A new, specialized computer/calculator features separate functions to chart the three Biorhythm cycles. The pocket-size Kosmos I Biorhythm Computer and Calculator has in addition to the four standard mathematical functions (addition, subtraction, multiplication and division), separate functions to compute the emotional, intellectual and physical Biorhythm cycles, as well as the Biorhythmic compatibility between two or more persons through its memory function. Kosmos I sells for $49.95. For further information, write to Kosmos International, 3930 First National Bank Tower, Atlanta, GA 30403.

CIRCLE 64 ON READER SERVICE COUPON

Car Speaker Digs Big Sound

With increasing popularity of high powered stereo sound systems in autos, vans and recreational vehicles, Acoustic Fiber Sound Systems, Inc. (AFS) now offers an acoustically designed 6-in. x 9-in. convertible (surface or flush) mount external speaker. The Kriket Model KK-6069 is the first of a series of super-stereo speakers designed by AFS to provide overall balance and a sense of smoothness throughout the entire music frequency range. Extended frequency response is provided, while sound dispersion is assured by the company's exclu-

CIRCLE 56 ON READER SERVICE COUPON

MIDLAND POWER

IT'S WHAT YOU GET WHEN YOU RUN WITH NUMBER 1. MIDLAND CB.

WE GOT TO THE TOP ON PURE GUTS.

Consistency. If one word can sum up Midland's rise to Number 1 in CB, that's it.

We've got to know that the ten-thousandth Midland will perform every watt and ohm as reliably as the first Midland off the line.

To make sure, we use computer technology throughout the manufacture of all our new 40-channel models.

In the assembly and integration of our state-of-the-art circuitry.

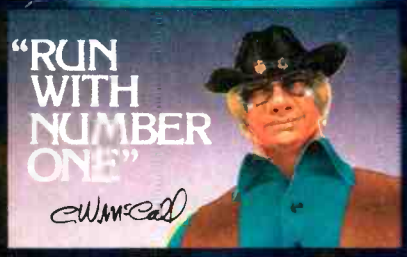
In the ultra-fine tuning of those circuits.

And in the final testing of your new 40-channel Midland CB, so you know it'll deliver, right out of the box.

Add to that Midland's 15 years' experience in CB, Midland's warranty and convenient authorized service centers, coast to coast.

Pure guts. Pure reliability. Pure Midland Power. That's what you get when you run with Number 1.

For your free, full-color, 24-page 1977 Midland CB brochure, write: Midland International, P.O. Box 12737, North Kansas City, Mo. 64116



MIDLAND CB

A member of the Beneficial Corporation family.

Shop for these active living products from Midland International: Benchmark Tools • Goodwin Sporting Goods • Medallion Car-Sound Products • Midland Television • Young World Toys.

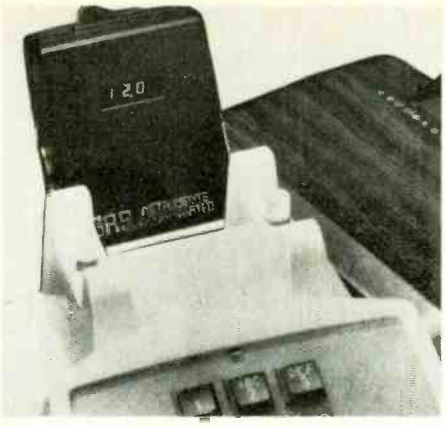
CIRCLE 12 ON READER SERVICE COUPON

HEY, LOOK ME OVER

sive air suspended front-loaded speaker chamber to insure bass response. The new Kriket stereo speaker mounts on the hat rack, dashboard or any surface selected, or it snugs under-the-deck, with or without grill exposure. Complete instructions and mounting hardware for either application come with the speaker. The Kriket KK-6069 sells for $44.95. For further information, write Acoustic Fiber Sound Systems, Inc., P.O. Box 50829, Indianapolis, IN 46250.

Telephone Timer

By using this unique telephone timer to time telephone calls, you can keep

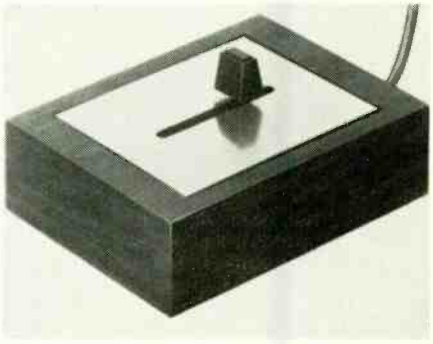


CIRCLE 53 ON READER SERVICE COUPON

conversations short and your telephone bill down. Called the GRS Model 200 Digital Telephone Timer, this solid-state timing device starts and stops with a push of a button. It features a bright, 3-digit LED display that indicates tens of minutes, minutes and tenths of minutes. Power is supplied from 4 penlite alkaline batteries that will keep the GRS Timer timing for about a year under average use. When not used to time phone calls, it can be simply removed from bracket and carried in pocket or purse and can be used to time conferences, speeches, in the dark room, plus anywhere else a timer is needed. The complete price with bracket carries a manufacturers suggested retail price of $29.95 (less batteries) and it can be ordered F.O.B. Dallas, Texas from GRS Instruments Inc., 8730 King George Drive, Dallas, Texas 75235.

Tabletop Dimmer

A new full-range tabletop lamp dimmer by Leviton with slide control, incorporating solid-state circuitry, is now available in hardware stores, home improvement centers, and building supply centers. The new dimmer plugs directly into any conventional wall outlet. The



CIRCLE 51 ON READER SERVICE COUPON

lamp plug is then inserted into the dimmer's adapter plug. The new dimmer, which also features a "locator light" for quick, easy location in the dark, is especially useful and convenient with chain lamps, desk lamps, table and floor lamps, pole lamps and indirect mood lights. This unique dimmer is part of Leviton's approach to Light Conditioning for every room in the house. Set lights medium-high for partying. Full bright for reading. All the way down for nightime. In between for conversation or TV watching. You make the scene your way. Sells for under $11.00. For additional information, write Marketing Communications Department (Consumer Division), Leviton Manufacturing Co., Inc., 59-25 Little Neck Parkway, Little Neck, NY 11362.

Improves Auto FM Listening

FM radio lovers will welcome the auto radio FM booster by GC Electronics. The booster, 18-821 Model, amplifies weak, fading FM signals into clear and sharp reception for true FM listening pleasure. It can be installed in any AM/FM car radio and will not affect AM listening. Irritating fading signals and "picket fencing" is reduced or eliminated. A

Revolutionary breakthrough in CB antenna design

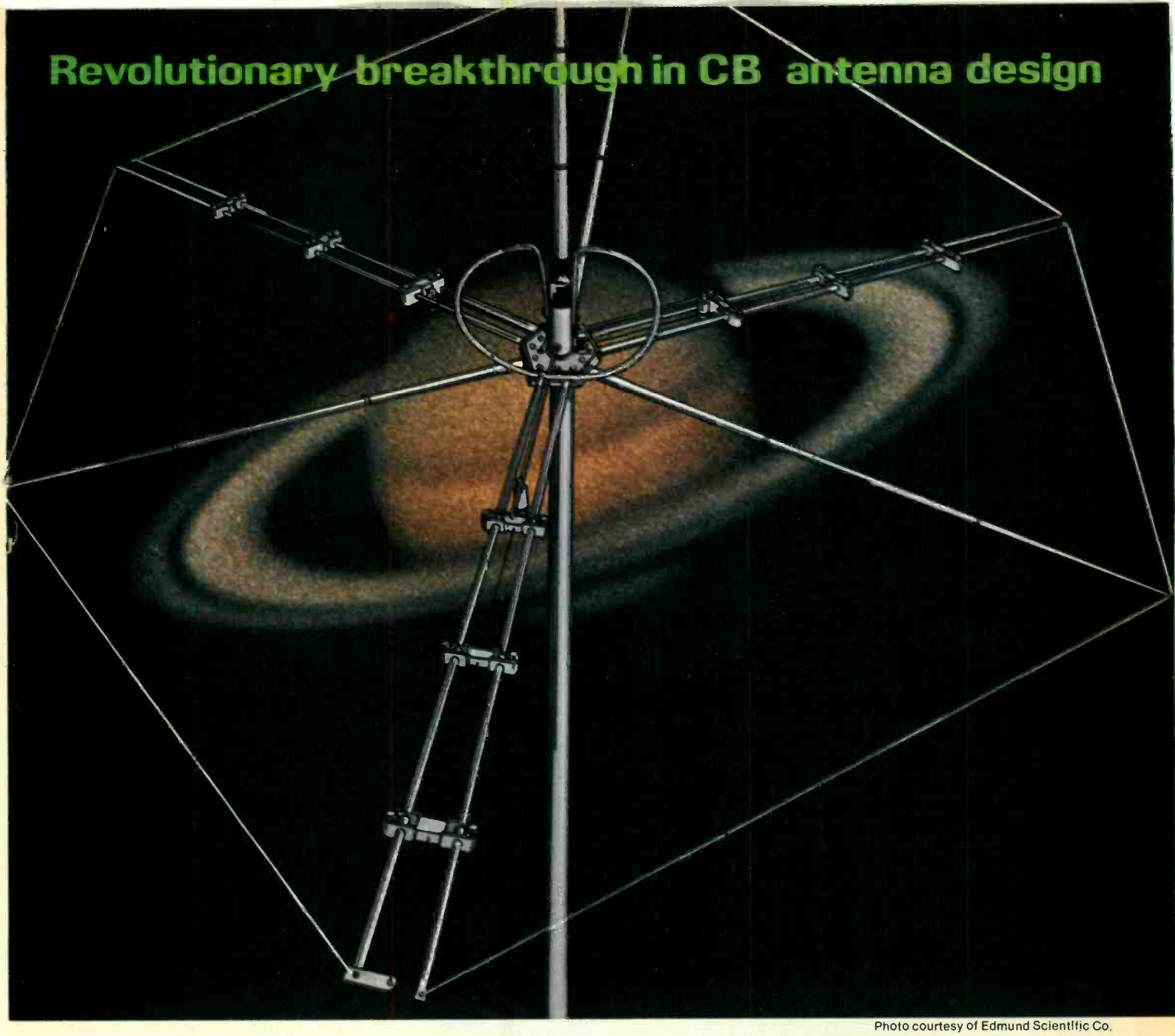


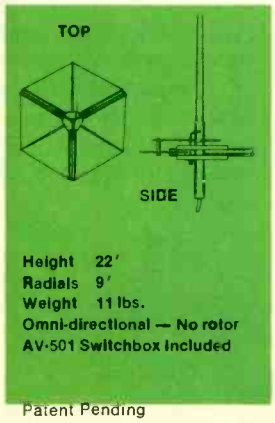
Photo courtesy of Edmund Scientific Co.

AVANTI® Invents the Saturn™ Base

The reason the "Saturn" is so revolutionary is that it is absolutely the only **combination vertical *and* horizontal omni-directional antenna.** That's right, it needs no rotor! You can pick up mobiles (which are vertical) or horizontal and vertical beams.

The "Saturn", invented after years of research by Avanti engineers, is the latest development using AVANTI's unique CO-INDUCTIVE principle to give you the performance of two antennas combined into one.

The "Saturn" not only works on both polarities, but pounds out signals like an air hammer and picks them up like a magnet. Both polarities offer high gain figures.



Patent Pending

Those of you who are worried about sun spots and "skip" can relax too. This antenna really helps. When the sun spots cause a signal shift, you can often change polarity (just like our P.D.L. or Moonraker) and still pick up the desired channel with no loss of transmission.

The P.D.L. and Moonraker made dual polarity famous as the only antennas to have during the last sun spot cycle, and this time around any serious C.B.'er will want to have the "Saturn."

In fact, having a "Saturn" and a "P.D.L." or "Moonraker" will put you in the elite group of C.B.'ers who "always seem to get out better."

Write for free Avanti catalog.

avanti

AVANTI RESEARCH AND DEVELOPMENT, INC.,
340 Stewart Avenue, Addison, IL 60101

Creators of the famous

MOONRAKER®

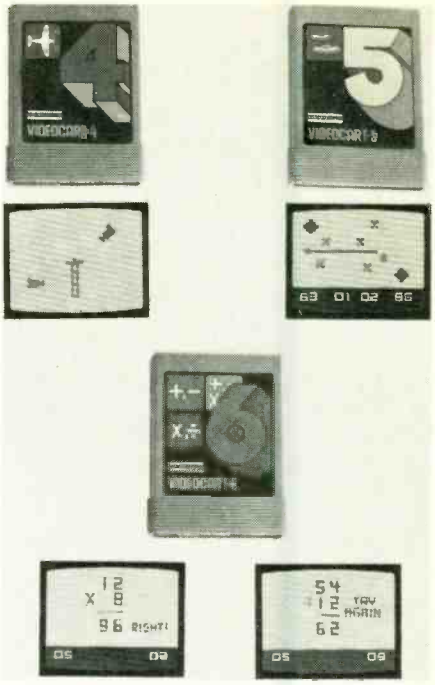
HEY, LOOK ME OVER

CIRCLE 49 ON READER SERVICE COUPON

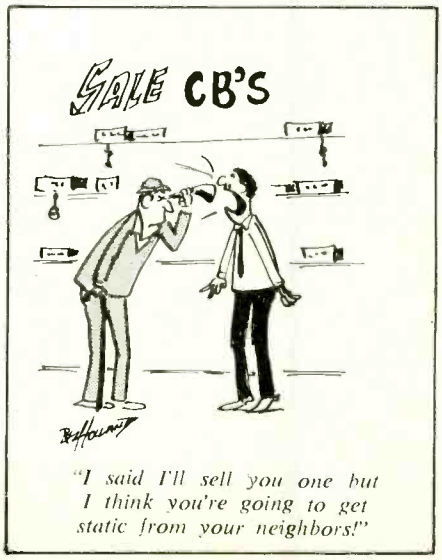
convenient LED indicator lights up when the On-Off switch is in the "On" position. There is no danger of over-loading when the booster is switched "Off." Installation is simple and all hardware is supplied. Easy to follow instructions are included. Sells for $19.95. For more information, write to GC Electronics, Division of Hydrometals, Inc., 400 South Wyman St., Rockford, IL 61101.

Three Game Cartridges

Three new plug-in Videocart cartridges, Spitfire, Space War and Math Quiz, have been added to the Fairchild library, giving their Video Entertainment System a capability of 11 games. Spitfire is an airplane dogfight for two players or for one player versus the console's microcomputer. Space War, a two-player game, permits each participant to maneuver his flying saucer into position to try to defeat his opponent with successive blasts of a laser gun. Math Quiz is the first non-game Videocart cartridge. It challenges young players to correctly add, subtract, multiply and divide numbers selected randomly by the microcomputer. Other Videocart cartridges also available are Tic-Tac-Toe, Shooting Gallery, Doodle, Quadra-Doodle, Desert Fox and Black Jack. Tennis and Hockey are already in the systems console. Videocart cartridges contain programmed semiconductor memory that functions with the console's microcomputer to greatly increase system versatility. Videocarts have a suggested retail price of $19.95, and the Video Entertainment System, $169.95. For more information, write to Fairchild Camera and Instrument Corp., Consumer Products Group, 4001 Miranda Ave., Palo Alto, CA.



CIRCLE 61 ON READER SERVICE COUPON



"I said I'll sell you one but I think you're going to get static from your neighbors!"

FREE

THE NEW HEATHKIT CATALOG!

World's largest selection of fun-to-build money-saving electronic kits

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Learn design, installation and maintenance of commercial, amateur, or CB communications equipment.

The field of communications is bursting out all over. In Citizens Band alone, class D licenses grew from 1 to over 2.6 million in 1975, and the FCC projects about 15 million CB'ers in the U.S. by 1979. That means a lot of service and maintenance jobs . . . and NRI can train you at home to fill one of those openings. NRI's Complete Communications Course covers all types of two-way radio equipment (including CB), AM and FM

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The complete course includes 48 lessons, 9 special reference texts, and 10 training kits. Included are: your own electronics Discovery Lab, Antenna Applications Lab, CMOS Frequency Counter, and an Optical Transmission System. You'll learn at home, progressing at your own speed, to your FCC license and into the communications field of your choice.

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Electronics in the News!

CB Radio a Family Affair

You name it — computer operator, secretary, welder, packer, tester, engineer—chances are a Roemhildt does it at E. F. Johnson Company, manufacturers of CB radio equipment. Shown in the photo (front row, left to right) are Violet, Rosalind, Sue, Irene, Lois, Cindy and Alice. Then (back row, left to right) there's Shirley, Nydia, Elsie, Yvonne, Collette, Sara, Dorothy and Aaron. Not shown are Roxanne and Lorraine. That's seventeen Roemhildts (count 'em). It's also a total of almost one hundred and thirty years of on-the-job experience. An average of seven plus years with the Waseca, Minnesota based CB manufacturer.

All in the family is an occupational theme for the Roemhildt family. The E. F. Johnson Company is smiling to have this family team producing their CB rigs.

Build Your Own Solar Heat Collector

Designer Daniel I. Hadley, updating and improving a 40-year-old Federal design for solar energy, has come up with plans for a simplified, low-cost, do-it-yourself solar heat collector that is capable of heating a room approximately 15 feet square. Hadley calls his basic four-by-eight foot heat collector a "truly workable solar heater of the future for the average family, harnessing, gratis, the greatest energy force on earth. I regard this unit as a very fundamental contribution toward energy conservation."

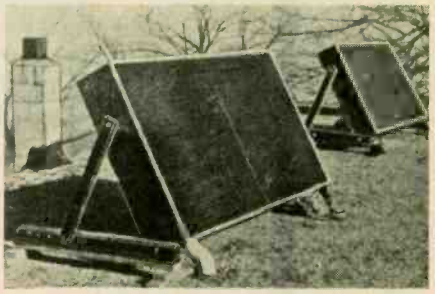
Through test models—some operating continuosuly for as long as seven years—Hadley said he has proved conclusively that his hot air or hot water

NEWSCAN

solar heat collector will heat a well-insulated room 15 feet square when the sun is shining. He stressed the factor of well-insulated rooms. Hadley added that the unit can be attached to existing heating systems for supplemental supply, or coupled together to warm larger areas.

The plans and specifications for the solar heat collector are so simple that almost any handypersons can build the basic unit from standard materials obtainable at neighborhood suppliers at a cost of about $150 to $200.

Hadley is the first to point out the idea is neither new nor patentable. He simply utilized the basic principles of a



Solar Heat Collectors such as shown here can provide years of free heat with very little maintenance. Made of standard materials, one 4 X 8 foot unit produces enough heat for a well-insulated room approximately 15 feet square and cost less than $200. A complete set of plans and specifications showing how several units can be connected for larger areas and giving information on heat storage and prices are available by sending $7.00 to Hadley Solar Energy Co., Box 1456, Wilmington, Delaware 19899.

Department of Agriculture design of 1936, and, through years of testing and implementation, and the use of modern, more durable and efficient materials, evolved a system which "nearly anyone with hammer, drill, saw, and soldering equipment can build."

Basically, the hot air collector is a four-by-eight-foot panel of thin plastic mounted on a wooden box lined with insulating board and containing a piece of galvanized sheet metal, an ordinary clothes dryer hose and a small fan to carry hot air into the house. The hot water unit utilizes a coil of copper pipe and a small pump. The coils alone hold 10 gallons of hot water—about enough for a shower, shave and shampoo.

Some of the many points outlined in Hadley's plan include:

- Single sheet thickness clear Plexiglas or fiberglass lets in more ultraviolet rays than glass and is tougher and more efficient.

(Continued on page 89)

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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, switches, solid state devices, etc.

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

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• 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

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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."

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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.

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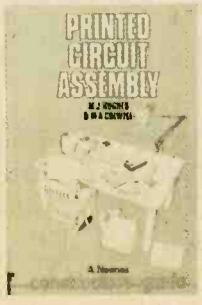
CIRCLE 16 ON READER SERVICE COUPON

BOOKMARK
BY BOOKWORM

New Bugbook! The term Bugbook is a name for a series of excellent books that provide a laboratory-oriented approach to electronic topics. The last title is *The 555 Applications Sourcebook, with Experiments* by Howard M. Berlin. This book could not have been written five years ago because that was when the 555 tuner, a new and revolutionary type of linear integrated circuit was developed. The text shows what the 555 tuner is and how to use it, by itself, and with other solid-state devices, without having to become an electronic engineer. The book is full of circuits that you can use to build projects. Published by E&L Instruments, Inc., 61 First St., Derby, CT 06418.

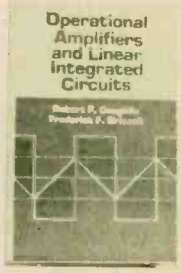
Soft cover
165 pages
$6.95

PC ABC's. Hobbyist experimenters now can read the first of several heavily illustrated two-color texts presenting practical advice and valuable information. *Printed Circuit Assembly*, by M. J. Hughes and Morris A. Colwell, describes the characteristics of the various bases used in printed circuit systems and guides the reader through the stages of translating circuit diagrams into printed circuit layouts. Image transference, etching, milling and trimming methods are described. Some special techniques such as through-hole plating, edge connector tabs and multi-layer assembly are also outlined, and reliability and maintenance procedures are discussed. The merits of alternative ready-made proprietary assembly systems are reviewed and tabular comparisons made. Other titles currently available are: *Electronic Components* and *Electronic Diagrams*. All are published by Newnes-Butterworth and available from Hayden Book Company, Inc., 50 Essex St., Rochelle Park, NJ 07662.



Soft cover
82 pages
$4.50

Hooking Up Op Amps. The purpose of *Operational Amplifiers and Linear Integrated Circuits* by Robert F. Coughlin and Frederick F. Driscoll is to show the ease of using op amps in a variety of applications, including signal generation and control. The text shows an inexpensive, reliable op amp that forgives most mistakes in wiring, ignores long lead capacitance and does not burn out easily—such as op amp 741, whose applications appear throughout the text. Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632.



Hard cover
312 pages
$15.95

Getting Started. Microcomputers are typewriter-size computers that are becoming so popular with both the public and industry that many are comparing the microcomputer explosion to the CB explosion. A new title, *Microcomputer Primer* by Mitchell Waite and Michael Pardee, is for anyone knowing basic electronics who wants to learn just what a microcomputer is and how it works. Following a short introduction to microcomputers, their history, capabilities and avalability, the book goes on to discuss the five main parts of a computer: central processing unit (CPU), memory, input/output (I/O) devices, input/output interfaces and programming. One appendix describes the binary, octal and hexadecimal number systems, while another provides useful and hard-to-find information on read/write and read-only memories. Published by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46206 ■

Soft cover
224 pages
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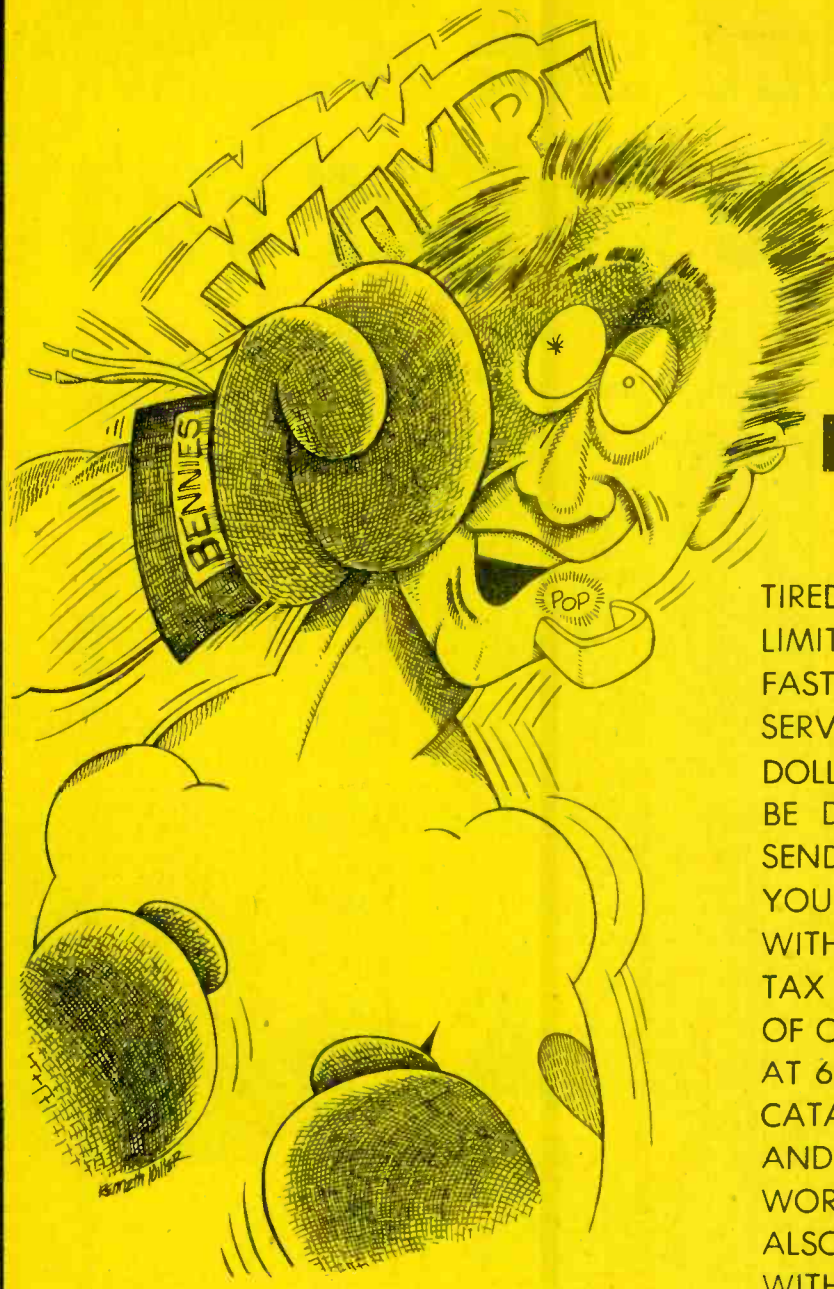

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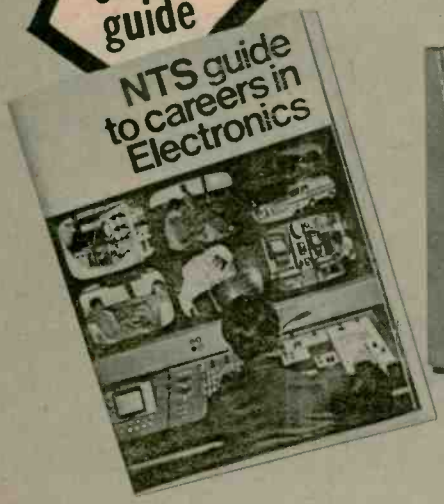

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and the equipment be equipped.

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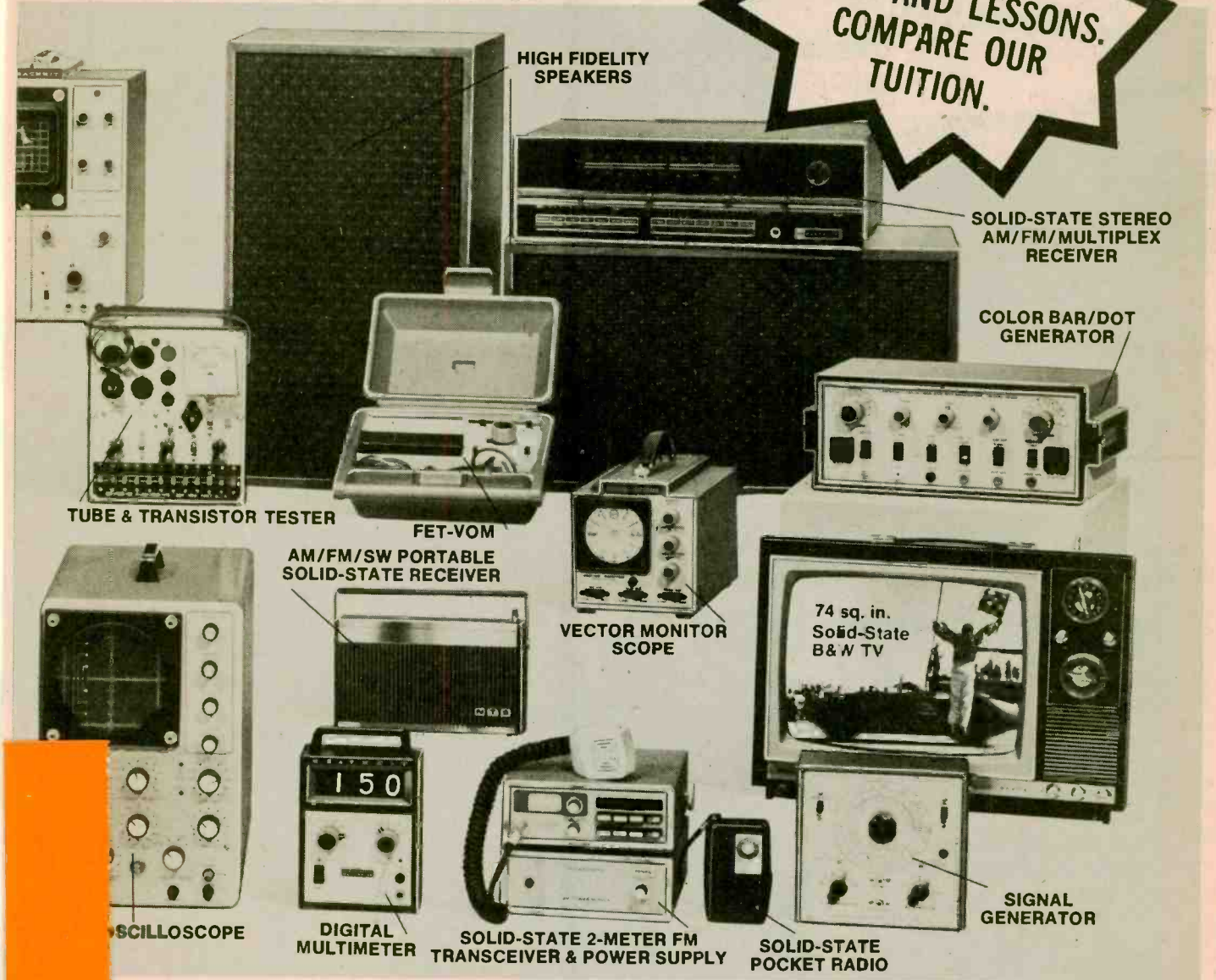

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DX central reporting

A world of SWL info!

BY DON JENSEN

☐ Mention DXing Latin America to many people and a horrified look comes over their faces. "What? Not me! They're tough to hear on shortwave and even tougher to identify. Those stations broadcast all in Spanish or Portuguese!"

Well, that's not really true. With a little effort, and some care and experience, it is possible for almost anyone who wants to try to log and identify Spanish and Portuguese speaking SW stations. But for the moment, and for the less experienced SWL, I should note that there are more stations in Latin America than you might think which do feature, sometime during their schedules, programs in English. And that's a good way to start your Latin listening project.

The Number One, out-and-out easiest station in Latin America to hear and verify is the old familiar HCJB, the *Voice of the Andes* in Quito, Ecuador. HCJB is a Christian religious station that has been broadcasting on shortwave since the 1930s. Today the station programs in a number of languages to listeners around the globe. HCJB signals are easily heard since the station uses powerful transmitters, three 50,000-watt and three 100,000-watt units. In the future the signal may even be better when planned half-million watt transmitters become operational.

If you haven't already tuned HCJB, look for English programming on 6,095, 9,560 or 11,915 kHz every evening from before 0100 until 0700 GMT. Or in the morning from around 1230 until after 1600 GMT on 11,745 and 15,115 kHz.

Heard equally as well as HCJB, but whose programs have an entirely different slant, is *Radio Havana Cuba,* from the island just 90 miles off our southern coast. Most listeners, even the very beginners, have already heard this shortwave voice during the evening, broadcasting in English on 9,685 and 11,725 kHz.

The government SW outlet at Buenos Ares, Argentina is another Latin station that schedules English programming, albeit not too extensively. The station is called RAE, which stands for *Radiodifusion Argentina al Exterior.* The identification in English, however, is simply, "This is RAE (pronounced like "rye") calling."

Look for RAE weekdays at 2300 GMT on 11,710 kHz; and on 9,690 kHz at 0300 and again at 0600 GMT.

Cruising through Latin America alphabetically, the next stop is Brazil, largest

(Continued on page 37)

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Our fully transistorized BFO unit can locate a quarter at 18". Powerful 6 trans.-oscillator-amplifier circuit. Comp. to others priced 50% more! Aluminum, just 2 lb.
No. 80,222 EK $39.95 Ppd.

Patent Pending

THERE IS NO OTHER TELESCOPE LIKE IT!
THE NEW EDMUND 4¼", f/4 NEWTONIAN WIDE FIELD REFLECTOR TELESCOPE

*Clear, bright, spectacular wide angle views of stars, moon, comets . . . easy to use . . . **portable!***

IN SECONDS YOU'RE SCANNING THE ASTOUNDING UNIVERSE, able to see and study the breath-taking cosmos as perhaps you never have before awesome vastness, unbelievable orderliness, stark silent beauty. All the fascinating heavenly mysteries are yours to enter and explore. This new reflector telescope makes it easy for everyone to span a thousand light-years to space-age enjoyment of the heavens and outdoors. No complicated set up! Just insert the eyepiece, focus, and its big 3½° field of view gives you more stars in a single view than any other type of telescope. Bright, crisp, finely resolved images to capture your interest and imagination. It's probably the easiest to use telescope ever . . . over your shoulder, in your lap, on a tripod. Or just rotate the spherical base on its own mount for use on a table, car hood. Take it anywhere (only 17", 10 lb.). Top quality optical system: 4¼", f/4 parabolic primary mirror (⅛ wave, 17" F.L.); prealigned ⅛ wave diagonal on a coated optical window seals optics from moisture and dust; 28mm Kellner eyepiece (gives 15X, higher without other eyepiece or Barlow). Fast focusing (25' to infinity). Bright Scharfanian red (doesn't impair night vision); adj. carrying strap. A "first" scope . . . must" an ideal second scope!

There is no other telescope like it. NO. 2001 EK **$149.95 Ppd.**

FOR GREATER RELAXATION, CONCENTRATION, *listen to your Alpha and Theta brainwaves!*

No. 1689EH

Do it with an amazing biofeedback monitor. This ultra-sensitive sensor detects brain signals, lets you monitor (hear and see!) your Alpha and Theta brainwaves. Great aid to relaxation, concentration. This portable (8 x 3 x 4") lightweight (24 oz.) metal unit has a unique electrode headband to slip on or off in seconds without messy creams or solutions. Hooked to amplifier, it filters brainwaves, and signals an audible beep for each Alpha or Theta wave passed. You get both audio and visual (L.E.D.) feedback with this reliable, completely safe unit. It operates on two 9v transistor batteries, offers features comparable to many costlier models. A comprehensive instruction booklet is included.

Do-It-Yourself Kit #61069EK ..... $37.50 ppd.
Low Cost 'Starter' Unit #71809EK ..... $59.95 ppd.

No. 1689EK JUST $99.95 Ppd.

LOW COST, HIGH QUALITY INFRA-RED EYE

A must for Infra-red crime detection surveillance, security system alignment, I.R. detection, laser checking, night-time wildlife study—any work requiring I.R. detection and conversion to the visible spectrum. Self-contained scope (11 x 14¼ x 3") includes I.R. light source (for up to 90' sight at night!), 6032 I.R. converter tube, f/3.5 telephoto lens, adjustable triplet eyepiece, an adapter for use with your car's cigarette lighter—more! Bright 1.6X image **(Binocular style gives super-bright 2.5X).** Focuses from 10' to infinity, runs on 6 or 12v DC.

Not for sale to Cal. residents other than authorized by U.S. Armed Forces, law enforcement agencies or solely for scientific research and education purposes.

STANDARD STYLE, STOCK NO. 1683EK ..... ONLY $299.95 Ppd.
BINOCULAR STYLE, STOCK NO. 1685EK ..... JUST $329.95 Ppd.

GIANT *FREE* 164 PG. CATALOG

4,000 UNUSUAL BARGAINS FOR HOBBYISTS, SCHOOLS, INDUSTRY

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Radio Shack CB Song Search

☐ Would you believe that the Top Forty are all CB songs—in the Radio Shack 1976 $100,000 CB Song Search. More than 7,000 songs, each entered on a cassette tape, were listened to by a panel of judges and evaluated according to their musicality, and the way in which they expressed the relationship of Citizens Band radio to the everyday lives and loves of Americans. James A. Cox of Muncie, Indiana won a total of $18,000 for his first place song, "Talkin' on the CB." Robert J. Miller of Huntington, West Virginia received $14,000 for his "Ernie's Talking Kitchen," and Jeffrey Boyan of Hammond, Indiana got $8,000 for the third place song, "Heart Breaker (Break In On Me)."

The judges included 1976 truck "Queen of the Road," Geri Ann Atl ton, 1976 truckers' "Disk Jockey of Year," Charlie Douglas of WWL Ra composer-producer Danny Wolfe, music star Gary U. S. Bonds country-western performer, Tom Overstreet. There are plans to rec the top ten songs professionally

Here Richard J. O'Brien presents Robert J. Miller (r) of Huntington, West Virginia with $13,000 for his song "Ernie's Talking Kitchen." Bob won second place in Radio Shack CB song contest.

James A. Cox (l) of Muncie, Indiana is presented with a che for $15,000 by Radio Shack regional manager Mark L. Seam for his first place entry.

ELECTRONIC GAMES?

By Jack Schmidt

"Yes, sir, it is kind of a game. You try to speed through here and we try to catch you!"

". . . talk about sore losers!"

"Okay, who hooked up the ping-pong game to the computer terminals?"

"Making it yourself, so you'll know better how to cheat, dear?"

"How about you taking Dad on your team so Mom gets a chance to win?"

e/e checks out the...

BLACK & DECKER 1908 CORDLESS ELECTRIC DRILL

CIRCLE 57 ON READER SERVICE COUPON

☐ It appears that just about every electric hand tool needed by the home handyman is now available in a portable version powered by rechargeable batteries. Good as these handyman tools are—and they are certainly convenient—they often lack the power needed for something heavier than an aluminum or copper raingutter.

And even when a handyman-quality battery-powered tool will do the job you often find the battery has run down while waiting on the shelf from its last job, and you must wait up to 16 hours for the darn thing to recharge.

But these problems and frustrations are now a thing of the past when it comes to battery-powered drills because Black & Decker's new No. 1908 ¼-inch Cordless, Reversible Drill is a *heavy duty* drill using a special battery that can be recharged from total exhaustion in only one hour. Better still, the battery plugs in to the tool, so if you're a professional with need for guaranteed portable power you can also carry along a spare, fully-charged battery.

The complete package consists of the drill, one battery pack, and a rapid charger. Though the charger takes one hour for a full recharge, a partially-discharged battery pack takes proportionately less time to fully charge.

Differences between the No. 1908 drill and the typical handyman rechargeable types are immediately apparent as soon as you squeeze this tool's trigger. It doesn't just start. Rather, it shudders with a healthy starting kick indicating high torque. And should you try to stop the drill by grasping the chuck you'll find it will take off some skin—it's almost impossible to stop the chuck by hand.

Unlike other handyman drills, which run at under 1000 RPM, this drill runs at 1500 RPM, a good compromise for light and heavy materials. A switch on the handle provides *Forward, Reverse* and *Lock*.

As shown in the photographs, the battery pack is an extension of the handle. To release the pack you simply press the metal tab on the bottom of the pack, releasing the holding arm, which allows the battery pack to slide out of the handle and into your hands. To replace the pack you simply insert it into the handle and pivot the holding arm until it locks onto the bottom of the pack. A special slot in the bottom of the pack holds the chuck key, which with AC-operated tools is attached to the line cord.

To fast-charge a battery you drop it into the rapid charger and push a button, causing a pilot lamp to go on. When the lamp goes out you know the battery is charged. A special temperature-sensing circuit delays the battery charging if it's hot from recent heavy use. When the battery cools to normal temperature the charging starts, automatically.

Though the rapid charger is fast, a less-expensive 16-hour trickle charger is available for those who don't need immediate recharging capability, or who want to keep a battery on permanent trickle charge to have a fully charged battery available at all times.

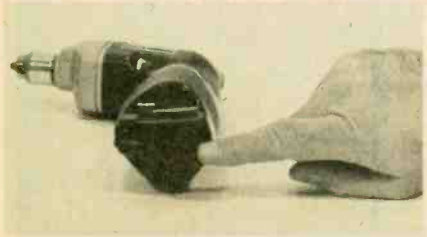
For those who want to carry the drill around on the job, an optional leather holster is available for $9.95 as catalog No. 98-004/91-012.

The drill components are also individually available. The battery is catalog No. 98003/91-009 and costs $29.95. Trickle charger 98015/91-007 is priced at $9.95.

Because the 1908 cordless drill is a professional tool it may not be in stock at all hardware stores that handle tools for the Saturday mechanic and home handyman. If your dealer doesn't stock the drill look for a tool distributor who handles the commercial line of Black & Decker tools.

For additional information on the No. 1908 ¼-inch cordless drill and its accessories circle No. 57 on the Reader Service Coupon. ■

Finger indicates the three-position switch on the handle which permits selection of Forward, Reverse, and Lock functions.



Here we're indicating the small metal tab on bottom of the battery which is pressed, releasing battery from drill body.

Black & Decker 1908 packs man-sized wallop outdoors. For more information circle number 57 on Reader Service Coupon.

SPECIAL PRICING!

PRIME - HIGH SPEED RAM

21L02-3 400 NS

LOW POWER - FACTORY FRESH

1-24	$1.95 ea	100-199	$1.60 ea
25-99	1.75 ea	200-499	1.45 ea

OVER 500 PCS. **1.39** ea.

PRINTED CIRCUIT BOARDS for CT-7001 Kits sold separately with assembly info. PC Boards are drilled Fiberglass, solder plated and screened with component layout.

Specify for 7001 ***B, C or X*** - $7.95

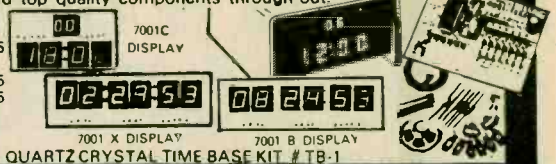
6-DIGIT LED CLOCK CALENDAR KIT

DATE-TIME-SNOOZE ALARM & MORE... KIT 7001

FOR THE BUILDER THAT WANTS THE BEST. FEATURING 12 OR 24 HOUR TIME — 29-30-31 DAY CALENDAR. ALARM, SNOOZE AND AUX. TIMER CIRCUITS

Will alternate time (8 seconds) and date (2 seconds) or may be wired for time or date display only, with other functions on demand. Has built-in oscillator for battery back-up. A loud 24 hour alarm with a repeatable 10 minute snooze alarm, alarm set & timer set indicators. Includes 110 VAC/60Hz power pack with cord and top quality components through-out.

KIT - 7001B WITH 6 - .5" DIGITS $39.95
KIT - 7001C WITH 4 - .6" DIGITS & 2 - .3" DIGITS FOR SECONDS $42.95
KIT - 7001X WITH 6 - .6" DIGITS $45.95



KITS ARE COMPLETE (LESS CABINET)
ALL 7001 KITS FIT CABINET I AND ACCEPT QUARTZ CRYSTAL TIME BASE KIT # TB-1

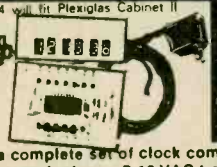
6 DIGIT LED CLOCK KIT # 850-4

12/24 HR. OPERATION BIG .4" DIGITS - 50/60 HZ OPERATION.

KIT INCLUDES
- INSTRUCTIONS
- QUALITY COMPONENTS
- 50 or 60 Hz OPERATION
- 12 or 24 HR OPERATION

6-LED Readouts (FND-359 Red, com. cathode)
1-MM5314 Clock Chip (24 pin)
13-Transistors
3-Switches
6-Capacitors
5-Diodes
9-Resistors
24-Molex pins

Kit # 850-4 will fit Plexiglas Cabinet II



$11.95 ea. QTY. 1-5
$10.95 ea. QTY. 6-11
$9.95 ea QTY. 12 OR MORE

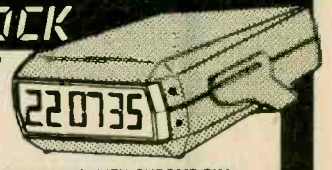
"Kit #850-4 will furnish a complete set of clock components as listed. The only additional items required are a 7-12 VAC transformer, a circuit board and a cabinet, if desired."

PRINTED CIRCUIT BOARD FOR KIT # 850-4, SCREEN PRINTED DRILLED AND SOLDER PLATED FIBERGLASS $2.95
MINI-BRITE RED LED'S (FOR COLON IN CLOCK DISPLAY) ... Pkg. of 5-$1.00
MOLDED PLUG TRANSFORMER 115/10 VAC (WITH CORD) $2.50

NOTE: Entire Clock may be assembled on one PC Board or Board may be cut to remote display.

MOBILE LED CLOCK

12/24 HR .4" DIGITS!



MODEL #2001
12 VOLT AC or DC POWERED

- 6 JUMBO .4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM
- SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24-Hr. TIME FORMAT
- STYLISH CHARCOAL GRAY CASE OF MOLDED HIGH TEMP. PLASTIC
- BRIDGE POWER INPUT CIRCUITRY — TWO WIRE NO POLARITY HOOK-UP
- OPTIONAL CONNECTION TO BLANK DISPLAY (Use When Key Off in Car, Etc.)
- TOP QUALITY PC BOARDS & COMPONENTS - EXCELLENT INSTRUCTIONS
- MOUNTING BRACKET INCLUDED

KIT #2001 COMPLETE KIT (Less 9V. Battery) 29.95 EA. 3 OR MORE $27.95 EA.
115 VAC Power Pack #AC-1 $2.50 EA.

ASSEMBLED UNITS WIRED & TESTED ORDER #2001 WT (LESS 9V. BATTERY) WIRED FOR 12 HR OP. IF NOT SPECIFIED OTHERWISE $39.95 EA. 3 OR MORE $37.95 EA.

60 HZ. XTAL TIME BASE

Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC. 1"x2" PC Board
Power Req.: 5-15V (2.5 MA. TYP.)
Easy 3 wire hookup
Accuracy: ± 2PPM
#TB-1 (Adjustable)
Complete Kit $4.95 ea
Wir & Cal $9.95

PLEXIGLAS CABINETS

Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

CABINET I
3"H, 6¼"W, 5½"D
Black, White or Clear Cover

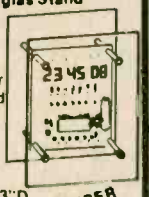
CABINET II
2½"H, 5"W, 4"D
$6.50 ea.

RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS
3"x6"x1/8" 95¢ ea. 4/$3

SEE THE WORKS Clock Kit Clear Plexiglas Stand

- 6 Big .4" digits
- 12 or 24 hr. time
- 3 set switches
- Plug transformer
- all parts included

Plexiglas is Pre-cut & drilled
Kit #850-4 CP
Size: 6"H, 4½"W, 3"D



$23.50 ea. 2/$45. A SUPER CLOCK!

JUMBO DIGIT CLOCK

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC, 12/24 Hr. time, 50/60 HZ., Plug-Transformer, Line Cord, Switches, and all Parts. (Ideal Fit in Cabinet II)
Kit # 5314-5 $19.95 2/$38.
WITH PC Board $

JUMBO DIGIT CONVERSION KIT $ 9.95 ea.
Convert small digit LED clock to large .5" displays. Kit includes 6 - LED's, Multiplex PC Board & easy hook-up info.
Kit # JD-1CC For common Cathode
Kit # JD-1CA for common Anode

TELEPHONE FORMAT KEYBOARD

BY Chomerics
EF-21360
2-1/4"x3"

5/32" thick

$4.95
6/$28.

25 AMP BRIDGE

$1.95 ea.
3/$5.00

NEW LSI TECHNOLOGY

FREQUENCY COUNTER KIT

8 LARGE .4" RED LED DIGITS

Kit #FC-50 • 8 IC's • XTAL TIME BASE

A truly "State of the Art" counter using quality components throughout.

KIT INCLUDES: DETAILED INSTRUCTIONS, XTAL, TOP QUALITY FIBERGLASS DOUBLE SIDED PC BOARD, IC'S WITH SOCKETS AND ALL PARTS LESS POWER SUPPLY AND CABINET.

50 MHZ COUNTER KIT #FC-50 $69.95

5 VOLT REGULATED 1 AMP POWER SUPPLY KIT	#PS-02	$9.95
350 MHZ PRESCALER KIT	#PSL-350	23.95
650 MHZ PRESCALER KIT	#PSL-650	$29.95
CABINET [& MTG HARDWARE]	#CAB III	$19.95

[CABINET WILL HOUSE #FC-50, #PS-02, AND A PRESCALER]

Fairchild Super Digit FND-359

.4" Char. Ht. 7 segment LED RED Com. Cath. Direct pin replacement for popular FND-70.

95¢ ea, 10/$8.50 100/$79.00

SET OF 6 FND-359 WITH MULTIPLEX PC BOARD $6.95

NYLON WIRE TIES

8" TIE WRAP 100/$1.95
4" TIE WRAP 100/$1.75

PLUG TRANSFORMERS

12 VAC at 150 MA	$ 2.50
12 VAC at 500 MA	3.50
7VAC at 1.75 VA	$3.50

SCHOTTKY TTL

74S00	$ .35
74S01	.40
74S04	.55
74S05	.60
74S09	.55
74S10	.40
74S20	.50
74S22	.45
74S40	.45
74S50	.45
74S51	.55
74S60	.85
74S64	.55
74S74	.85
74S75	1.75
74S78	1.50
74S86	.95
74S107	.95
74S112	.95
74S113	1.40
74S114	.95
74S133	.75
74S134	.75
74S138	1.75
74S139	1.50
74S151	1.95
74S153	1.95
74S155	1.95
74S156	1.95
74S157	1.80
74S158	2.50
74S174	2.50
74S175	2.50
74S181	2.95
74S182	1.95
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DIGITAL CLOCK IC's

MM5312	$ 4.95
MM5314	3.95
MM5375 AB	3.95
CT-7001	7.95
CT-7002	13.95
MM5369	2.50

LED DRIVERS

7447	$ .95
7448	.95
75491	.65
75492	.65
9368	2.50

PRESCALE

11C90DC	$15.95
95H90	9.95

VOLTAGE REGULATORS

LM 309 H	TO-5	$ .95
LM 309 K	TO-3	1.25
7805	TAB	.95
7812	TAB	1.25
7812	TO-3	1.50
7815	TO-3	1.25
7815	TAB	1.25
78L 15	TO-5	.75
7824	TO-3	1.25
723	DIP	.75
723	TO-5	.75

PROM

1702	E Prom $8.95
5203	E Prom $8.95

SPECIAL IC'S

7207A	INTERSIL
7208	INTERSIL
MC14553	MOT $ 9.95
MC14410	MOT $12.80
2513	SIG $ 9.95

IC SOCKETS

PINS	1-24	25	100
8	$ .25	$ .22	$ .20
14	.25	.22	.20
16	.28	.25	.23
18	.31	.28	.26
24	.50	.45	.40
28	.60	.55	.50
40	.75	.70	.65

XTAL

5.242880 MHZ. $4.95
3.579545 MHZ. $1.95

TRANSISTORS

2N2222 A	TO 18	3/$1.00
2N2712	TO 98	5/$1.00
2N3415	TO-9	5/$1.00
2N3704	TO-92	5/$1.00
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IN 4005	1A, 600 PIV	11/$1.00
IN 4007	1A, 1000 PIV	10/$1.00
RECTIFIER	2.5A, 1000 PIV	4/$1.00
IN 914	SIL. SIGNAL	20/$1.00
IN 4148	SIL. SIGNAL	20/$1.00
DYAC	28V.	4/$1.00

LINEAR

555	TIMER	2/$1.00
556	DUAL TIMER	.95
565	PLL	95
566	FUNCTION GEN.	1.75
567	TONE DECODER	1.75

TRANSISTOR SOCKET TO-5/18 GOLD PINS 5 $1.00

7-SEG LED

COMMON CATHODE

	COLOR	HT	DEC PT.	PR EA
FND-359	RED	4"	RHDP	$ .95
FND 503	RED	5"	RHDP	$1.35
DL 750	RED	6"	LHDP	$2.95
XAN 654	GREEN	6"	NDP	$1.95
XAN 664	RED	6"	NDP	$1.95

COMMON ANODE

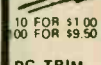
DL 747	RED	.6"	LHDP	$1.95
XAN-72	RED	.3"	LHDP	$1.25
MAN 72	RED	.3"	LHDP	$1.25
XAN-81	YELLOW	.3"	RHDP	$1.75
XAN 351	GREEN	.3"	RHDP	$1.50
XAN-362	ORANGE	.3"	LHDP	$1.50
XAN-662	RED	.6"	NDP	$1.95
XAN-692	RED	.6"	NDP	$1.95

OP AMPS

3/$1.00
301 TO-5
709 DIP
709 TO 5
741 DIP
741 M-DIP
741 TO-5
747 TO 5

DISCRETE LED's

JUMBO RED



10 FOR $1.00
100 FOR $9.50

PC TRIM POTS

25K 6/$1.00
4.7K 6/$1.00

SPECTROL 10K 10 TURN 95c 4/$3.00

CMOS

	ea.
4001	$ .20
4002	.20
4010	.40
4011	.20
4013	.40
4015	.95
4016	.40
4023	.20
4025	.20
4027	.40
4028	.85
4030	.35
4042	.75
4044	.60
4046	1.75
4049	.40
4050	.40

AUTO BURGLAR ALARM KIT

AN EASY TO ASSEMBLE AND EASY TO INSTALL ALARM PROVIDING MANY FEATURES NOT NORMALLY FOUND. KEYLESS ALARM HAS PROVISION FOR POS & GROUNDING SWITCHES OR SENSORS. WILL PULSE HORN RELAY AT 1HZ RATE OR DRIVE SIREN. KIT PROVIDES PROGRAMMABLE TIME DELAYS FOR EXIT, ENTRY & ALARM PERIOD. UNIT MOUNTS UNDER DASH - REMOTE SWITCH CAN BE MOUNTED WHERE DESIRED. CMOS RELIABILITY RESISTS FALSE ALARMS & PROVIDES FOR ULTRA DEPENDABLE ALARM. DO NOT BE FOOLED BY LOW PRICES! THIS IS A TOP QUALITY COMPLETE KIT WITH ALL PARTS INCLUDING DETAILED DRAWINGS AND INSTRUCTIONS OR AVAILABLE WIRED AND TESTED

KIT #ALR-1 $9.95
#ALR-1WT WIRED & TESTED $19.95

VARIABLE REGULATED 1 AMP POWER SUPPLY KIT

- VARIABLE FROM 4 to 14V
- SHORT CIRCUIT PROOF
- 723 IC REGULATOR
- 2N3055 PASS TRANSISTOR
- CURRENT LIMITING AT 1 Amp

KIT IS COMPLETE INCLUDING DRILLED & SOLDER PLATED FIBERGLASS PC BOARD AND ALL PARTS (Less TRANSFORMER) KIT #PS-01 $8.95

TRANSFORMER 24V CT will provide 300MA at 12V and 1 Amp at 5V. $3.50

MOLEX PINS

$9.95 Reel of 1000
100 for $1.25

OPTOELECTRONICS, INC.

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Fla. Res. Please Add 4% Sales Tax.

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SEE OUR BOOTHS AT THE ATLANTA HAMFESTIVAL - JUNE 18-19, 1977

CIRCLE 22 ON READER SERVICE COUPON

DX CENTRAL

(Continued from page 32)

nation in South America and probably the most shortwave "radio-active" country in the world. Among its many shortwave voices is the national station, *Radio Nacional Brasilia*. Brazil was rather late in getting involved in international broadcasting, and, even today, lags behnd her southern neighbor, Argentina. But there is English scheduled from this station at 2100 GMT on 11,700 kHz.

Also, there is a new Latin entry in the field of English language programming. It is *Radio Clarin* (pronounced, "clair-EEN") in the Dominican Republic. In this instance, the aim is to reach potential tourists who might be lured to vacation in the Dominican Republic, the Spanish-speaking half of the Caribbean island of Hispanola.

Radio Clarin's broadcasts have been a bit irregular. But you can look out for

GLOSSARY

AM—Amplitude modulation, a transmission mode, but sometimes used in a shorthand way to refer to the everyday-540 to 1600 kilohertz-Top 40 and Golden Oldie-radio band.
DX—Listening to distant radio signals.
DXer—Person who listens for DX.
GMT—Greenwich Mean Time, the universal time standard also known, in the military as "Z" or "Zulu" time. It is equivalent to EST+5 hours, CST+6, MST+7, and PST+8.
Hz—Hertz, a unit of measure meaning one cycle per second.
kHz—kiloHertz, a frequency measuring unit; 1,000 cycles per second.
MW—Medium wave, also called by listeners, BCB for broadcast band; the range of frequencies below shortwave, between, roughly 540 and 1600 kHz.
SW—Shortwave
SWL—Shortwave listener

English-speaking Rudy's tourist tips at 2330 GMT on either 4.850, 11,700 kHz, both or either. Sometimes one or the other of these frequencies is silent.

There are two religious stations in Central America that feature nightly English language programs as a break from their normal Spanish fare. They are TGNA, *Radio Cultural* in Guatemala City, and HRVC, *La Voz Evangelica* in Tegucigalpa, capital of Honduras. TGNA uses 3,300, 5,955 and 9.505 kHz. Its English programs can be heard between about 0300 and 0430 GMT. HRVC's English programs begin earlier, at 0200 GMT. The station is normally heard with ease on 4,820 kHz.

And while on the subject of misionary broadcasters, I can't forget to mention *Radio 4VEH*, Cape Haitien, Haiti, on the French Creole-speaking part of the island of Hispanola. 4VEH regularly uses three shortwave frequencies, 6,120, 9,770 and 11,835 kHz. Times to tune are 0100 to 0200 GMT and, in the morning, from 1100 GMT. English programs can be heard during these time slots.

Log Peru with English programming? Maybe you thought that wasn't possible, that there isn't an English-speaking voice in that Andean land. Well, not so. There is *Radio del Pacifico* in Lima. By this time it will probably come as no surprise that this too is a religious station. But to make ends meet, a common practice for such stations in Latin America, its Spanish programs are handled much like any commercial broadcaster. Its English programs are scheduled for 0200 GMT on 4.975 kHz in the 60 meter band.

Then there is the *Voice of Chile* from Santiago, which can be heard with good signals in the U.S. You can hunt for an English language newscast about 0115 GMT. A frequency to try is 9,565 kHz. And there are a few others that have or have had English programs at times, *Radio Mexico* and *Radio Nacional de Venezuela* to name a couple.

So even if you don't habla the slightest Espanol, you can still get started SWLing the English speaking stations of Latin America.

Learning Lingos. So far I've been talking about how you can hear stations in Central and South America even though you don't know a word of Spanish or Portuguese. But there is no need to shy

(Continued on page 88)

Ask Hank, He Knows!

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

Hank Scott, Workshop Editor
ELEMENTARY ELECTRONICS
229 Park Avenue South
New York, NY 10003

A Real Winner

I just wanted to write and thank you for the help that all of you at ELEMENTARY ELECTRONICS *gave me when I was building the Project Spaceflight that you described in the November/December 1975 issue. The project worked so well that I entered it in the 39th Annual School Science Fair in New York City and won Second Prize competing against 200 other seventh and eighth-graders. I am 13 years old and attend St. Agnes school in Brooklyn, New York.* —*Constance Lamicella, New York*

Congratulations! Building a full-fledged analog computer which can simulate spaceflight conditions, tell you how to dock in orbit and how to regulate your fuel consumption in powered flight is serious business for anyone, especially anyone under 30. Keep us posted on your future projects, and thanks for sending your picture.

Tune, not Trim!

How do I trim my antenna coax to reduce VSWR? I'm new to 2-way personal communications. —*D. N., Bed Springs, NE*

You cannot tune the antenna system by trimming the coax cable. Coaxial cable construction, especially the spacing between inner conductor and shield, imparts an impedance, expressed in ohms. This impedance, 52 ohms for RG-58/U and RG-8/U, holds throughout the cable, no matter what its length. If both ends of the cable are attached to 52-ohm loads (the transceiver and antenna) the VSWR will be very low. If the VSWR is high in your antenna system, look to reducing it by tuning the antenna. Remember, you'll never get a 1:1 ratio. Just tune for minimum.

Not a Bad Idea

My dad says that if everyone had to get a Ham license before going CB, there would be no problems. What's your opinion, Hank? —*B. T., Baton Rouge, LA*

If everyone had a Ham license, there'd be no CB, just one big Ham fraternity.

Lend a Hand, Boys

It's gratifying that so many readers have assisted those requesting help in this column. Keep it up, boys.

Δ If anyone has the schematic diagram and/or instruction manual on the Grundig Model TK-54 reel-to-reel tape recorder, please send it to Bob Landoni, 113 Leonard St., Gloucester, MA 01930.

Δ Sean A. Devitt of 2237 Wharton Rd., Glenside, PA 19038 would like to get the schematic diagram of a Fada Stereo Model FC-0212, Chassis No. R-285.

Δ Sorry, boys, we can't help you on old tube testers where the company went out of business. The tube charts for these testers are not available because they were never made!

Δ Gaylord Smith has a Zenith "Long Distance" Radio, Model H503Y, Serial No. J-536199 that works fine on AC. He would like to connect a battery to the radio as it was originally designed, but knows nothing of the battery details. If you can help, write to 413 Highway 79, Henderson, TX 75652.

Δ Attention, Shortwave Listeners! Steven Shaffer of 10956 Indianapolis Blvd., Box 4, Hammond, Indiana 46326 would like to rap eye-ball to eye-ball with another SWLer. Make contact, boys.

Making Holes

How can I cut holes through aluminum and light steel cabinets used in project building? —*K. F., Custer, SD*

You should look through catalogs of tools or tool listings in electronics parts catalogs to get ideas. For example, to get an odd shaped oval hole, drill a hole and use a rat tail file to elongate it. Small square holes can be punched out, if you have the punch set. If not, drill a hole and square it with a small triangular file. Larger holes can be made with a nibbler tool that cuts out small ⅛-in. bites at a time. Holes for meters and sockets are best made with round punch sets, however, the nibbler can do the job with some filing to smooth the edges. If you are interested in project work, plan to acquire tools of the type mentioned slowly to ease the cost.

Sounds Good

I hear a hi-fi outfit now makes quality ham gear. Do they have anything for 2 meters? —*L. V., Los Angeles, CA*

You're putting me on? You are referring to the Trio-Kenwood people at 116 E. Alondra, Gardena, CA 90248. They make a beauty of an FM transceiver for 2 meters. It's the TR-7400A that sells for about $400. Whatta rig!

(Continued on page 87)

EVERY PROJECT IN THIS BOOK IS ANOTHER REASON TO OWN CSC'S QT SOCKETS AND BUS STRIPS.

With QT solderless breadboarding sockets and bus strips, you can build twice the projects in half the time. Because making connections or circuit changes is as fast as pushing in—or pulling out—component leads. No special clips or jumpers required, either.

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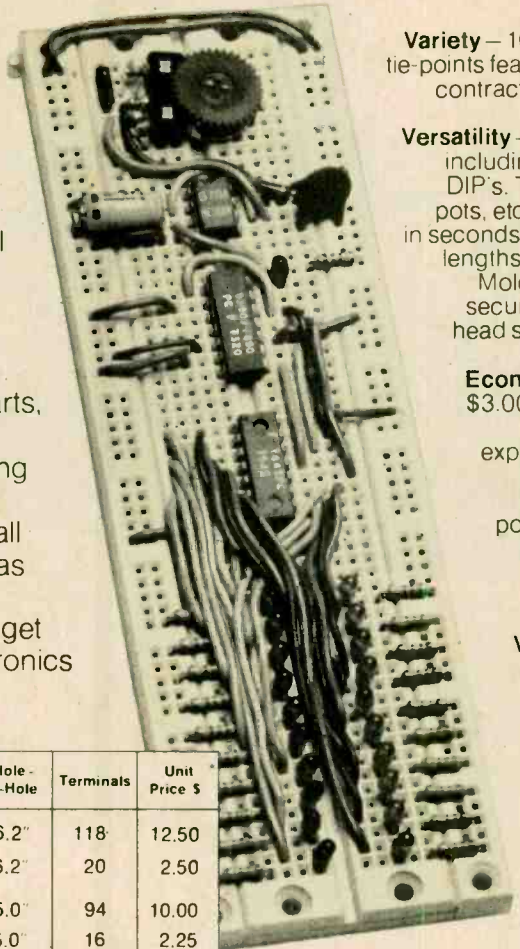

Variety—10 models from 70 to 590 solderless tie-points feature snap/lock design to expand or contract your breadboard to fit every circuit and budget requirement.

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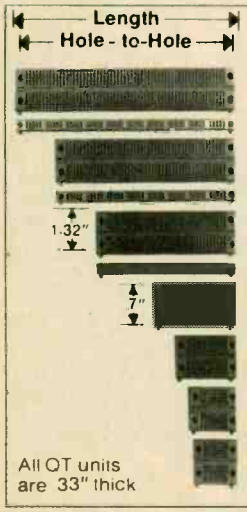
Reliability—Ruggedly designed to professional engineering standards, for heavy day-in, day-out use. Non-corrosive prestressed nickel-silver contacts insure more secure mechanical and electrical connections. Vinyl backing prevents shorting when mounted on conductive surfaces.



	Length	Hole-to-Hole	Terminals	Unit Price $
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QT-35S	4.1"	3.8"	70	8.50
QT-35B	4.1"	3.8"	12	2.00
QT-18S	2.4"	2.1"	36	4.75
QT-12S	1.8"	1.5"	24	3.75
QT-8S	1.4"	1.1"	16	3.25
QT-7S	1.3"	1.0"	14	3.00

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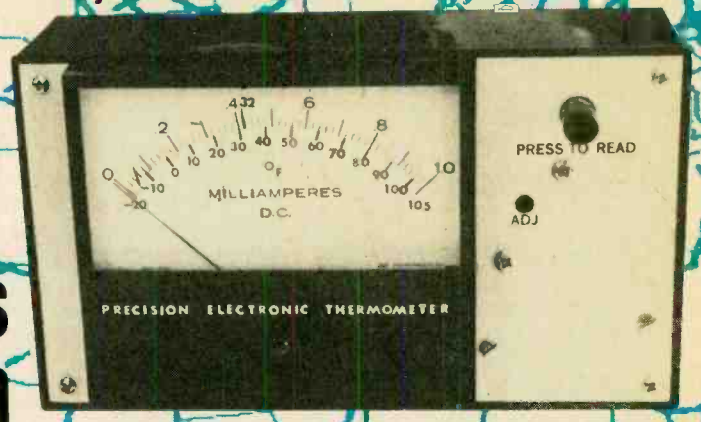
CIRCLE 32 ON READER SERVICE COUPON

elementary Electronics JULY/AUG. 1977

by Thomas R. Fox



Make This Precision Electronic Thermometer Your PET

New sensor and IC chip let you measure temperature accurately, anywhere, even under water.

by Thomas R. Fox

IF YOU'VE ALWAYS WANTED a really precise electronic thermometer so you can measure the temperature outdoors at a distance, or to continuously check the operation of your heating system at home, or monitor the cold in your refrigerator or ice compartment, or check the temperature down deep in the water for fishing up the big ones, or for medical or other uses where the need for continuous temperature readings in a distant, inaccessible, or uncomfortable situation makes an electronic thermometer desirable, the *Precision Electronic Thermometer* –PET, is for you.

If the cost, or the supposed complexity has scared you off—or if you've heard it's difficult to calibrate an electronic thermometer, take heart, PET is for you. Most electronic thermometers have calibration directions which instruct one to fiddle with 2 or even 3 adjustments while alternately sticking the thermometer's probe in ice water and lukewarm water. Even after minutes or hours of fussin' and cussin' and water everywhere, the accuracy of the thermometer often leaves much to be desired. But not so with PET.

The trouble with most electronic thermometers is the most important component—the sensor. Most temperature sensors have a temperature-versus-output curve that would make Raquel Welch envious. Also, few inexpensive sensors include the necessary identical twin. This causes even more problems.

Now, however, National Semiconductor has brought out a relatively inexpensive temperature transducer, the LX5700, which makes electronic thermometers fun to build and calibrate again. The LX5700 has a temperature-versus-output curve as flat as a pancake. Its non-linearity is less than ½ of one percent, compared to over one percent for *good*-quality mercury thermometers. Its only real deviation from perfection is an easily-corrected offset error of about ±4 degrees Celsius. This means you can build PET, a simple highly-accurate electronic thermometer with this transducer, yet have only one simple adjustment.

The heart of the LX5700 transducer is the sensor, which is made of two identical transistors fabricated on the same silicon chip but operating at different current densities. The 10-millivolt-per-degree Kelvin output of the sensor is proportional to the difference in emitter-to-base voltages, which is linearly related to temperature. This sensor was impossible to construct before integrated circuit techniques were perfected since it depends upon making two identical transistors right next to each other on the same chip.

In addition to its temperature linearity this transducer has two other features which make it a really neat device for people who love simplicity. First, it has its own built-in voltage regulator (See Figure 1, showing the zener diode in the block diagram) which makes it great for accurate, battery-operated thermometers. Second, the transducer also includes in its tiny case that marvelous device, the op-amp. By adding two resistors you can take that 10 mV-per-°Kelvin output of the sensor and amplify it to any practical output.

(Note that 1 mV is one-thousandth of a volt. °K is degrees Kelvin, which is the absolute temperature in the metric system. Kelvin degrees are the measure of temperature universally used by physicists. All you have to do to get the absolute—Kelvin—temperature in any system is to put a plus sign on its

absolute zero and add it to the regular (Celsius) temperature. That is, degrees Kelvin = degrees Celsius + 273°. As an example, the room temperature of 25°C (77°F) is actually 298°K. Other equivalents:

$$Tc = (40 + Tf)\frac{5}{9} - 40 \text{ and}$$

$$Tf = (40 + Tc)\frac{9}{5} - 40$$

where, of course, Tf stands for degrees Fahrenheit and Tc for degrees Celsius.)

Figure 2 shows an electronic thermometer that uses only 4 components (including a voltmeter). Assuming the transducer in Figure 2 is at the room temperature of 298°K (25°C–77°F), if you connect an accurate voltmeter to the output of the transducer, you will get a voltage reading of 2.98 volts (±.04 volts). The problem with such a thermometer, however, is the same problem some people find with life in general—a lack of *meaning*. For instance, wouldn't it sound funny to hear a DJ say on the radio, ". . . so folks another bitter cold night tonight with a low near 260° Kelvin . . ." Another problem arises if a standard 0-5 VDC meter is used as a thermometer's readout, for even if the thermometer is taken from Niagara Falls to Miami in January, the needle's movement will

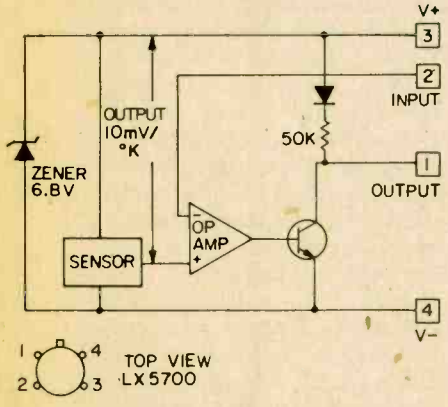


Fig. 1—Block diagram shows what's inside the LX5700 temperature-sensing transducer by National Semiconductor. Heart of device is the sensor itself, which produces output of 10 millivolts per degree Kelvin (see text). Op amp and transistor raise output, and voltage divider (external to transducer) determines meter deflection due to output at terminals 1 and 4.

hardly be visible. If cost were no problem, a digital voltmeter could solve this problem but the issue of "meaning" would remain.

In order to make a simple, useful thermometer with "meaning" we must add a few more resistors and a capacitor. Although our prototype PET measures temperatures between −20° and +105°F, I also explain how to make thermometers with ranges of 0-100°F and −50°C-+50°C. The only variation between the three thermometers are three resistors. If you plan to use your thermometer to measure the outside air temperature, the range you choose depends on where you live. If you live on the East, West or Gulf Coasts the 0-100°F range would do nicely. If you live in the northern great plains, desert southwest or similar areas or you are into metric, the −50°C to +50°C range is for you. For most of the rest of the country the −20°F to

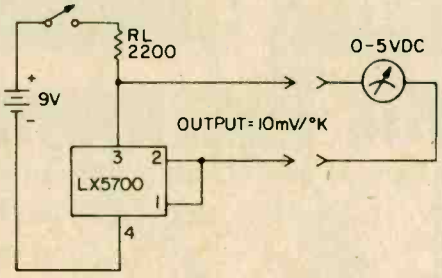


Fig. 2—Basic electronic thermometer circuit shows voltage divider is in the PET case, sensor and op amp contained in LX5700 transducer package and readout meter.

+105°F range is ideal. See the Tables for the resistors required for each temperature range.

Circuit Operation. Although the full schematic diagram is fairly simple it isn't much help in understanding exactly how the circuit works. To help clarify the matter, I have simplified that schematic in Fig. 3. R1, R2 and R3, are the same resistors shown in the full schematic.

From basic operational amplifier theory we know the following: The differential input voltage is zero, so V1 = V2. It can also be shown that

$$Vo = \frac{R2 + R3}{R3} \times V2.$$

From basic electricity,

$$Im = \frac{V1 - Vo}{R2} + \frac{6.8 - Vo}{R1}$$

To simplify the equation further, to understand the circuit, we can say that

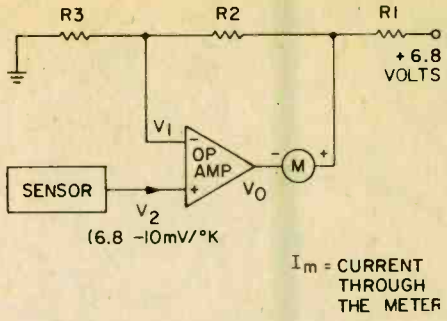


Fig. 3—Simplified schematic of PET precision electronic thermometer shows basic thermometer circuit adapted to LX5700 sensor.

Im is approximately equal to

$$\frac{6.8 - Vo.}{R1}$$

We can do this since we know that R2 is much greater than R1. Since Vo = KV2, where K is a constant and V2 = 6.8 −10 mV/°K, we see that the higher the temperature the smaller will be Vo. Thus, the current through the meter, Im, increases as the temperature increases.

The exact values of R1, R2 and R3 are chosen so that at the minimum temperature we want to measure, Im = 0, and at the maximum temperature we want to get a full scale deflection of our meter. (In the thermometer described in this article, Imax = 1 mA).

In the actual circuit, R7 and the transducer's own zener diode form a

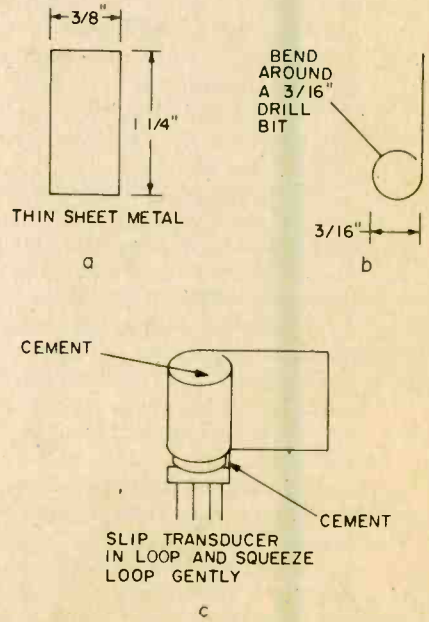


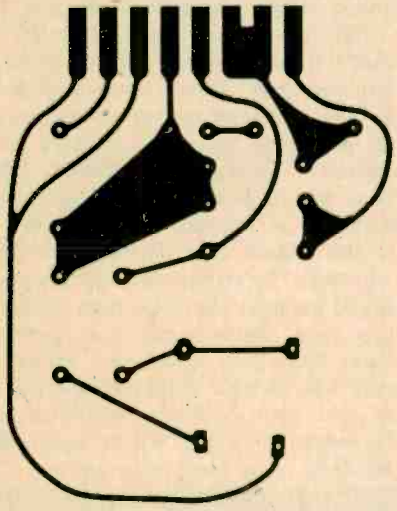
Fig. 4—How to construct a simple heat sink for the LX5700 temperature-sensing transducer. No heat sink is required if PET will be used in water or to measure only cold situations (below 32 degrees F, or zero C.).

voltage regulating system. R6 is an external load resistor for the transducer's output transistor. R8 and C1 increase the circuit's stability, and R4 and R5 form the calibration circuit.

Putting It Together. Although the circuit can easily be constructed with perf board techniques, a printed circuit board foil layout and component guide is given for your convenience. See Fig. 6. If a printed circuit board is used, R5 should be of the printed circuit type.

By far, the easiest way to make simple printed circuit boards is to draw directly on the copper clad board with a felt tip resist pen. An excellent resist pen is available as part of the Archer printed circuit kit #276-1576 at your local Radio Shack store for $6.95.

The only critical components in addition to the transducer are resistors R1, R2 and R3. For precision readings these three resistors should be the one-percent tolerance kind. However you can use the five percent resistors shown in the tables, although some adjustment of R1 may be required. See the section on Testing and Adjusting. The exact values of these three resistors depends upon the temperature range you want the thermometer to measure. The Tables give the values. Notice that extra room is available on the foil layout of the printed circuit board for R1, R2 and R3 so that two resistors could be tied together in series, if necessary.



Printed circuit board pattern shown above is same size as the actual foil for the components board of PET. Foil side shown.

Although tiny, the power used by the transducer does raise its temperature slightly. If the transducer is to be operated in still air, a small heat sink should be used. Most other applications such as medicine, fishing, etc. do not require a heat sink. If small errors (up to about two degrees) can be tolerated, or if you take your temperature readings quickly, you don't even need a heat sink for measuring still air temperature. If you won't need the heat sink, disregard Figure 4 and the next two paragraphs here.

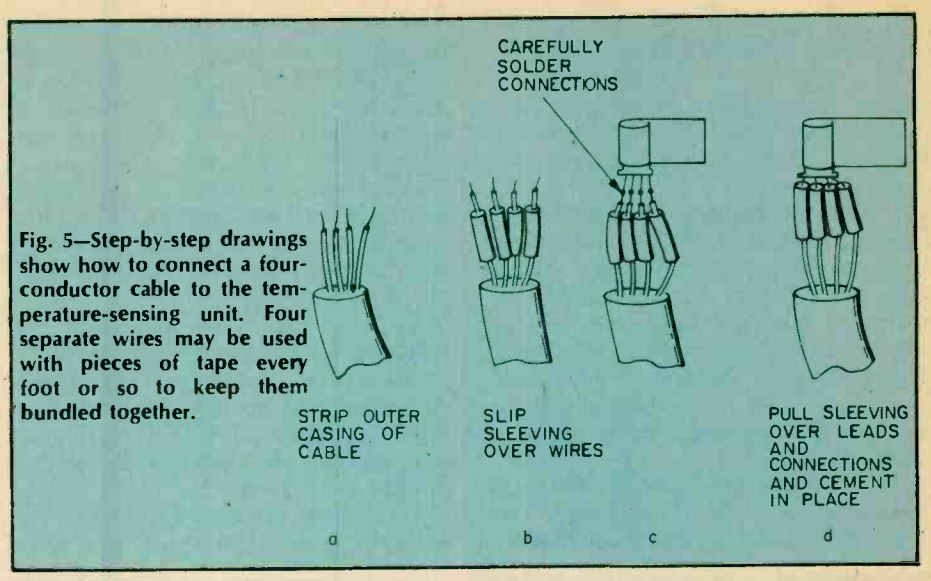


Fig. 5—Step-by-step drawings show how to connect a four-conductor cable to the temperature-sensing unit. Four separate wires may be used with pieces of tape every foot or so to keep them bundled together.

The heat sink can be constructed from a ⅜" × 1¼" piece of aluminum or copper sheet metal as shown in Figures 4(a) and 4(b).

Place the transducer in the loop made out of the sheet metal and give the loop a very gentle squeeze. See Figure 4c. Using a good epoxy, cement the transducer permanently to the heat sink.

As shown in Figure 5, strip the outer casing of the four-conductor cable and slip plastic tubing or sleeving over the leads. This sleeving will be used shortly to insulate the connections and bare leads of the transducer.

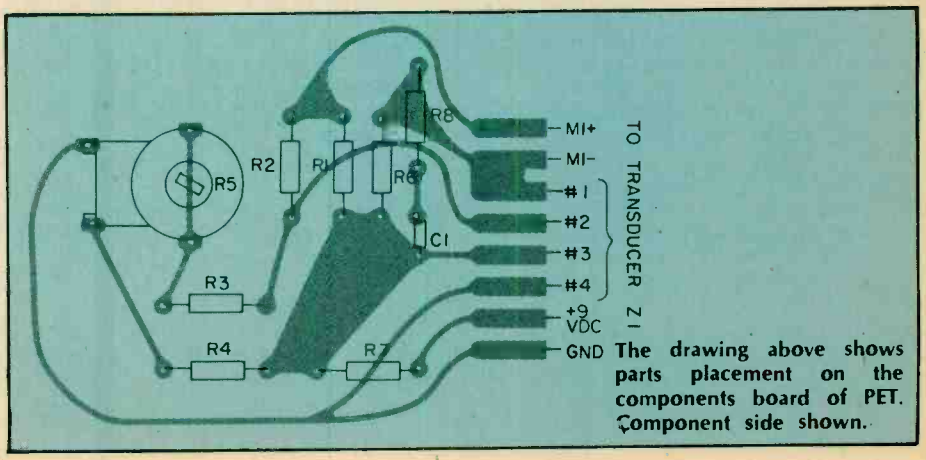
Using a 25-watt or smaller soldering iron, solder the leads of the transducer to the end of the four-conductor cable you have prepared. Be sure to use a small alligator clip or long-nose pliers as a temporary heat sink between the soldering iron and the transducer. After soldering the leads, pull the sleeving over the connections and bare leads and cement the sleeving in place.

Next, spray all the exposed wires and connections with several coats of a clear sealant such as Spra-Clear by Plasti-Kote, or GC Insul-Volt, available at some electronic suppliers or Archer silicone sealant, sold at Radio Shack stores. Let the assembly dry between each coat.

After the unit is completely dry, immerse it in the sealant. I have also found that Plasti-Dip, a product used to coat tool handles works well. Let the assembly dry overnight and re-coat if desired.

To avoid accidentally leaving the thermometer on for long periods of time and depleting the battery, the power switch should be the momentary-contact pushbutton type.

If you decided to build the thermometer that measures temperatures between 0 and 100°F, you've just won the bench warmer prize—you won't have to touch the meter's dial at all! Just let 0 mA stand for 0°F, .10 mA for 10°F, .20 mA for 20°F, .30 mA for 30°F, .32 mA for 32°F etc. If you chose the −50 to + 50 Celsius (Centi-



The drawing above shows parts placement on the components board of PET. Component side shown.

grade) thermometer, your job isn't much harder. Just add the temperature markings shown in the chart to your meter's dial.

If you are building the same thermometer as the one which I built, which measures temperatures between −20°F and +105°F, you have a decision to make on how you mark the dial on the meter. The easy way out is to mark it according to Table II, which labels every tenth of a milliamp with a temperature reading. Each division stands for 12.5°F.

If you find a thermometer that reads according to Table II confusing, you can instead label the meter's dial every 5 or 10°F. As shown in photo, my prototype was labeled every 10°F. However, to have the thermometer show every 5°F you must place a label at .04 milliamperes intervals (or .08 mA every 10°F). While this can be easily done on some of the larger and better quality meters, most meters will require careful work and constant checking with drafting dividers (an instrument similar to a compass).

To label the temperatures on the meter dials, carefully remove the plastic or glass panel that protects the meter's movement and needle. This panel can often be pulled off with your fingers, but some meters have machine screws holding it in place.

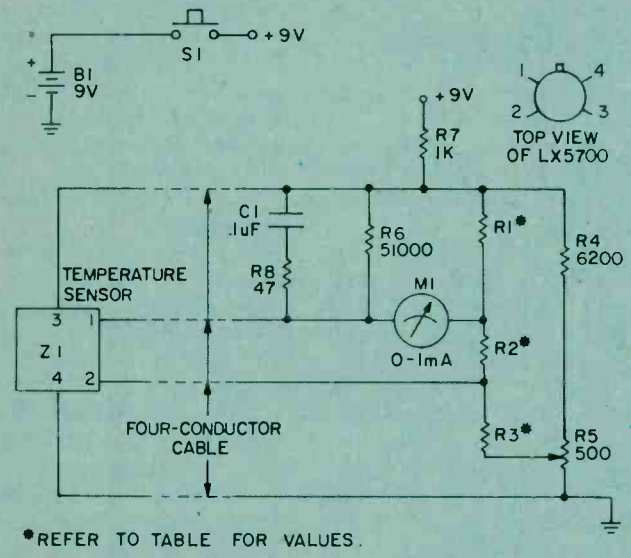
Unless you are an artist or are just naturally great at lettering, use commercial dry transfer lettering. It's worth that extra little effort to do a nice job in building electronic projects, especially this thermometer, which you will use every day, for many years.

Testing and Adjusting. Connect the four-conductor cable to the thermometer. With the potentiometer, R5, set to its mid-point, depress the power switch. The needle should move upscale to the vicinity of the transducer's temperature. If the transducer is in still air, and has no heat sink, the needle will continue to slowly move upscale 1 to 2°F more.

Before attempting the following calibration, make sure all bare wires in the transducer probe assembly are completely insulated with one of the waterproofing materials.

Fill a small plastic pail half full of small ice cubes, bits of ice, or, if available, clean, compacted snow. Pour enough cold water into the pail to fill it approximately two-thirds full.

Place the transducer probe assembly into the icy concoction in the plastic pail. Wait several minutes. Press the power switch and adjust the pot, R5, so the thermometer shows 32°F (0°C). That's about all there is to the calibration, easy huh? What's that! You didn't use the precision resistors recommended, and you have an *accurate* thermometer (surgical) available! Well then, you should test your new thermometer at another temperature. To do this obtain luke warm water from your tap. The temperature of the water should be near the maximum temperature your thermometer can measure. Place both the transducer probe assembly from your electronic thermometer and your accurate (store-bought) thermometer in the warm water. Stir the water every few seconds or so. After



*REFER TO TABLE FOR VALUES.

PARTS LIST FOR PET PRECISION THERMOMETER

C1—0.1-uF 25 VDC capacitor, ceramic (Radio Shack 272-135 or equiv.)
M1—0 to 1-mA panel meter (Radio Shack 22-052 or equiv.)
R1, R2, R3—see text and the Tables—depends on temperature range you choose.
R4—6200-ohm resistor, 5% tolerance (Allied Electronics 824-1489 or equiv.)
R5—500-ohm, printed-circuit board mounting potentiometer (Radio Shack 271-226 or equiv.)
R6—51,000-ohm, ¼-watt resistor (Radio Shack 271-1300 or equiv.)
R7—1000-ohm, ¼-watt resistor (Radio Shack 271-1300 or equiv.)
R8—47-ohm, ¼-watt resistor (Radio Shack 271-1300 or equiv.)
S1—SPST, momentary-contact pushbutton switch (Radio Shack 275-618 or equiv.)
Z1—temperature sensing transducer, National Semiconductor LX500 or equiv. (Available from address below)
Misc.—9-volt transistor radio battery (Radio Shack 23-583 or equiv.), 4-conductor cable, cabinet, wire, solder, etc.

Allied Electronics' address is 401 East 8th St., Ft. Worth, TX 96102.

Temperature transducer Z1 is available from TR Electronics, Box 604, R.R. 4, Newaygo, MI. 49337 for $5.50 postpaid. Send check or money order.

R1, 2, and 3 values depend on the thermometer scale you use, Celsius or Farenheit, from −20 to +105, or from 0 to 100 degrees. Consult Table at the right of this box for resistances. Four-conductor cable may be made from two lamp-cord wires taped together every foot or so. Or you can use two audio or speaker cables.

For Farenheit Thermometer −20 to +105 degrees

	1% (ohms)	5% (ohms)
R1	1100	1100
R2	23.7K	24K
R3	43.2K + 470	43K + 680

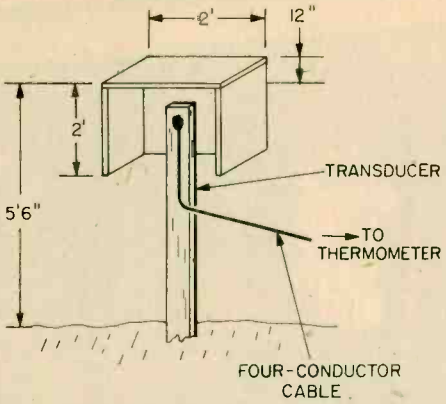
For Farenheit Thermometer 0 to 100 degrees

1% (ohms)	5% (ohms)
900	910
25K	24K + 1100
42K	43K

For Celsius Thermometer −50 to +50 degrees

	1% (ohms)	5% (ohms)
R1	1.5K	1.5K
R2	21.5K	22K
R3	46K	43K + 2.7K

Note that the plus sign between resistance means the two resistors should be placed in series.



If PET's temperature sensor will be outdoors where sun may shine on it a simple cover should be built for it. Dimensions are approximate. If not thus sheltered the readings might be off a degree or two.

about five minutes take readings from both thermometers. If the readings differ by 2°F (1°C) or more, you can increase the thermometer's accuracy by slightly changing the value of R1. If the thermometer reads low, place a 100K resistor in parallel with R1. If it reads high, add a 10- or 15-ohm resistor in series with R1. Or you can replace fixed resistor R1 with a 500-ohm potentiometer in series with an 820- or 680-ohm resistor. However, you should do this approach *only* if a laboratory-grade thermometer is available for use as your standard.

Using PET. The real advantage of an electronic thermometer over the common garden variety is that it is the only kind of thermometer which can accurately measure temperature at a distance. The Viking landers on Mars use electronic thermometers in their miniature weather stations to keep constant track of Mars' air temperature at two surface locations in the planet's northern hemisphere. Although our PET thermometer described here isn't designed to measure temperatures from quite that far away, it does have many uses right here on good old terra firma.

Because of its accuracy and quick response, it can be used as a fast responding medical thermometer if the probe is placed under one's arm. Underarm temperature averages around 97.5°F (36.4°C) in healthy people—about 1°F lower than oral temperatures. PET can also be used as a super-accurate fishing thermometer to get the big ones, or in your car to measure the outside air temperature. When used in an automobile, it is most accurate when the car is moving. The only modification necessary to run PET directly off a car or boat's 12 VDC electrical system is that the resistor R7 must be increased to 3300 ohms. Because of its low power consumption, no power switch is necessary when a storage battery is used for power.

One of the most popular uses for electronic thermometers is the measurement of the outside air temperature from the comfort of one's home. However, even with such an accurate electronic thermometer as described here, this isn't as easy as it first may appear. Although just about everybody knows you must keep the thermometer out of sight of that 11,000°F Ball of Fire in the sky to measure the true air temperature, few realize that a clear night sky has an effective temperature that would make a penguin shiver. Even on a clear, July night the effective temperature of the sky is around −100°F!

A thermometer without a shelter, placed in the shade of the north side of a building, may read correctly during the day or on a dark and foggy night, but on a crystal-clear night it will read several degrees colder than the true air temperature. Moisture or frost will also lower a thermometer's temperature below that of the air on account of cooling by vaporization. Like it or not, you need some sort of thermometer shelter if you are to accurately measure the outside air temperature. The National Weather Service uses quite a sophisticated shelter, but for most purposes the shelter shown on this page is sufficient, especially if located in the shady area on the north side of a building. This shelter can be constructed out of an old apple box or built from scrap lumber. The transducer probe assembly should be mounted near the top of the inside of the enclosure and approximately 5 feet from the ground. All dimensions shown in the drawing are approximate and are given only as a guide. The shelter should be painted, inside and out, with a white or, better yet, aluminum exterior paint. Notice the enclosure has no bottom. This is to provide good air circulation for the transducer.

The Components Board. In this project the parts layout is entirely uncritical so the parts may be mounted on a printed circuit board, using the board pattern shown, or a similarly-sized piece of perf board, with flea clips inserted into holes at roughly the

(Continued on page 92)

For Celcius Thermometer
−50 to +50 degrees

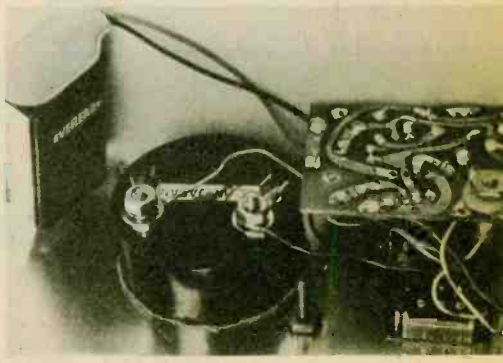
mA	Degrees
0.0	−50
.10	−40
.20	−30
.30	−20
.40	−10
.50	0
.60	+10
.70	20
.80	30
.90	40
1.00	50

For Celcius Thermometer
−20 to +105 degrees

mA	Degrees
0.0	−20
.10	−7.5
.20	+5
.30	17.5
.40	30
.416	32
.50	42.5
.60	55
.70	67.5
.80	80
.90	92.5
1.00	105

For Farenheit Thermometer
−20 to +105 degrees

mA	Degrees
0.0	−20
.04	−15
.08	−10
.12	−5
.16	0
.20	+5
.24	10
.28	15
.32	20
.36	25
.40	30
.416	32
.44	35
.48	40
.52	45
.56	50
.60	55
.64	60
.68	65
.72	70
.76	75
.80	80
.84	85
.88	90
.92	95
.96	100
1.00	105



Inside view of PET shows simple construction using printed circuit board. Parts placement is non-critical and perf-board construction may be used if preferred.

HEY, GOOD BUDDY, COME UP TO HAM RADIO

You CBers can have the best of both worlds with Ham Radio.

by Charlene Babb Knadle WB2HJD

☐ "Smokey's coming in your back door," says a fellow CBer who's travelling the same route as you. You stay within the speed limit to avoid getting a ticket. You ragchew briefly with "Sweet Nothings" and "Big Toot," and you have a blast. You spot a picture taker and announce its location over your rig. You use your CB radio to get help for a stranded motorist. You keep a list of handles you've worked, just to top your own record. What a terrific hobby!

But what about when you need to reach a fellow CBer, and your realize that you're beyond range and your signals have faded out? Or you try to keep a sked with a station within range, but you can't get through the noise of other stations? Then you need amateur radio. Because with ham radio you can have static-free QSOs without other stations audible in the background. You can talk via mobile rig, using repeater stations along the way to boost your range to 100 miles. You can send and receive amateur television. You can talk around the world, bounce signals off the moon or through a special satellite, and even have a telephone in your car.

The author at the microphone. With the compact transceiver shown it is possible to operate portable, using a battery power supply, mobile, with the unit mounted under the dashboard of your car, or at a fixed location, with a separate AC supply. With suitable attachments, this VHF rig can be used to make phone calls from your car.

The Best of Both Worlds. It's amazing, maybe, that many CBers have never heard of amateur radio. But, then, Madison Avenue doesn't advertise "regular" amateur radio—just citizen's band radio. Why? Perhaps because CB is so easy to get into by comparison. You just buy a rig (all Madison Avenue cares about) and you're on the air. With amateur radio you have to try a little harder and take an FCC-sponsored exam. But you won't have to give up your Citizens Band friends to become an amateur radio operator. I know people who keep both CB and ham rigs in their cars. Some of them even listen to both transmissions simultaneously. CB and amateur radio fulfill different needs and have very different "flavors."

Maybe alleviation of boredom on the road is all you want from your hobby. CB will certainly provide that! But if you itch to get into more extensive radio experimentation or if you want to increase the range of your possibilities and the distance of your signal, then consider "regular" amateur radio too. You could have the best of both worlds. ■

DXING THE TWO CHINAS

Using radio transmissions instead of bullets, these two exotic countries compete for attention on the shortwave bands.

by C. M. Stanbury

ALMOST EVERY SHORT WAVE LISTENER has heard *Radio Peking*, and many SWLs have also listened to the *Voice of Free China* on the island of Taiwan. Each of these stations produces its specific form of programming, and, as you can imagine, they are sharply different. But in addition to these powerhouses, which we will talk about first, there are many Chinese stations that can be logged in North America—stations that might in fact be considered the most exotic DX targets in the world.

Radio Peking. If you're a novice SWL, this one's North American service (during the evening hours) will probably be the first Asian station you'll log. Or put it like this: There's probably no way a short wave DXer can avoid hearing it. But be careful, the evening transmissions on 7120 and 9780 kHz don't come from Asia: they are from *Radio Peking's* relay in Albania (shared with *Radio Tirana*). Frequencies which do come from Chinese sites include 7060, 9460, 9940, 11675, 11945, 12055 and 15060 kHz.

Once you log *Radio Peking*, report for your QSL and receive that card or letter, you'll probably do your best to avoid this station. All politics aside, *Radio Peking's* programs are probably the most boring to be found anywhere on the SW bands. But right at the beginning of this decade *Radio Peking* did hold the DX spotlight for a few months. In the spring of 1970 the Maoist government launched their first satellite. It was known in the West as Chicom I and it broadcast on 20009 kHz a few bars from Radio Peking's interval signal "The East is Red." In other words, *Radio Peking* briefly became the closest thing yet to a shortwave broadcast station in orbit.

For some reason *Radio Peking* never followed up this propaganda coup. None of the other Chinese communist satellites aired anything even remotely resembling a broadcast transmission. If possible *Radio Peking* became even duller than it already was—probably due to the 1970s power struggles within mainland China itself. But with a new regime now in command who knows what might lie ahead for *Radio Peking*.

Meanwhile if you want to make *Radio Peking's* International Service a little more of a DX challenge, you might try for their Russian transmissions which are of course heavily jammed (sometimes the jamming takes the form of counter-broadcasting on the same frequency). *Radio Peking's* Russian broadcasting has been heard by North American SWLs on 11680 kHz at 1030 EST, 6995 at 1600 EST, 9880 at 1800 EST, and along the West Coast on 3500 kHz at 0900 PST, and on 9030 kHz at the same time.

Radio Peking's transmitter sites are used by at least one widely received clandestine station, the *Voice of the Malayian Revolution*. This one is often

heard in North America around 1800 EST on 8305 kHz. Another clandestine using a *Radio Peking* transmitter site is *Voice of the People of Thailand*: much more difficult to hear in North America but try 9423 kHz any time that part of the short wave spectrum is open to the Far East.

Taiwan. Across the Formosa Strait we find *Radio Peking's* arch enemy, the *Voice of Free China*—one of two major international broadcasters to have operated from the island since the mainland became the Peoples Republic of China. The other was *Radio Liberty* (originally run by the CIA) which maintained a multi-transmitter facility here until 1974 when closed by the island's government in a dispute over Washington's contacts with Peking. *Radio Liberty* programs in Russian and continues to transmit from Europe. At one time, the *Voice of Free China* itself carried programs of another European headquartered anti-Communist Russian organization, *Radio Free Russia*. This arrangement was also terminated—for unknown reasons.

While *Voice of Free China's* North American service is not as widely heard as *Radio Peking's*, it is nevertheless a good bet for novice DXers—especially west of the Mississippi. *Voice of Free China* beams English our way at 2000 and 2200 EST (1700 and 1900 PST) on 11825, 15425 and 17890 kHz. As the sunspot count starts to rise again, reception on these upper short wave frequencies should improve.

Voice of Free China is just one arm of the Broadcasting Corporation of China whose primary assignment is to produce Chinese home service programming which they beam both to Taiwan and the mainland. This activity is mostly carried out on the standard AM band (where 500 KW transmitters are listed on 600 and 1000 kHz), but sometimes it can be heard in North America around sunrise on 3230, 6086 and 7130 kHz. These broadcasts are subject to heavy jamming.

Back in the Peoples Republic. The job of beaming Chinese language transmissions into Taiwain is primarily assigned to an organization called the Peoples Liberation Army. The PLA has more transmitters in Fukien province than you can count but many of the more widely heard frequencies are listed in the table. Now at this point let's state a rule of thumb for Far Eastern reception below 7 MHz. If both your receiving location and the transmitter site are in darkness, you have a chance of hearing the station. Whether you actually do hear it of course depends on interference plus variations in ionospheric conditions. And remember, this rule is not absolute. Even on Medium Wave (around 2 MHz) reception can occur occasionally when the path through the ionosphere is slightly in daylight. And the rule becomes less and less true as we move up toward 7 MHz.

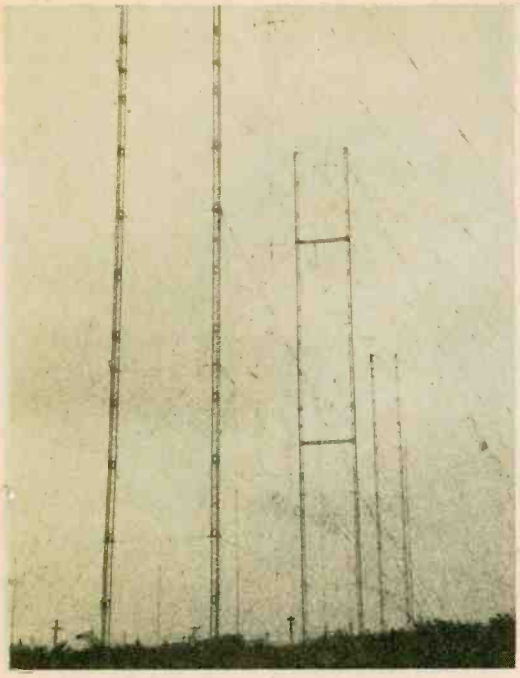
Thus December and January reception in the eastern U.S. and Canada of PLA transmitters is even possible on 2490 kHz between approximately 1700 and 1730 EST. As we get into February and March, more and more of the path is in daylight during this time period yet reception is still possible on such frequencies as 4840 or 6400 kHz. A similar pattern will show up during the early AM period, except a path wholly in darkness can be found until at least early spring. West Coast SWLs have a decided edge in the early AM Chinese DX hunt.

A young Chinese worker rests in the lap of a statue as he waits along the street in Peking. The name Peking means "Northern Capital" in Chinese. Peking has been the capital for over 1000 years.

The Ultimate Targets. Finally, the

Members of Mao Tse-tung's Red Guards pause for some sightseeing at the Great Wall of China while on their way to Peking from rural districts. Because their activities frequently created disorder and disrupted local economies, the Red Guards were disbanded in the late 1960s.

Because of the great distances involved, radio communication is especially important in the People's Republic of China. Here a new high-speed facsimile apparatus transmits the "People's Daily," a newspaper printed in Peking and now also in cities and towns throughout the vast country.



The curtain transmitting antenna system of the Overseas Service of the Broadcasting Corporation of China. This is the setup used at the Taipei Transmitting Station

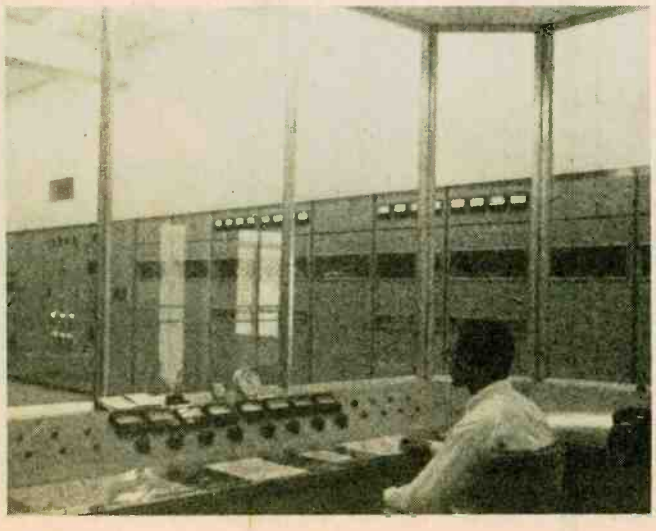
Peking government airs numerous transmissions intended for reception only within the Maoist world itself. Many such broadcasts come from the central transmitter site near Peking and we have included a few of these Peking frequencies in the table. Similar Peking home service signals can also be heard on frequencies above 7 MHz including 9064, 10245, 11290 and 11330 kHz which you should watch for during daylight hours. But four provincial stations provide the top challenge.

First, there is the operation at Kumming in Yunnan province. In an earlier article on 2 MHz DX (January-February 1976 (*Elementary Electronics*) we mentioned East Coast reception of home service transmissions on 2310 kHz from an unknown site—probably in central China. Well, these 2310 kHz broadcasts come from Kumming in south central China, not too far from the Vietnamese, Laotian and Burmese borders. It is also believed that Radio Peking uses Kumming for its clandestine *Voice of the People of Thailand* alias mentioned earlier.

In addition to 2310, Kumming also operates on 2460 kHz but reception of the latter frequency has yet to be reported east of the Mississippi. One of the factors which presumably has made 2 MHz Far East reception possible at all is a very low sunspot count. Most experts now expect that count to rise soon. But when that does happen you'll still be able to log Kumming. We have listed frequencies all the way up to 6937 kHz.

Another provincial station which every DXer dreams of logging is the one at Lhasa in the formerly semi-independent, mysterious (at least to us) holy land of Tibet. This is somewhat to the west of Yunnan province thus whenever you hear Kumming on any frequency you should start listening for Lhasa on 4035 and 5935 kHz. The other two provinces of major DX interest are in northern China. Of these Harbin in Manchuria will be the easiest on 4925 and 5950 kHz. Then you can move slightly to the west again and look for the various Inner Mongolian frequencies listed in the table.

QSLs. Broadcasting Corporation of China/*Voice of Free China* (53 Jen Ai Road, Section 3, Taipeh, Taiwan, Republic of China) verifies all correct reports promptly. *Radio Peking*—International Service (Peking, Peoples Republic of China) also is a good verifier but if you send them a report you will receive a quantity of propaganda material. *Peoples Liberation Army* (Foochow, Fukien, PRC) once verified a report for a European SWL. A Canadian DXer last year obtained an unofficial QSL from *Radio Peking's* International Service for a home service transmission from the Peking area. To accomplish this feat he wrote his report in Chinese. So far as we know, no DXer has ever QSLed a provincial station either directly or through Peking. But things are supposedly changing on the mainland. If DXers keep trying . . . well, again who knows what might happen. ■



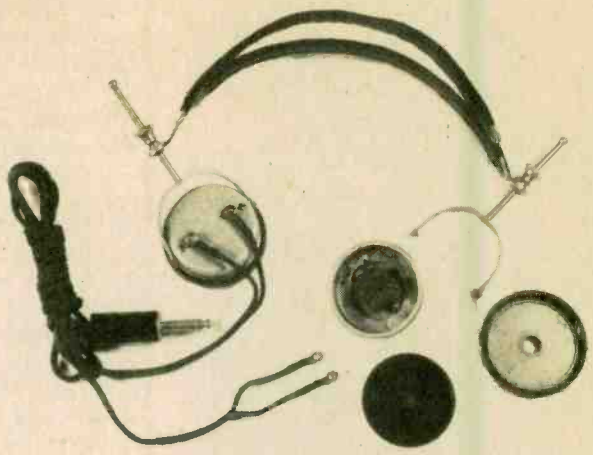
The control room, showing banks of transmitting equipment, of the Taipei Transmitting Station Number Five of the Broadcasting Corporation of China Overseas Service.

A view of downtown Taipei. Originally called Formosa, the island of Taiwan has experienced a healthy growth in its economy in recent years. Among other products, Taiwan manufactures many different kinds of electronic equipment.

China Below 7 MHZ

kHz	Station
2310	Kumming, Yunnan Province
2460	Kumming, Yunnan Province
2490	Peoples Liberation Army
2600	Peoples Liberation Army
2800	Peoples Liberation Army
3200	Peoples Liberation Army
3230	Broadcasting Corporation of China, Taiwan
3450	Peking Home Service
3500	Radio Peking Russian Service
4001	Inner Mongolia
4035	Lhasa, Tibet
4525	Inner Mongolia
4759	Kumming, Yunnan Province
4840	Peoples Liberation Army
4850	Peking Home Service
4925	Harbin, Manchuria
4952	Inner Mongolia
5075	Peking Home Service
5163	Radio Peking Russian Service
5935	Lhasa, Tibet
5950	Manchuria
5960	Kumming, Yunnan Province
6045	Inner Mongolia
6086	Broadcasting Corporation of China, Taiwan
6400	Peoples Liberation Army
6937	Kumming, Yunnan Province
6995	Radio Peking Russian Service

LOW-COST FILTER IMPROVES CODE RECEPTION



Old-fashioned phones convert to mechanical filter for separating CW broadcasts.

by George X. Sand

Amateur radio operators and short wave listeners often find CW (continuous-wave code) reception difficult, if not impossible, when several radiotelegraph stations are transmitting on, or near, the same frequency. Such interference can be eliminated, or at least greatly reduced, by a narrow band electronic filter circuit that can be installed in the radio receiver or transceiver. However, this extra equipment can cost up to $150.

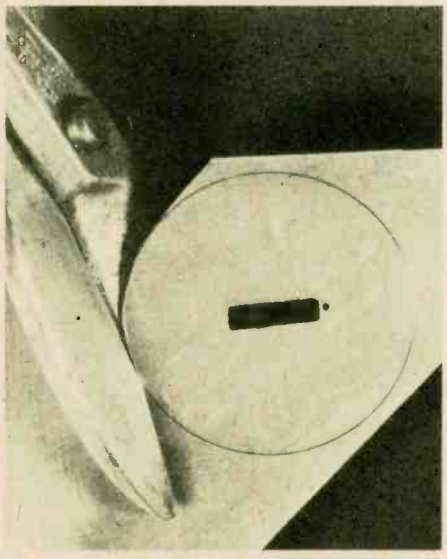
What You Need. A mechanical filter that will do the job can be built for $15, or less. In fact, should you already own a pair of earphones—the old-fashioned kind with metal diaphragms—and have access to a music store that will sell a used steel reed removed from an accordion (the writer was given his at no cost by such a store) you can build this effective filter for practically nothing.

A low-frequency reed should be used. A 440-Hertz (A) reed will work well. In fact, anything from about 300 to 1000 Hertz will be ok.

Should you have access to a steel (not brass) reed from an old harmonica, that could be used, too.

The removed reed is installed in one earphone of the headset so that it vibrates only when an incoming CW signal sets up a beat note at the reed's resonant frequency. All other interfering signals will automatically be eliminated since they will be of a different beat frequency, and the reed will not respond (audibly) to them.

To Get More Volume. Should you wish to have both earphones of the headset operate in this manner, the *matching* reed of the same length (they come in pairs in the instrument) must be installed in the second earphone.



A thin piece of aluminum is cut to same size disc as the original iron diaphragm of the 'phones. Rectangular center opening is for the iron frequency-resonant instrument reed. Small hole at right of rectangle is for rivet (or nut and bolt) to secure reed.

Here's how it's done: Use a pair of tin snips to cut from a thin sheet of aluminum (about 1/32-inch thick) a disc that will replace the earphone diaphragm. At the center of the aluminum diaphragm make an elongated hole that will permit the reed to vibrate freely (see picture) when it is riveted fast at one end of the opening.

In installing the reed it is important that the little strip of steel extend into its opening for the *same* vibrating distance that it did when it was in the musical instrument.

The operation is simple. The aluminum diaphragm, being non-ferrous metal, will not be influenced by the magnets in the earphone. Only the reed will vibrate, instead. In use, only the desired CW signal will be heard loudly as the receiver or transceiver is tuned. The resulting silence can be uncanny!

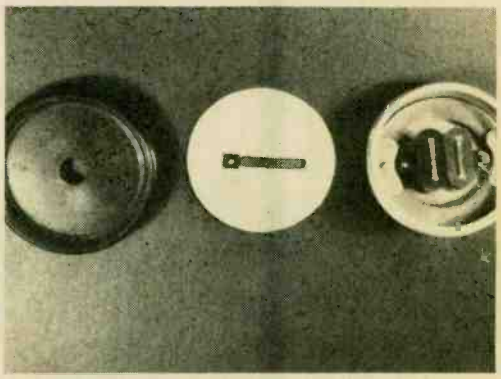
PARTS LIST FOR CW FILTER

Communications-type headphones, 1000-ohms or more. (Not stereo headphones, which are all wrong for this project).

Steel reed(s) from accordion or harmonica.

One (or two) small rivets of the same size as were used to hold the reed in place in the instrument.

Use These Tools. You'll need a pair of tin snips or metal cutting shears. An electric (or hand) drill, with bits the right size for drilling out the rivet(s) which secure the reed(s) in the instrument will be needed, and you'll find a small square-edge (or triangular) file good for dressing the opening in the aluminum disc. ■



Original hard rubber cap (left), original magnet and coil assembly (right) and new aluminum diaphragm (center) with steel reed in place.

LONE RANGER LIGHT METER

Faster and brighter than a silver bullet, LEDs flash your light levels.

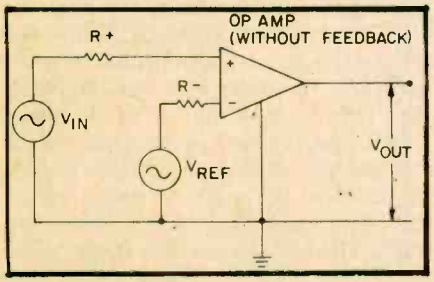
by Walter Sikonowiz

☐ Lone Ranger is a photographic light measuring instrument without the usual (needle-and-scale) mechanical meter. Instead, it uses light-emitting diodes (LEDs for short) to tell you what lens opening to use. In addition to cutting the cost by more than 50 percent, eliminating the meter has other advantages. The chance of damage from dropping is much less. People with no knowledge of photography can easily use this exposure indicator once taught the significance of the displays.

Finally, because the readout is on LEDs, it's always easy to see, even in low light where an ordinary meter's needle might be hard to read accurately.

This comparator-LED light meter is ideal for the serious beginning or intermediate photographer because most people shoot with the same speed film most of the time. And if you do use two or three different speed films, it's easy to apply a conversion factor to the Lone-Ranger's lens-opening scale.

It's a one-speed-range photographic light meter which tells you at what f-stop diaphragm opening to set your 35 mm or other precision camera lens. It provides readings for setting your camera lens opening between f-stops as large as 2.8 and as small as 32. These are based on the most popular black-and-white film for 35 mm use, Plus-X, a widely available fine-grain film.



Operational amplifier without feedback has extremely high gain. It can be used to compare an input signal voltage (unknown) with a known (reference) voltage, and indicate clearly (by its output's going to saturation, or by staying at its initial (very low) voltage that the unknown voltage is either below or above the reference voltage. This makes it a "comparator."

Photo Basics. First before showing how the meter works, let's review some basic photography. The photographer is concerned with three numbers when making an exposure: 1) the ASA rating (the speed) of his film, 2) the f-stop of the lens aperture, and 3) the speed of the shutter. Let's see how these factors interrelate. Suppose you take a correctly-exposed picture under light of intensity **I**, with f-stop **n** and exposure time equal to **T**. If the intensity suddenly jumps to **2I**, you must compensate by either reducing the aperture (multiplying the f-stop by 1.4) or by reducing the exposure time by half—**T/2.** And if the light intensity is reduced by half you would compensate either by making the f-stop 1.4 times larger, or by increasing the exposure time to **2T.** This assumes, naturally, that the film's speed (ASA) remains constant.

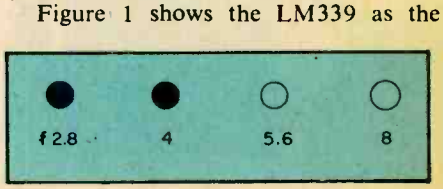
Now suppose that a correctly-exposed photograph is made under light of intensity **I**, with f-stop = **n**, and exposure time = **T.** To take the same picture with a film whose ASA rating is twice that of the original, you'd compensate by making the f-stop = **1.4 n** or by making the exposure time = **T/2.** To take the same picture with a film whose ASA rating is half that of the original film, make the f-stop = **n/1.4**, or make exposure time = **2T.** Now let's look at an electronic circuit to measure the ambient light.

Use a High-Gain Amplifier. Suppose we take a high-gain differential amp and place a known voltage on one input, an unknown on the other. Since we're using the amp open-loop (without the usual feedback), only a small voltage difference at the two inputs is required to send the output either to saturation, or to cut-off. Specifically, if the voltage at the non-inverting (+) input is a few millivolts greater than that on the inverting (−) input, the output will go high. Likewise, if the voltage on the inverting input is the greater, the output will go low.

There are limitations to the size of the voltages which may be compared. For the LM339, input voltages should be less than supply voltage (V)— 1.5V. Furthermore, these input voltages should be much greater in magnitude than a few millivolts, to swamp out measurement errors due to the inherently imperfect nature of the comparator itself. Between these extremes a comparator can give a very accurate answer to the question, "Is the unknown voltage above or below the reference voltage?"

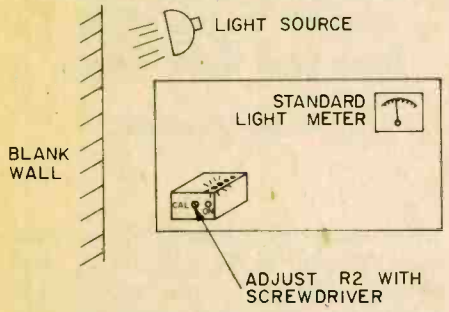
The LM339 incorporates four comparators on a single chip. If one input of each comparator reads some common, unknown, voltage, while the other four inputs connect to different reference levels, then the size of the unknown voltage can be estimated by observing the output states of the comparators.

Figure 1 shows the LM339 as the



This is the way the LED readout of the Lone Ranger would look if the amount of light being measured was enough for a camera opening of F-stop 5.6. The two LEDs at the left are dark, the two on the right are lit up.

heart of a light meter. All the inverting inputs go to the junction of PC1 and R1, and thus sense a voltage whose magnitude increases as the intensity of the light being measured increases. C2 bypasses any interference caused by fluorescent lighting in the vicinity. The non-inverting input of each comparator goes to a reference voltage,



This is the setup you use to calibrate the Lone Ranger light meter. You'll need to borrow an old-fashioned (analog) light meter for this procedure.

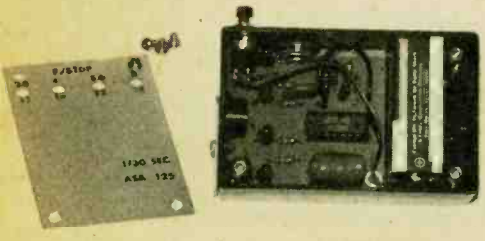
with section A connected to the lowest reference voltage and section D to the highest. Consequently, in very dim light all four comparator outputs will be at cutoff, hence all four LEDs will be extinguished.

As the light intensity increases, section A will be the first to change state (rise toward saturation) and thus cause LED1 to light. At higher intensities LED1 and LED2 will both be turned *On*. The reference voltages I used were chosen to correspond to differences in lens aperture of one f/stop. Thus, a display like the one shown here would indicate that the correct photographic exposure is between f/4 and f/5.6.

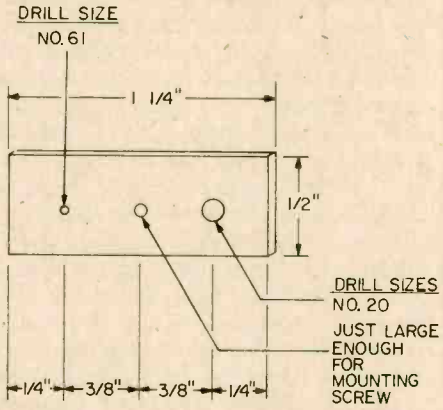
Extending the Meter's Range. Notice that in contrast to the continuous readout of an analog meter, this comparator system of voltage measurement indicates proper exposure as being between two levels. In order to get better resolution (more detailed information as to lens opening) we would need more comparators. We would also need more comparators if a larger measurement range is desired. To accomplish such a range expansion we could add another LM339—inputs 4, 6, 8, and 10 would go to the junction of PC1 and R1, while pins 5, 7, 9, and 11 would go to new (added) reference voltages. However, there is a cheaper method of range expansion. We simply install a variable aperture in front of the photocell. In this way the measurement range of the photometer is doubled to 8 stops, by using two apertures whose areas are in the ratio of 16:1. This is the scheme I adopted for Lone Ranger.

The total measuring range of this instrument thus spans from f/2.8 to f/32 with ASA 125 film (such as Plus-X) at a shutter speed of 1/30th second. Later on we'll discuss the simple mathematical conversion necessary to allow use of the light meter with different film speeds and different exposure times.

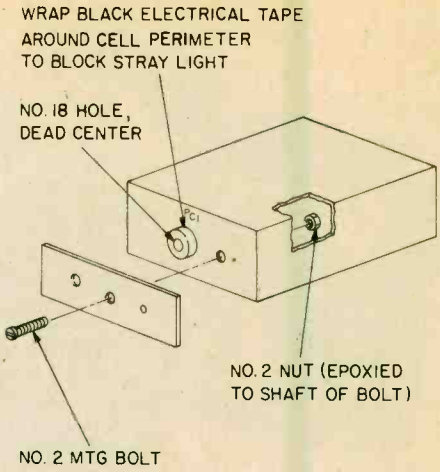
Building Lone Ranger. Actual construction of the Lone Ranger meter is non-critical, but will require some care because of its small size. A printed circuit board was used in my Lone Ranger prototype, and although it is not necessary that you use the printed circuit, it would be wise to copy the same general layout as the prototype. My Lone Ranger is housed in a 3¼ x 2⅛ x 1⅛-inch plastic minibox. If you use the same box, note that the mounting post in the upper-right-hand corner must be removed to make room for S1. A soldering gun with a cutting tip was used to slice out the mounting post, leaving three posts to hold down the metal cover of the box. If you are inexperienced in small-scale construction, by all means use a larger box. Regardless of the box size used, however, the following construction details given will still apply.



Here's how author's Lone Ranger looks inside. To keep it small, make a printed circuit board like his. Perf board is OK too, but requires bigger box.



Dimensions of the range-extender for Lone Ranger are shown above. It's a simple piece of aluminum with two different-size holes in it. The middle hole is for mounting the strip to the front of Lone Ranger.

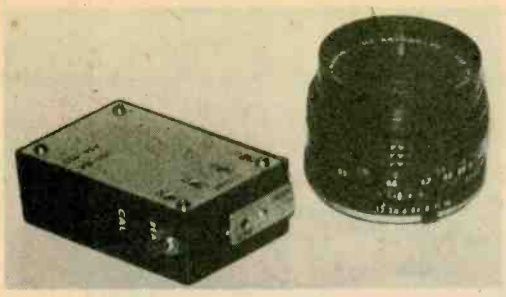


Here are the details for mounting the range extender to the front of the case, and for taping around the photocell to keep it from receiving stray light which can cause misreading of the ambient light.

When the board has been completed, mount the IC socket, trimmer R2, and all resistors and capacitors. Next, solder the negative lead from the battery clip to its hole near pin 12 of the IC socket. Solder a 2-in. length of flexible wire to the hole indicated in the upper-right-hand corner of the board. This wire will later be connected to S1. Now mount the photocell so that its light-sensitive face is perpendicular to the board and facing toward its upper border. Finally, mount the four LEDs into the circuit board, but be sure to observe proper orientation. The tops of the LEDs should all extend the same distance above the board—about ⅞-in. if you have a cabinet of the same depth. Now plug IC1 into its socket and set the board aside temporarily.

The range selector is just a simple aluminum plate (about 18 gauge) with the dimensions shown in the diagram. Note that two holes, one #20 and one #61, must be *carefully* drilled. Further note that the plate must be absolutely flat. Don't cut it out with tin snips. Use a nibbling tool or hacksaw, which will cut the aluminum without distorting it. Now use a file to round off all the edges, and then buff it with steel wool. This will make the range selector rotate readily when you're out shooting.

More On Construction. The drawing of the cabinet shows how to mount the photocell relative to the range selector. When the proper holes have been drilled, mount the range selector with #2 hardware and tighten until the fit is just snug. Use a drop of epoxy to



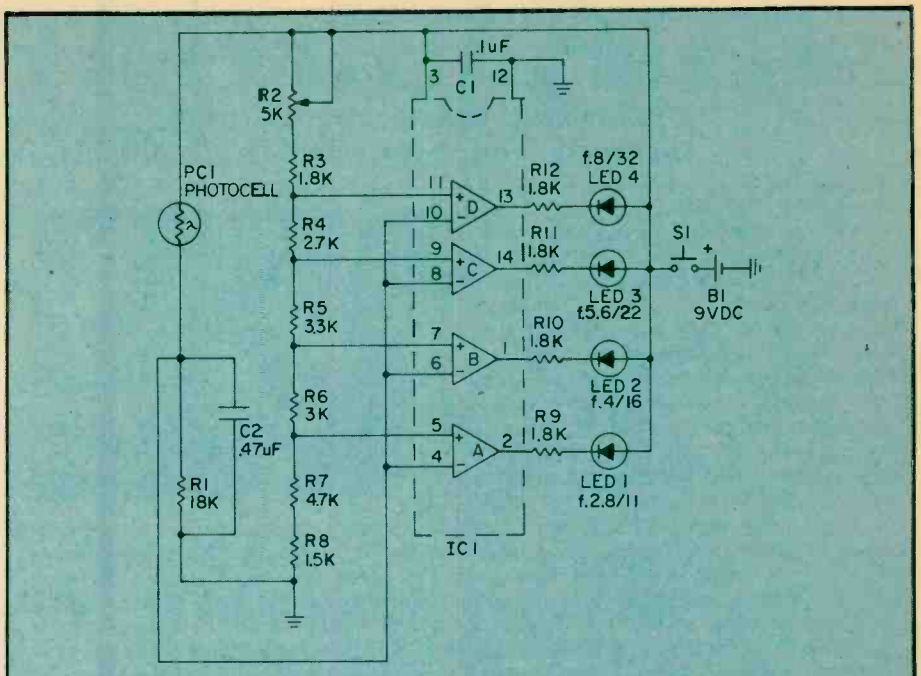
Lone Ranger light meter is about the size of a good lens, as shown here (Pentax Rokkor f=1.7, 50 mm).

lock the nut to the shaft of the bolt, and let the cement dry.

S1 may be placed wherever it is convenient. Be sure to drill a hole to allow calibration-adjustment of trimmer R2 from the outside. Now locate and drill four holes in the cover to allow the LEDs to be visible. The exact location of these holes will depend upon the dimensions of your case and the dimensions of your board. Simply insert the board into the bottom of the box and measure how far from the sides each LED's center is located. Transfer these dimensions to the cover and drill four #22 holes.

Mount the board in the cabinet so that the photocell lies directly behind and flush against its mounting hole. If you used the same size box as I did the ¼-in. spacers will be needed between the board and the bottom of the case to allow the LEDs to protrude slightly through the thin metal cover. After the board has been securely mounted, take a ¼-in. wide, 1½-in.-long strip of black electrical tape and wrap it around the perimeter of the

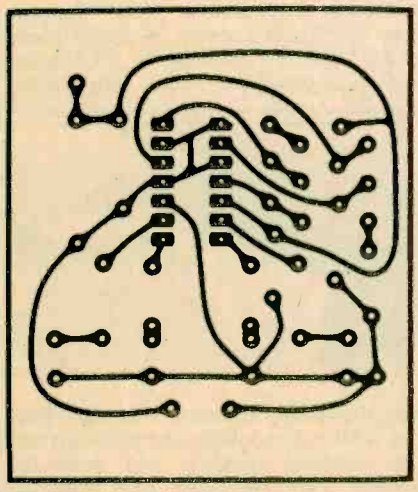
(Continued on page 92)



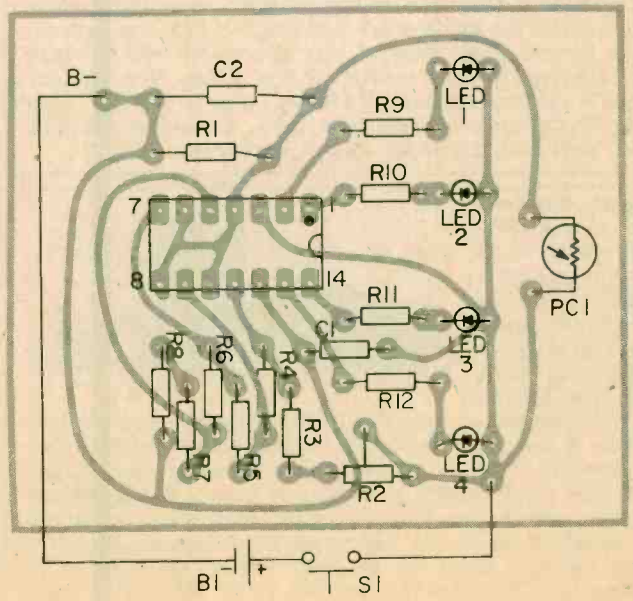
LONE RANGER PARTS LIST

C1—.1-uF capacitor (Radio Shack 275-135 or equiv.)
C2—.47-uF capacitor (Radio Shack 272-1071 or equiv.)
IC1—Quad comparator integrated circuit LM 339 (Radio Shack 276-1712 or equiv.)
LED1,2,3,4 — Light-emitting diodes
PC1—Cadmium sulfide photocell (Radio Shack 276-116 or equiv.)
R1—18,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R2—5,000-ohm potentiometer, printed circuit board-mounting (Radio Shack 271-217 or equiv.)
R3,9,10,11,12 — 1800-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R4—2700-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R5—3300-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R6—3000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R7—4700-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R8—1500-ohm, ½-watt resistor (Radio Shack 271-00 0or equiv.)
S1—SPST momentary on switch (Radio Shack 275-609 or equiv.)

Misc.—Minibox 3¼-in. x 2⅛-in. x 1⅝-in (or larger) (Radio Shack 270-230 or equiv.), socket for IC1 (Radio Shack 276-1999 or equiv.), 9-VDC transistor radio battery (Radio Shack 23-464 or equiv.), clip for battery (Radio Shack 270-325 or equiv.), wire solder, printed circuit board kit, etc.



This is a full-size template for the printed circuit board, if you want to make yours just like the author's. See the text for suggestions on making printed circuit boards if this is your first.



Placement of parts on Lone Ranger's printed circuit board. If you use perf board instead you can put the parts wherever you want, but you'll find this general arrangement most convenient.

COMPUTER NEW PRODUCTS

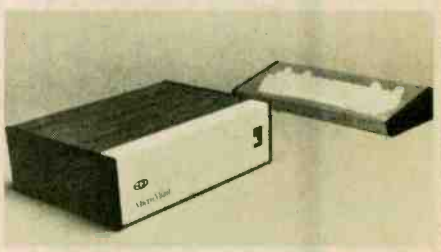
Here in one place each issue of e/e you will find product information on the newest hobby computers and accessories.

Hand-Held Terminal — National Semiconductor offers an inexpensive hand-held terminal, for use with the 8-bit "SC/MP" microprocessor kit, to eliminate the need for a costly teletype system. The SC/MP Keyboard Kit provides input/output capability through a calculator-type keyboard with a 6-digit hex display. It features a simple microprocessor control to allow the user to evaluate the SC/MP CPU, and direct object code program manipulation for development of a variety of application software. The keyboard package includes: manual, all required integrated circuits, resistors, keyboard display cable connector assembly, wire wrap connectors, precut wires, hand-held wire wrap tool. Heart of the keyboard kit is a ROM firmware package (512 bytes) which replaces the "Kit Bug" ROM originally supplied with the SC/MP kit. The keyboard is arranged as an 8 x 4 matrix array, but only 20 of the possible 32 keys are used. Functions of the used keys: 16 keys for hex command value 0 thru F; abort command; memory command; go command; terminate command; power on/off switch used for initializing SC/MP. Price: $95. National Semiconductor, 2900 Semiconductor Drive, Santa Clara, CA 95051. Circle number 46 on Reader Service Coupon for more information.

Home TV Game System—This Fairchild Video Entertainment System, designed to be a fully programmable home electronic game system, uses plug-in cartridges to provide an "unlimited number" of game and other format selections. Key to the system's versatility is the new Videocart cartridge which contains a semiconductor memory programmed to reproduce specific games, in full color, on a TV screen. Game selection is made through a keyboard console with mobile screen elements manipulated by means of dual controls. The game console incorporates a Fairchild F8 microprocessor and four solid-state, random-access memories. The console is connected to the TV set by means of a control box. In operation, the cartridge is inserted in the console and the player selects a game from the Videocart cartridge jacket and presses the appropriate key on the console. Time limits and speed-of-play can be varied. The game score and elapsed time are continuously displayed on the TV screen. Interruption of play is possible with a freeze switch, and sound effects are used to add "realism" to the games. Use with any color or black-and-white TV receiver. Priced at $169.95, plus $19.95 for each Videocart cartridge. Fairchild Camera and Instrument Corp., Consumer Products Group, 4001 Miranda Ave., Palo Alto, CA 94303. Circle number 61.

Low Cost Microcomputer System — E & L Instruments offers a Mini-Micro Designer microcomputer system in kit form for "people having minimal experience in digital techniques." The unit is based on Intel's 8080 microprocessor chip and combines ease of programming (direct input via built-in keyboard) with input/output buses via external card edge connections, or through a unique SK-10 interface/breadboarding socket. Internal status/date is shown by three sets of LED indicators. Included in the package is a memory card featuring 1K of read/write memory space. The system is easily expanded with many options, according to E & L. This unit is an outgrowth of E & L's major system, the Micro-Designer, and is supported by software that is easily understood by people having no previous background in microcomputers. Complete software takes the kit user from kit construction to system usage. Prices range from $125 for the simplest kit to $500 for a completely assembled and tested version with extra features. E & L Instruments Inc., 61 First Street, Derby, Conn. 06418. Circle number 54 on Reader Service Coupon.

Logic Tester— Fluke Trendar's 3040A Logictester, a new digital logic board tester specifically designed and manufactured to test microprocessor boards, can apply user-defined test sequences at rates up to 1,500,000 input words per second. At the same time, the unit can also run automatic sequences at rates up to 5MHz to minimize programming of the large numbers of conventional boards that don't need manually-defined bit patterns. Both programming techniques can be intermixed. The 3040A also incorporates new interface and control capabilities for dynamic LSI logic. For example, board-mounted clock oscillators no longer must be defeated for testing since the Logictester allows the unit under test to clock the tester and control the instant of test where appropriate. New programming features include entering of all sequence programs directly into a tester memory (through a calculator-like program panel). The 3040A also offers the first diagnostic application of cyclic redundancy checks to digital board testing, and it can use a known good reference board for faster troubleshooting. Offered in both 128 and 240 pin versions, at prices in the $60,000 to $95,000 range, depending on options. Fluke Trendar Corp., 630 Clyde Avenue, Mountain View, CA 94043. Circle number 43 on Reader Service Coupon for more information.



Total Hardware/Software Package—ECD Corp.'s MicroMind microcomputer system is a complete terminal and computer package with keyboard and software that sells for $987.54. The only additional items needed are a standard TV set (connect to antenna terminals with a supplied RF modulator), and an ordinary cassette tape recorder. It can be used for com-

(Continued on page 92)

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!

300 Ohm CB Filter

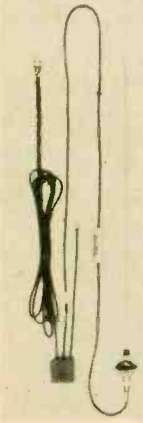
A 300-ohm Citizens Band interference filter made by RMS Electronics, knocks out CB and ham radio interference on television sets. The filter connects directly to the VHF antenna terminals on the rear of the TV set. Outstanding features are miniaturized circuitry, totally shielded network and housing, and heavy duty twisted and tinned twin

CIRCLE 65 ON READER SERVICE COUPON

lead that is oval cut for additional strength at the connection point. Penetrating washer terminals provide simple connection of the antenna lead-in-wire to the unit, and eliminates the need to strip and bare the wire ends of the lead-in wire. The RMS CB interference filter, model CB-300F has a list price of $7.75. For more information, write to RMS Electronics, Inc., 50 Antin Place, Bronx, NY 10462.

Disguise Antenna

Why advertise for a CB thief to rip you off? Install a CB-AM-FM disguise antenna that really works well on all 40 channels made by Antenna Incorporated. The Model 11004 is a cowl mount CB disguise antenna identical in appearance to most standard replacement AM-FM receiving antennas, and is pretuned at the factory for a standing wave ratio (SWR) of 1.5:1 or less across all



CIRCLE 44 ON READER SERVICE COUPON

40 channels. The Model 11004 includes an in-line coaxial cable connector for simplified installation and 18 feet of low-loss RG-58/U coaxial cable. Sells for $34.95. For further information on the Model 11004 CB-AM-FM disguise antenna and the complete line of Antenna Incorporated products, write to Antenna Incorporated, 23850 Commerce Park Road, Cleveland, OH 44122.

CB Monitor Radio and Clock

Here's a clock radio that does everything but wash the dishes. Called the Kings Point KP-23 CB Monitor Clock Radio, this desk top unit includes a digital clock that tells you the time, plus the day and month. It brings in CB signals loud and clear, plus it has an AM/FM radio and an advanced alarm system. The memory alarm system allows you

CIRCLE 52 ON READER SERVICE COUPON

to go to sleep by music and wake up by music or alarm or both. A built-in snooze alarm lets you sleep for 10 minutes before alarm reactivates. The KP-23 clock radio features easy-to-use slide and pushbutton controls that are easy to see and adjust. Its green display can serve as a night light. The price for the KP-23 is $59.95 and it is available from Kings Point Corporation, 106 Harbor Drive, Jersey City, NJ 07305.

Adapter Connector for Mikes

Avoid soldering new connectors and plugs to your power mikes and/or CB rigs. Mura has the answer with its new MikeMate microphone adapter system. It's difficult for CBers to set up accessories and power microphones because they come without connectors. The CBer has had to buy a connector (if he could find it) and solder it on himself. Because of the very fine wires used in CB cables and because of the very small size

CIRCLE 58 ON READER SERVICE COUPON

of CB Mike connectors, even skilled CB hobbyists have trouble properly attaching these connectors. The MikeMate, featured on all Mura microphones, uses a simple adaptor and master connector on each microphone to solve this problem. CB dealers now have a cross reference guide to show the CBer which Mura adapter fits his CB transceiver. The CBer selects a Mura microphone of his choice, purchases the appropriate adapter, and plugs both into his transceiver for immediate operation! Although there are dozens of different CB mike connectors, CB dealers will stock the most popular adapters which will connect to most CB transceivers. The remaining special adapters can be ordered by dealers so that a customer can fit any Mura CB microphone to every CB transceiver without difficulty. The adapters are priced to sell at $5.95. For further information, write to Mura Corporation, Westbury, NY 11590.

Great Gripper

Anixter-Mark's new Great Gripper antenna is not just another magnetic mount—but a totally designed package of mount, antenna and coax all working together efficiently in one handsome unit. The Great Gripper begins with a new super magnetic mount that really stays where you put it. That's because the mount contains the most powerful ceramic magnets available. A ground plane is also built into the mount to insure the perfect match. The new antenna is designed to com-

CIRCLE 74 ON READER SERVICE COUPON

plement the mount. The antenna is a full 3 feet long to clear most any obstruction. Fiberglass and top loaded, The Great Gripper antenna looks sleek and slim in black and chrome. And it's a 40-channel antenna—with an average VSWR of 1.4:1 over all 40 channels. The Great Gripper includes a full 18 feet of RG-58A coax cable that will reach anywhere on the car, van or whatever. Sells for $24.95. For further information write to Anixter-Mark, 5439 West Fargo, Skokie, IL 60076. ■

Kathi's CB Carousel

by Kathi Martin, KGK3916

Kathi discusses both sides of the CB coin—a great transceiver and an antenna fraud

☐ I'd like to tell you about a new line of CB transceivers that really impressed both me and the lab crew from CB BUYERS GUIDE magazine. I had dropped in to pick up a frequency counter I'd loaned them while theirs was out for calibration, and arrived just as they broke open a large case containing the complete transceiver line from a new outfit called "President." Instead of using model numbers they've named their rigs after presidents, such as the Dwight D, Teddy R, and Grant. Corresponding to the model names you find some real impressive equipment. In fact, I borrowed the AM/SSB Grant from the lab because it checked out so well and looked so good.

Actually, the entire President line looks like class. And I'll bet that someone from President must be there checking not only the finish but on the alignment, because every model checked in the lab while I was there was tuned right on the button.

Some Clean SSB. Anyway, the Grant is a full 40AM/SSB mobile transceiver for 13.8 volts with positive or negative ground. Among the usual features common to high performance transceivers are an LED digital channel indicator, a dimmer switch for the channel display and S/RF-output meter illumination, a plug-in power cable, a clarifier, and a local/DX (distance) sensitivity switch to prevent excessively strong local signals from overloading the receiver.

Among the unusual features are a front panel microphone gain control and a full side-chain noise blanker—the most effective kind.

The microphone gain control allows the user to adjust overall sensitivity between −20 and −40 dB. Since −20 dB is "normal"—the equal of an "average" voice level—the user can increase overall sensitivity up to 20 dB, the same as might be done with an optional power-mike. Since the Grant has 100% modulation, limiting the extra gain doesn't produce overmodulation or splatter, it simply amplifies the lower voice sounds. However, increasing the mike gain also amplifies the background ambient noise, so you've got to know when and how much to bring up the mike gain.

In the lab the transmitter put out 3.6 watts AM and 12 watts P.E.P. SSB into a 50 ohm dummy load. Out on the road where it's modulation quality that really counts the Grant must put out a rock-crusher sound because there were many breakers commenting on my wall-to-wall/tree-top-tall signal. Never before did I get so many breakers asking what rig I was using.

Quality Control Tells. As for the receiver, the President Grant is a real signal-snatcher, clocking in with a 0.4 uV AM sensitivity for a 10 dB S+SN/N ratio and 60 dB adjacent channel rejection. The SSB opposite sideband rejection was a whopping 60+dB, and I was actually able to work a sideband contact on channel 16 high side while another contact was going on channel 16 low side—that's real *pro* performance.

Any time I got in real close to a transmitter that could overload the receiver I simply pushed the sensitivity switch to *local* and cut the signal down below overload.

All in all, the President Grant is an all-'round outstanding performer that also looks as good as it sounds. You really can't appreciate its looks and "feel" until you handle one at your local dealer.

Anyway, welcome to CB Mr. President. For additional information on the President Grant and the whole new President line circle No. 68 on the Reader's Service Coupon.

Barnum Was Wrong! He said there's a sucker born every minute. He just didn't know CB, where two or more suckers are born every second. You don't believe me. Okay, I'm going to make you an offer you can't refuse. I will pay you to test CB equipment for me. No, there aren't any strings. Fact is, I will pay you one crisp U.S. dollar for your opinion on a new antenna I'm selling.

This antenna will sell for about $50 when I get it on the market. It's a mobile model, and I have a report from a famous independent university test lab that it is in fact a mobile CB antenna made of stainless steel, and will provide an SWR no higher than 1.5:1 on any of the 40 channels if installed as directed. In most instances it will outperform the typical loaded mobile antenna.

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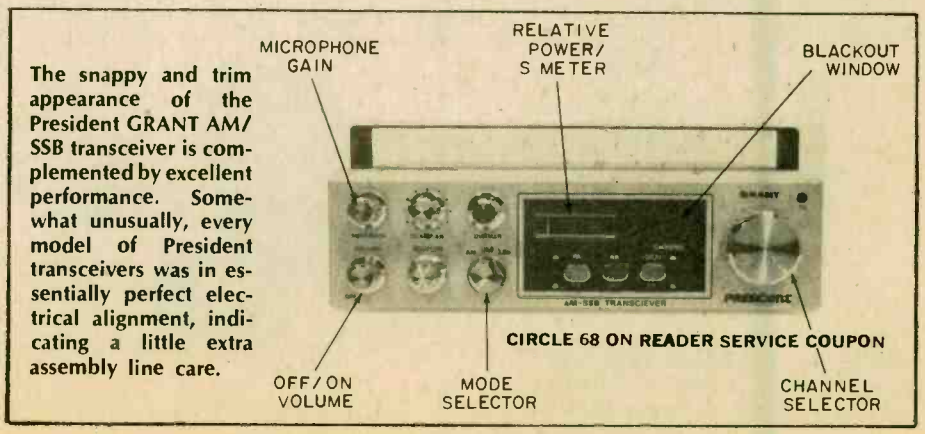
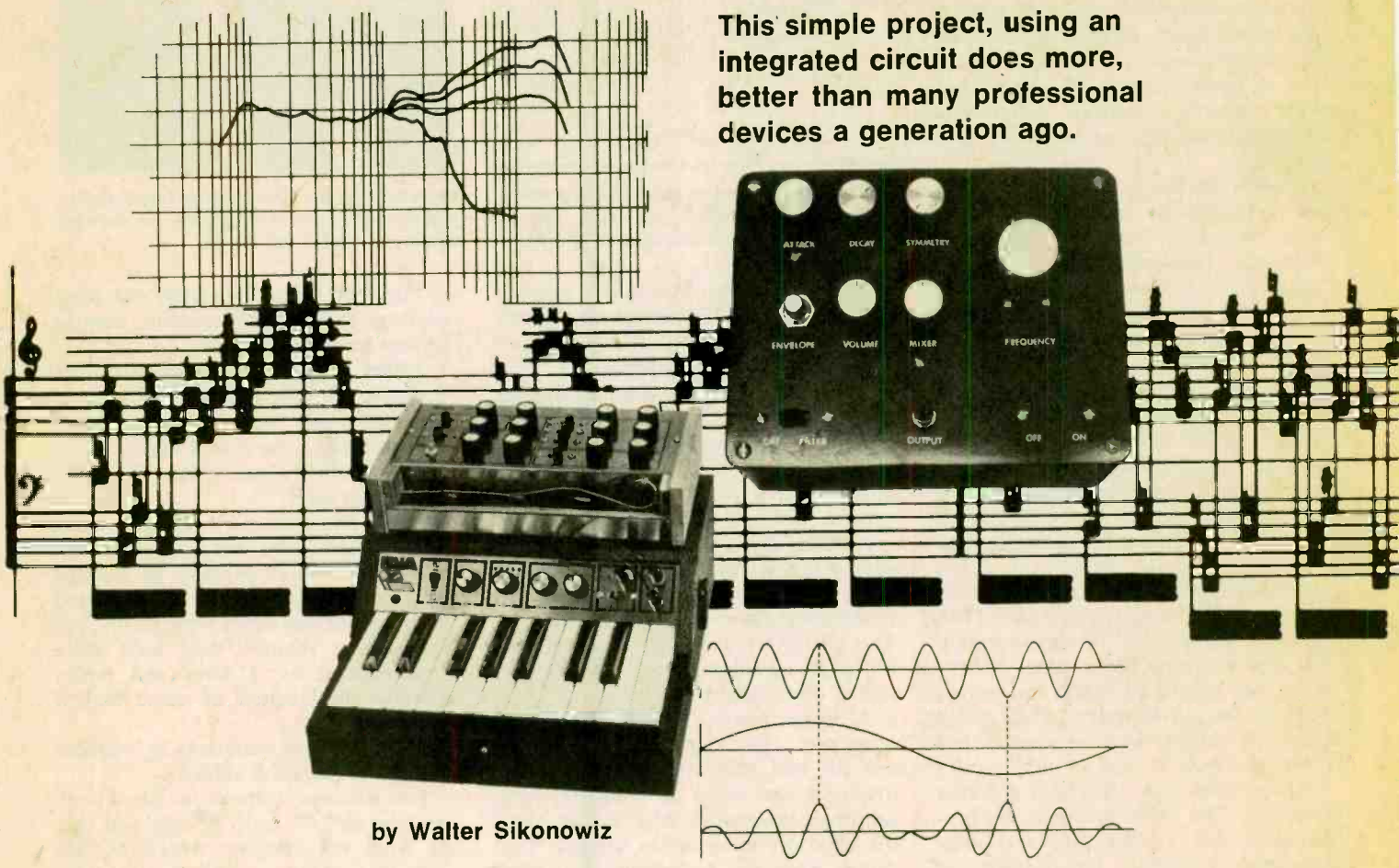


The snappy and trim appearance of the President GRANT AM/SSB transceiver is complemented by excellent performance. Somewhat unusually, every model of President transceivers was in essentially perfect electrical alignment, indicating a little extra assembly line care.

SIMPLE-SYN, THE MUSIC MACHINE

This simple project, using an integrated circuit does more, better than many professional devices a generation ago.



by Walter Sikonowiz

IT WAS INEVITABLE that modern man would use electronics to imitate the sounds of earlier musical instruments. Just as the pipe organ has been used for centuries to produce sounds similar to trumpets, flutes, and strings, for the past thirty years electric pianos and organs have been used to mimic the pianoforte and the pipe organ. Only today, with the advent of microelectronics—integrated circuits and other improvements on the vacuum tube and discrete transistors—we are seeing an explosion in the design and manufacture of electronic musical instruments.

In the Beginning. We've had electronic instruments as far back as the 1930's, though they were far simpler than even today's toys. In France the Martinot and the Oniolone used piano-like keyboards to control electronic oscillators which produced sustained tones. They were the forerunners of the keyboards which most rock-pop groups use today to produce those massive 120-dB sound crushers at festivals and concerts—to say nothing of thundering dance halls and discotheques.

Early Instruments. The best-known electronic instrument before today's was the Theremin. It consisted of two radio-frequency oscillators. One had a fixed frequency, and the frequency of the other was controlled by the player moving one hand nearer to, or farther from a sensing plate. The difference between the frequencies of the fixed and the variable oscillator produced a tone capable of being shifted throughout the audio range. The volume was controlled by slight movements of the player's other hand. Because nothing was actually touched to produce the frequency and volume changes, the Theremin made a weird, gliding tone which could, in the hands of a skilled performer, be extremely effective. However, it could produce only one tone at a time, and the world of music had to await the development of much more sophisticated circuitry before true electronic musical instruments were developed.

Electronic Music Today. The modern electronic synthesizer came into being with the construction of a vacuum-tube monster with thousands of tubes and other components. Called the Mark I RCA Synthesizer, and built at Princeton, New Jersey, it was dismantled after several years of experimentation to supply parts for the Mark II. This machine is still in use, and though smaller than the Mark I, it measures about 17 feet square and 7 feet high. It is still in use in the Columbia-Princeton Music Center, in New York City.

In the early 1960s Robert Moog (pronounced like "vogue") began developing and producing a line of electronic music synthesizers which revolutionized music. Within the next few years several other firms began producing synthesizer equipment, and in the last several years the microminiaturization made possible by the development of integrated circuits has made possible synthesizers controlled by keyboards—so now real performance instruments exist.

The Nature of Music. Before describing the construction of our simple syn-

thesizer, Simple-Syn, we should first examine the composition of its end product —the music itself. Musical instruments all produce sounds, which can be defined in terms of their *frequency* (also called pitch), *dynamics* (often described, inaccurately, as loudness), and *timbre*.

Timbre. This is the quality of sound that differentiates a trumpet from a violin when both are playing the same frequency. The timbre is the result of "secondary" frequencies (harmonics—also called "overtones") being present in the sound of the respective instruments. If there are many harmonics present, the sound is called bright. If there are only a few present, the sound is called dull or mellow.

These harmonics are *above* the basic pitch being played. The timbre of each instrument is different because each instrument has its own particular pattern of harmonics.

Assume both the violin and clarinet are playing the same pitch, A440. Then A440 would be called the fundamental. The first overtone has a pitch of 880 cycles per second (2x440); the second overtone has a frequency of 1320 cycles a second (3x440); the third overtone has 1760 cps (4x440) and so on.

The clarinet and violin have different overtones. The violin produces the fundamental and all the *odd* and *even* numbered overtones. The clarinet on the other hand produces the fundamental and the odd numbered overtones. The overtones are not as loud as the basic frequency and are therefore not recognized as the fundamental. The loudness of the higher numbered overtones decreases rapidly.

In other words, every instrument has its own set of overtones that make up its timbre. The two factors that account for the difference in timbre are: which overtones are present; and the relative strength of those overtones.

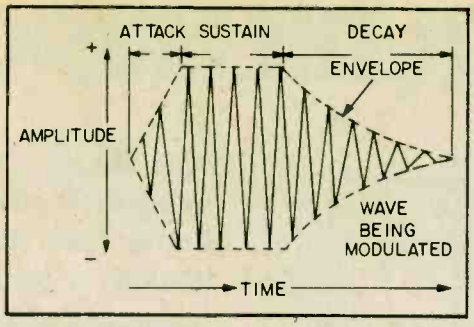
There are four basic combinations of fundamental and overtones that are important in electronic music. These specific combinations are named: sine, triangle, square, and sawtooth. A sine wave is like a flute in quality.

A triangular wave consists of a fundamental and the odd numbered overtones. The overtones that produce the triangle wave are very weak in strength. The quality of the sound produced by a triangle waveform at an audible pitch is like a wooden recorder.

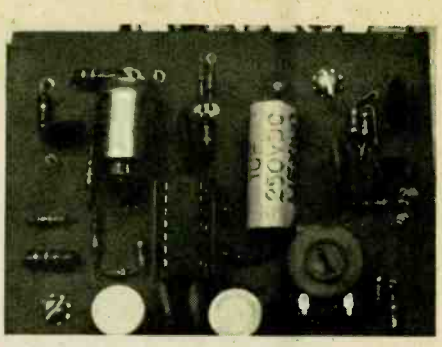
A square wave, like the triangular waveform, consists of the fundamental and the odd numbered overtones. The overtones that make up a square wave are more numerous and louder than the same overtones in the triangle. The square wave has a "hollow" sound to it, like a clarinet.

Lastly, the sawtooth waveform consists of the fundamental frequency and the even and odd numbered overtones. The sawtooth sound quality is very "bright" like a string or brass instrument.

Dynamics (loudness). Dynamics is the third property of sound. It has two important aspects. It includes *overall loudness*, which can vary from the rustle of leaves to the blast of a rocket. It also includes the changing ratios of sound as time passes.



Typical musical note shows approximate areas of attack, sustain, and decay, Any or all of these may be much shorter or longer.



Closeup view of printed circuit board shows placement of the components. Be sure to use an IC socket for the IC.

For most musical sounds the loudness versus time characteristic may be broken into three parts:

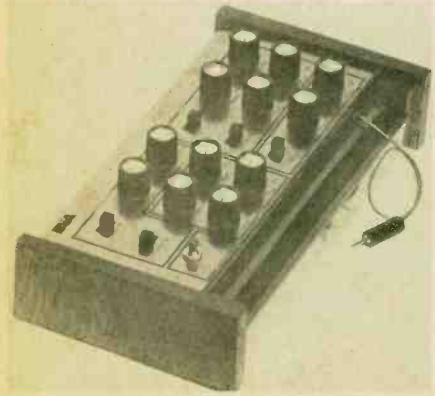
1. Attack time—the time period from silence to when the sound reaches its maximum loudness.
2. Sustain time—the period during which the sound is maintained at some loudness level.
3. Decay time—the period during which the sound fades away to silence.

The voice is an example of a sound that has flexible loudness. A sound from a voice can begin very quietly and increase in volume, then hold some volume level for a time, and finally decrease the loudness of sound until it is silent.

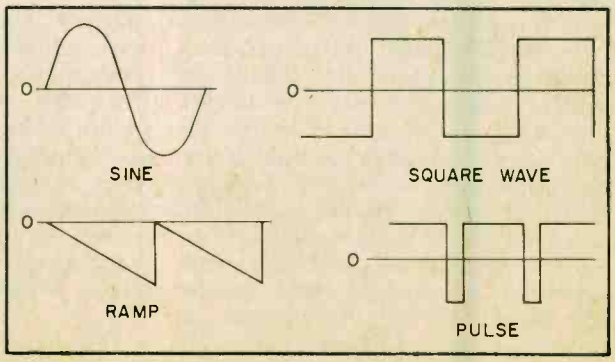
A graph of the variations in loudness in a typical sound is shown.

Two sine waves drawn in dotted lines are labeled "A" and "B." As you can see from the drawing, waveform "B" goes through two cycles in the time that it takes waveform "A" to complete a single cycle. Waveform "B" is therefore twice the frequency of "A" and is said to be the *first* harmonic of the *fundamental* frequency "A." If we draw another wave three times the frequency of "A" it will be the *second* harmonic, four times will be the *third* harmonic, and so on.

If at every point in time we sum together the amplitudes of waveform A and B the result is the waveform shown by the solid line. Note that while the new wave is shaped differently than



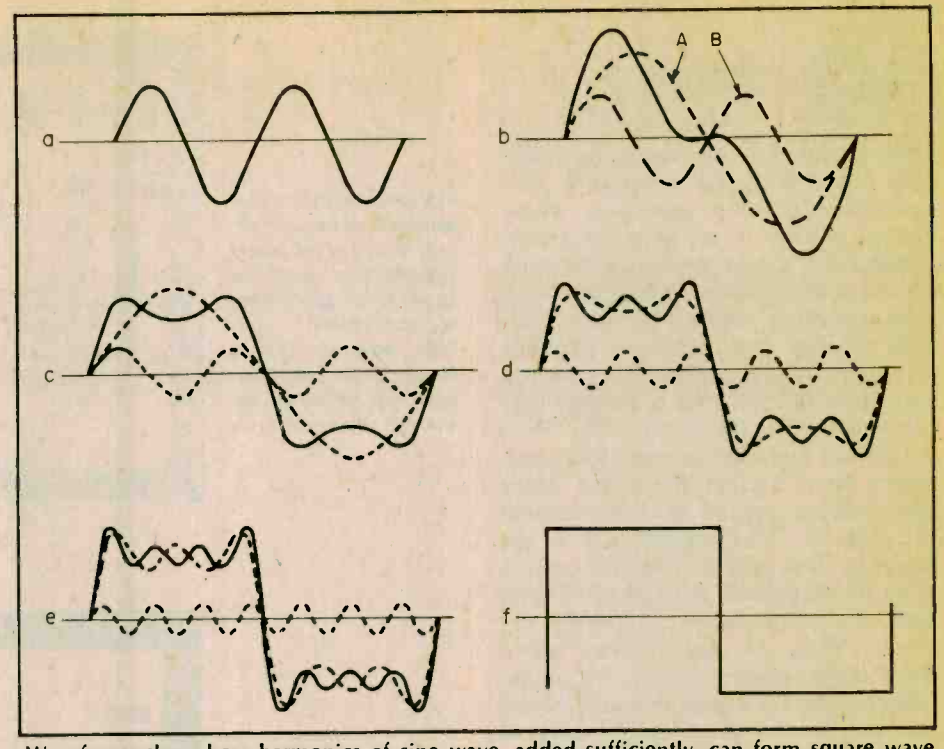
Small electronic musical instruments may be built from kits like this one from PAIA Electronics (address at end of article)



Musical tones may be generated by oscillators making simple sine waves, or any of several other shapes. The most common of these are shown. Note that the frequency of each note is the same, but the timbre (sound quality) will be different, depending on the wave-shape.

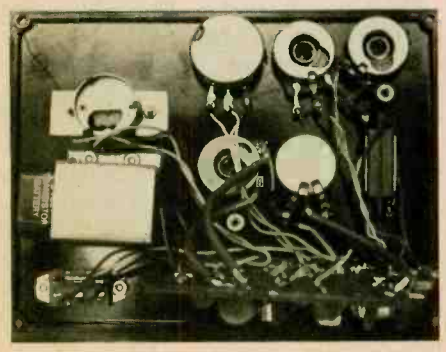
either A or B it has the same frequency (and consequently pitch) as the fundamental frequency A. If third, fourth, fifth and higher order harmonics were added into this wave the result would continue to change shape but the frequency would remain the same.

It is not necessary that every harmonic of a fundamental frequency be included in a wave and indeed the most musically interesting sounds have certain harmonics deleted. The square wave is a good example. It is difficult to imagine that the sharp-edged wave illustrated could be built up from smoothly changing sine waves, but it can, as shown in the progression of diagrams (a) through (e). In (b) the fundamental frequency is added to its third harmonic, producing the waveform shown by the solid line. In (d) the fifth harmonic has been added to the result of (b) to produce the new solid waveform and in (e) the seventh harmonic has been added to all the rest. You can see that the trend as higher order harmonics are added is to steepen the sides of the square and flatten and reduce the ripple in the top. When enough harmonics have been added the result will be a square wave. Notice in particular that not all harmonics are added together for a square wave, only the *odd* harmonics (3rd, 5th, 7th, etc.) are included.



Waveforms show how harmonics of sine wave, added sufficiently, can form square wave. At (b) the fundamental (A) and its first harmonic (B) add to produce shape (b). At (d) and (e) additional harmonics begin to approximate square wave. An infinite number of harmonics would make a perfect square wave, as in (f).

Making Waves. It is much easier to generate a complex ramp or square wave than a sine wave. Since synthesizers operate with harmonic-rich waveforms as their primary signal source there is no need to start out with a sine wave at all. The VCO's supplied with most synthesizers provide a variety of waveforms each of which provides different harmonic structures. Common practice is to use a relaxation oscillator to generate a voltage ramp which is then converted to triangle and pulse waves using simple shaping circuits. In some cases the triangle will also be shaped into a sine wave. These waveforms and their harmonic contents are listed in the Table.



Underside view of front panel shows printed circuit board in place, ready to be dropped into its case.

Building Blocks. Modern synthesizers are made up of one or more each of several different kinds of building blocks, just the way all component hi-fi systems include similar blocks (preamplifier, controls, power amplifier). These building blocks are mostly *oscillators, filters, envelope generators, mixers,* and *amplifiers.* Each circuit is itself fairly simple. When a number of them are connected together they can comprise a performer's synthesizer. To demonstrate the basic principles of the most important of these building blocks we are presenting Simple-Syn—a one-tone synthesizer which incorporates most of the principles needed for practical music synthesizers.

The simple synthesizer in this project shows how basic oscillators (tone generators) work, and how the frequencies they produce are modified to produce a wide variety of sounds.

Simple-Syn is capable of simulating many naturally-occurring sounds, as well as some unnatural ones. It will be useful as a demonstrator of the characteristics of sound, as well as a sound-effects machine for tape recordists. The output of Simple-Syn is sufficient to drive the *Aux* input of an amplifier or the *Line* input of a tape recorder. It may also be adapted to other uses, as will be discussed later

Shown here is a diagram of a burst of sound. The time interval during which the sound's volume builds from zero to some reference level is called the *Attack* time, while the interval during which the sound remains at the reference level is called the *Sustain* time. Finally, the period during which the sound level decays exponentially back to zero is the *Decay* time.

As you can see, what we have here is an amplitude-modulated sine wave. Now suppose that this sine wave is replaced by some other periodic waveform of the same frequency but with a different waveshape. For instance, consider the ramp, square, and pulse waveforms shown. If you think that they will sound different from the sine wave, you're right. Although these waveforms all have the same frequency as the sine wave, they are aurally perceived as having different timbre.

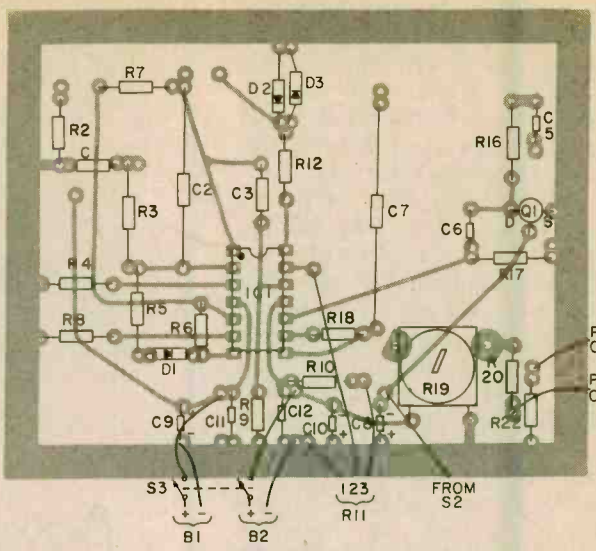
An important characteristic of natural sound generators is that they filter the waveshapes of the sounds they generate. For example, the body of a violin and the horn of a trumpet are natural resonators which reinforce some frequencies, and attenuate others. The overall shape of a waveform is correlated with the relative amplitudes of its harmonics. So, if a harmonic-rich waveform is filtered, we will alter its shape, since some of its harmonics will be attenuated more than others. Thus, *filtering* produces changes in *timbre.*

How the Circuit Works. Now let's turn

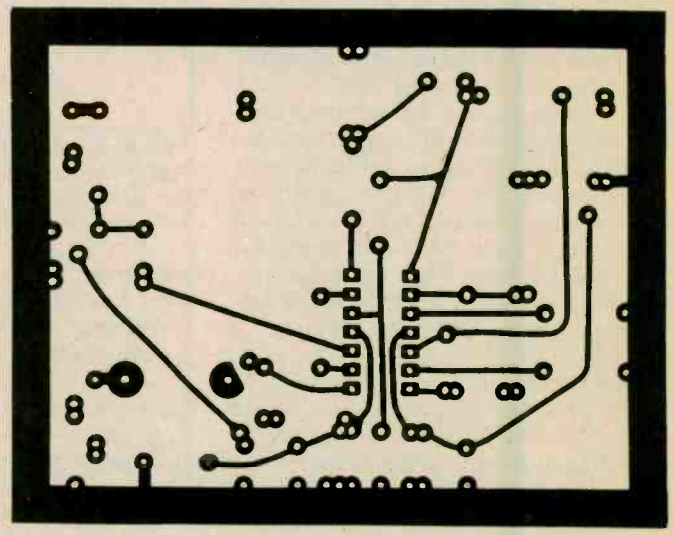
to the schematic of the synthesizer. Sections A and B of IC1 comprise a voltage-controlled ramp generator, whose control voltage is supplied by potentiometer R1. C1 bypasses contact noise generated by rotation of R1. Section A is an integrator, which when fed a constant positive input voltage, produces an output voltage that decreases linearly with time. Section B is a Schmitt trigger which senses the output of A. When A's output drops below some lower reference level, Section B's output drops low, causing current to flow through D1 and R5. This current flow is opposite to (and greater than) the current from R1 that passes through R3. Therefore, A's output is forced rapidly upward. When A's output rises above some upper reference level, B's output swings high, D1 ceases to conduct, and A's output can once again begin to linearly drop. Thus, the whole process repeats itself.

The ramp waveform is fed through C3 to section C, which acts as a comparator. By adusting the *Symmetry* control, R11, we can shift the reference level at which the comparator switches, and thus the ratio of "high" time to "low" time of the rectangular wave at C's output. This rectangular wave is clipped by D2 and D3. The ramp and rectangular waves are mixed in R13 and fed to volume control R15. Closing S1 connects C4 across R15, thus forming a low-pass filter. C5 couples the signal from R15 to the voltage divider formed by R16 and Q1, an N-channel JFET whose resistance decreases as its gate bias decreases.

Large synthesizer, the ARP 2600, has four-octave keyboard, three voltage-controlled oscillators which can produce tones from three Hertz up to 20 kHz. In addition to voltage-controlled oscillators, filters, etc., it includes a ring-modulator, two envelope generators and an envelope follower, a random noise generator, three voltage processors, and a reverberation unit.



Placement of the components on printed circuit board. Perf board construction may be used since placement is non-critical. Controls, however, should be positioned approximately as indicated, for manual convenience.



Printed circuit board layout for Simple-Syn is easy to make even if you haven't made one before. Radio Shack has inexpensive kits for boards.

Gate voltage for Q1 is developed across C8, which we can consider initially discharged with S2 in the position shown. Therefore, Q1's resistance is minimal and the audio signal at its drain is also minimal. Flipping S2 upwards causes C8 to gradually charge through R19, R20, and R21; consequently, Q1's resistance increases and so does the volume. Flipping S2 down again causes C8 to slowly discharge through R22 and R23, and the volume drops once again. Finally, the audio signal from Q1's drain is coupled by C6 to the buffer amplifier formed by section D of IC1.

Building Simple-Syn. Construction of the synthesizer is not critical. The best method would be to copy the printed circuit layout shown. The board is simple enough to be copied using one of the kits available at Radio Shack and elsewhere. My Simple-Syn was built in a plastic box but a metal case is recommended in order to eliminate hum-pick-up problems. The control layout shown in the photograph should be used. The completed printed circuit board will mount behind the control pots, with its foil side facing them, using 1¼-inch spacers.

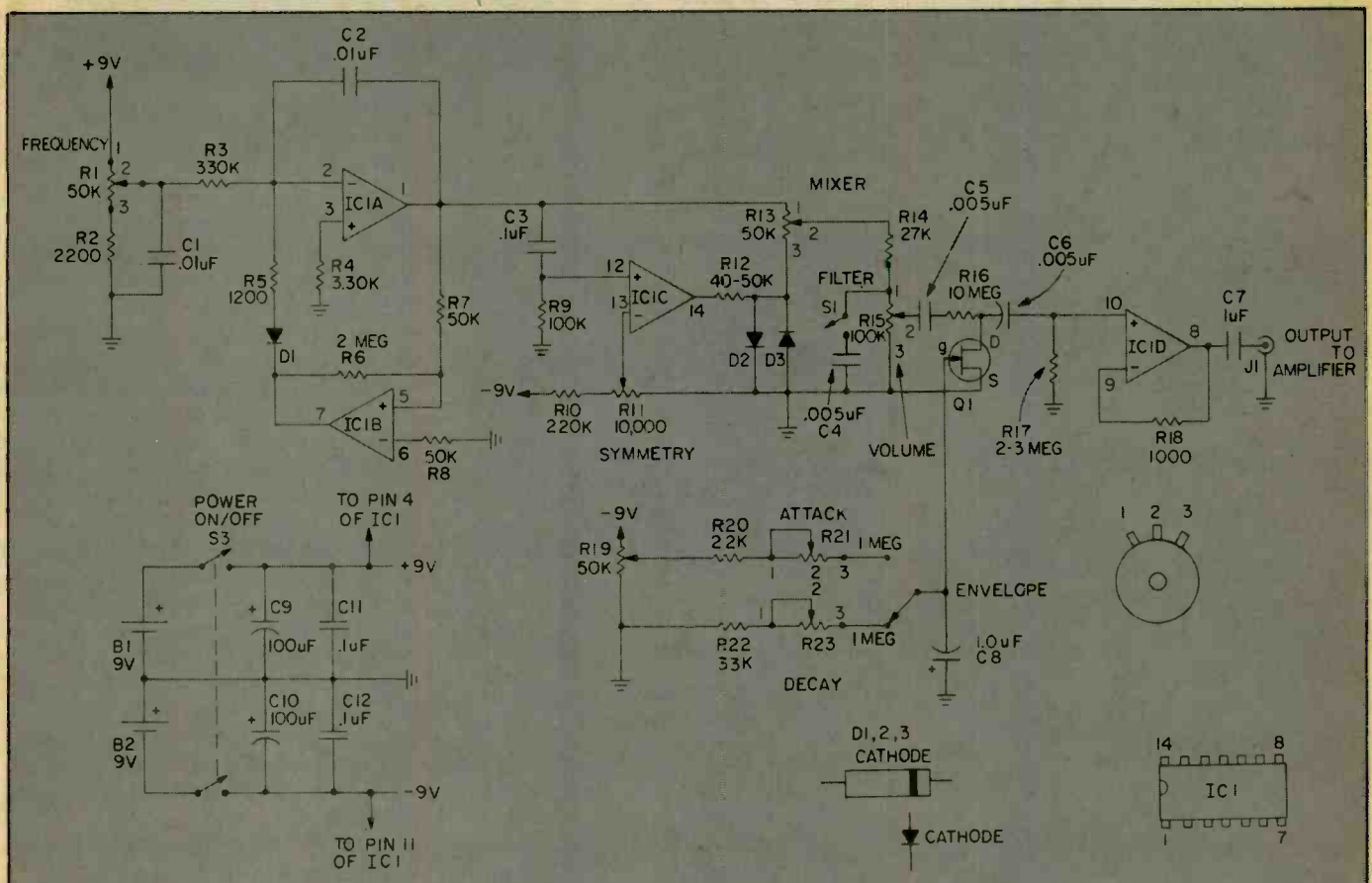
After you have fabricated the board, install the IC socket. The other components may be installed in any order, but solder Q1 last. Be sure to observe proper orientation of Q1, D1, D2, D3, C8, C9, and C10. Trimmer R19 used in my prototype was mounted horizontally. The two large upper pads connect to its wiper. If you use a vertical-mounting trimmer instead you will have to change the position of the pads to accommodate it. Finally, install IC1 in its socket and set the board aside temporarily.

Try to copy the construction of Simple-Syn's prototype cabinet as closely as possible. *Frequency control* R1 mounts in the upper-right-hand quad-

rant and is actuated by the largest knob. Directly below that pot is an aluminum bracket holding B1 and B2. Right below the bracket is *Power* switch S3.

The first row of controls on the left-hand side of the front cover contains R21, R23, and R11 (from left to right). The second row contains S2, R15, and R13. Below the second row are *Filter* switch S1 and *Output* jack J1. With this arrangement, the interconnecting wiring is shortest, and all components mount on the cover, which is convenient when batteries have to be changed. Incidentally, the battery drain is less than 2 ma., so the batteries will last a long time.

After you've located and drilled all holes in the front panel, including those for the spacers that mount the printed circuit, solder short lengths of #22 stranded wire to the appropriate lugs of the controls, then mount them. Six-inch lengths of wire will suffice. This is easier than mounting the controls and then trying to solder to the leads in close quarters. Note that R14 is not on the



PARTS LIST FOR SIMPLE-SYN TONE SYNTHESIZER

C1—.01-uF capacitor (Radio Shack 273-131 or equiv.)
C2—.01-uF mylar capacitor (Radio Shack 272-1065 or equiv.)
C3, 11, 12—.1-uF capacitor (Radio Shack 272-135 or equiv.)
C4, 5, 6—.005-uF capacitor (Radio Shack 272-130 or equiv.)
C7—1.0-uF, 250-VDC capacitor (Radio Shack 272-1055 or equiv.)
C8—1.0-uF tantalum capacitor (Radio Shack 272-1406 or equiv.)
C9, 10—100-uF, 16 VDC electrolytic capacitor (Radio Shack 272-955 or equiv.)
D1, 2, 3—1N914 silicon diode (Radio Shack 276-1620 or equiv.)
IC1—LM324 quad operational amplifier IC (Radio Shack 276-1711 or equiv.)
Q1—2N3819 JFET (N-junction field-effect transistor) (Radio Shack 276-2035 or equiv.)
R1—50,000-ohm, audio taper potentiometer (Allied Electronics 854-7333 or equiv.) See end of Parts List for Allied's address)
R2—2200-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R3, 4—330,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R5—12,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R6—1.8 to 2.2-megohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R7, 8—47,000 to 51,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R9—100,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R10—270,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R11—10,000-ohm, linear taper potentiometer (Radio Shack 271-1715 or equiv.)
R12—39,000 to 47,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R13—50,000-ohm, linear taper potentiometer (Radio Shack 271-1716 or equiv.)
R14—27,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R15—100,000-ohm, audio taper potentimeter (Radio Shack 271-1722 or equiv.)
R16—10-megohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R17—2.2 to 3.3-megohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R18—1000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R19—50,000-ohm, linear taper potentiometer (Radio Shack 271-219 or equiv.)
R20—22,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
R21, 23—1-megohm, linear taper potentiometer (Radio Shack 271-211 or equiv.)
R22—33,000-ohm, ½-watt resistor (Radio Shack 271-000 or equiv.)
S1—SPST slide switch (Radio Shack 275-401 or equiv.)
S2—SPDT pushbutton switch (Radio Shack 275-1553 or equiv.)
S3—DPDT slide switch (Radio Shack 257-403 or equiv.)

Misc.—knobs, cabinet (preferably metal); 9-VDC transistor radio batteries (2); battery clips; socket for IC1 (Radio Shack 276-027 or equiv.) wire, solder, etc.

Allied Electronics' address is 401 East 6th St., Ft. Worth, TX 76102.

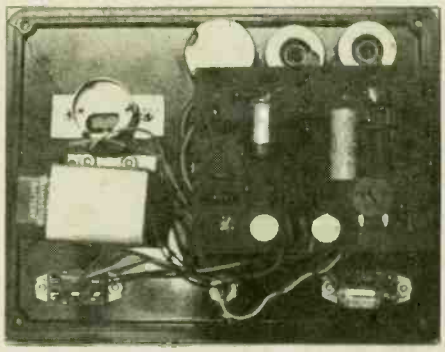
circuit board—it mounts point-to-point between lug #2 of R14 and lug #1 of R15. Likewise, C4 is off the board, wired between S1 and R15 as the schematic indicates.

Position the front panel face down on a table, and next to it place the printed circuit board, foil side up. Connect the control leads to the pads indicated on the board by inserting each lead into the appropriate hole from the foil side and then soldering. Trim off the excess wire that protrudes from the component side of the board. When the connections have all been completed, mount the board foil side down behind the controls. All the wiring will now be underneath the board, and your project will not be cluttered by dangling wires.

Final Adjustment. When Simple-Syn is completed, only one adjustment must be made. Turn on the power and adjust R21 for minimum attack time, and then R15 for maximum volume. Press S2. Now turn R19 fully to the right, and then fully to the left. Leave it at whichever end provides a loud tone in your speaker (the opposite extreme should produce silence). Now turn R19 back until there is a just barely-noticeable diminishing of sound intensity. The correct position for R19 is anywhere between R19's present position and the position it was in previously. You will notice that the position of R19 affects the attack and decay times somewhat if you play with those controls. Choose a position for R19 (within the two bounds previously indicated) that produces the most pleasing attack and decay behavior.

Using Simple-Syn. If you make tape recordings, Simple-Syn can be used to imitate foghorns, train whistles, sirens, musical instruments, insect buzzes and hums, as well as surreal science-fiction-movie sounds. In conjunction with a small amp and loudspeaker it can provide realistic horn and whistle effects for a model railroad. You might use it to replace your humdrum doorbell with some really wild sounds. Finally, Simple-Syn can be used as a musical instrument. All that is necessary is that you calibrate the frequency control, perhaps using a pointer affixed to the frequency knob and a scale with the positions of the various notes marked on it. Simple-Syn spans more than three octaves, so the larger scale you use, the easier it will be to calibrate. Calibration is easiest with a frequency counter, but you can also tune it by ear, using a piano as reference. In addition, you can

Completed prototype shows layout of controls. If your cabinet is larger you should still stick to this physical layout, to keep internal leads as short as author did.



Here's what the author's prototype looks like inside. Everything mounts on the top panel, so the cabinet body is used just for support. If you use a metal cabinet (recommended) it will also serve to minimize possible hum pickup.

replace the 9V. batteries with 8.6V. mercury cells, since the frequency of the ramp generator is voltage-sensitive. Your calibration with mercury cells will stay accurate because, unlike zinc-carbon cells whose voltage decreases with age, a mercury cell's voltage remains quite constant throughout its useful life.

Final Remarks. A few final remarks about operation of the synthesizer might be helpful. First, the *Symmetry* control will have its maximum effect when the *Mixer* is rotated to yield a pure rectangular wave; its effect will be inaudible when *Mixer* is rotated to pure ramp. The effect of *Symmetry* and *Mixer* controls, which vary the harmonic structure of the output, will be most evident at low frequencies. This is because the important harmonics (all those up to about the thirtieth) of the higher frequency tones fall above 15 kHz. Beyond 15 kHz the human ear has a rapidly diminishing sensitivity. Thus, a high frequency ramp won't sound tremendously different from a high frequency rectangle because the human ear does not respond to all the important harmonics.

The effect of the *Filter* control will be to attenuate the higher harmonics of a waveform, and produce a more mellow sound. In most natural sounds decay time is longer than attack time. Try using a long attack time together with a very short decay time for a really strange effect. Finally, if you are feeding the synthesizer's output into your hi-fi system, be careful not to sustain a loud tone for too long a time. Home speaker systems can handle large amounts of power only on a transient basis; sustained operation at high power can burn out voice coils.

Learning More About Synthesizers. If you'd like to learn lots more about how today's practical electronic musical instruments work you can get an excellent booklet called the *Synthesizer Primer* by writing to Electronic Music Laboratories, Box H, Vernon, CT 06066. If you're interested in knowing more about their extensive line of Synthesizers, say so, and they'll send you literature and prices, as well as a fascinating 7-inch phonograph disc of five short selections performed on EML synthesizers.

Another good source of information on the subject is PAIA Electronics, Inc., Box 14359, Oklahoma City, OK 73114, the makers of a wide variety of kits for synthesizers and allied instruments. They have several very interesting low-cost modules for producing all sorts of sounds, including wind, surf, chimes, in addition to musical and other sounds. The PAIA "Gnome" micro-synthesizer produces many sounds, such as winds and flutes. Gnome kit costs $48.95. For more information circle number 71 on the Reader Service coupon.

If you're into really heavy performing instruments you can look over the state-of-the-art models being sold by ARP Instruments, 45 Hartwell Ave., Lexington, MA 02173. ARP will send you a record demonstrating the sounds of the ARP Omni, which they call the world's first symphonic electronic keyboard, for $1.00. Moog and Buchla synthesizers are also still being produced, and are available in many music stores. ■

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BEARCAT 210 FM SCANNING RECEIVER

With five bands and excellent programming this scanner is state-of-the-art

☐ For many shortwave listeners scanning the so-called public service frequencies means eavesdropping on police, fire, and telephone calls, with occasional weather reports from the National Oceanic and Atmospheric Administration broadcasts on 162.550, 162.475, or 162.400 MHz.

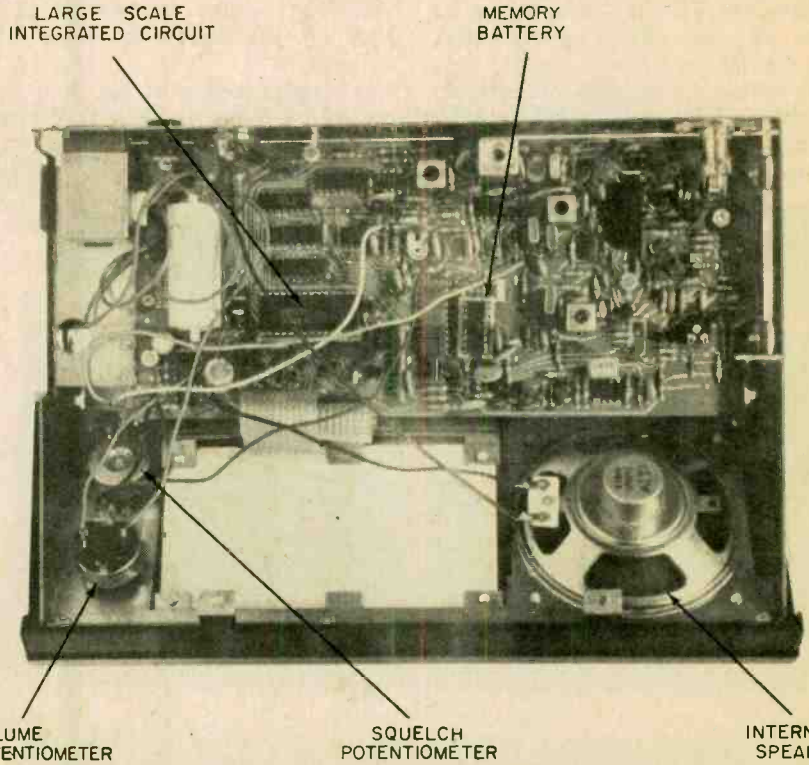
In actual fact, however, the public service frequencies are jam-packed with communications that often prove a lot more interesting and exciting than routine police and fire calls. For example, you might pick up remote radio broadcasts, a movie company's cueing instructions, the National Park Service, the entire marine radio service including the Coast Guard, even the FBI and assorted government agencies you probably didn't know existed. You might even hear your local utility trying to find out why your end of town is blacked out.

All sorts of private and public services utilize the public service frequencies. Problem is, many have virtually unlisted frequencies, and even if you knew the desired frequencies you would spend weeks waiting for crystals that probably cost a month's salary for complete desired frequency coverage.

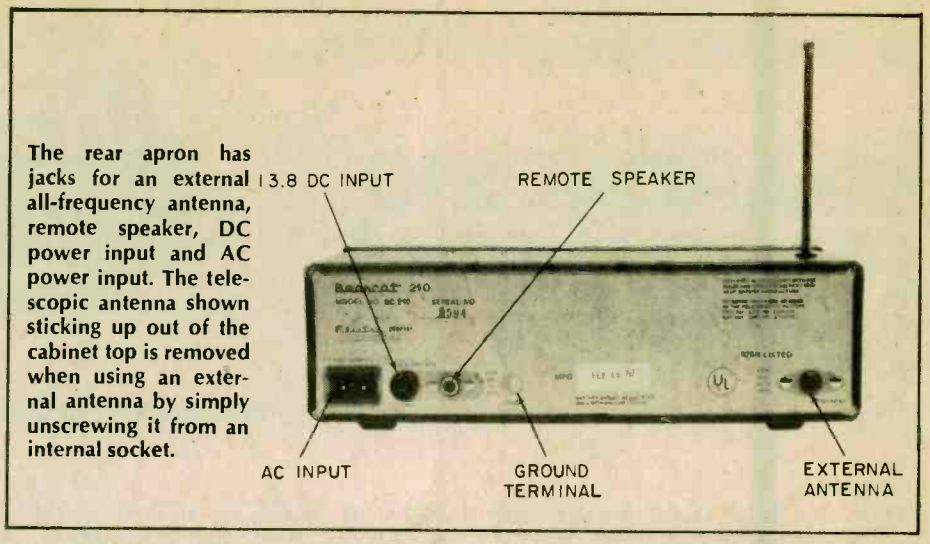
But with a Bearcat 210 Five Band FM Scanning Receiver you can actually search out any public service frequency, and never have need to purchase a single crystal because the 210 can be instantly programmed to any frequency within its tuning range—and the 210's tuning range covers everything in public service plus the 2 meter amateur band.

Seek And Find. Here's how the Bearcat's search mode works. Let's assume you're an amateur newly-arrived in town and you don't know the local 2-meter repeater frequencies, thereby precluding you from using your handheld transceiver to auto-patch into the telephone circuits. You simply program your Bearcat to a low frequency of 146 MHz and press the button marked *lower*. You then enter 148 MHz and press the button marked *upper*. The 210 is now programmed to search the frequency range of 146 to 148 MHz. When you press a button marked *start* the 210 scans the range of 146 to 148 MHz, stopping only when it senses a signal, and it displays the signal's frequency on a six-place digital readout. Eventually, you will search out all the active signals in the 146 to 148 MHz range, and you will know their frequencies which can be entered in any of the Bearcat's ten memory channels. Each time the 210 locks onto a signal it will stay locked as long as the station is transmitting unless you press *start;* in this manner you control the search operation. If you want to remain on the frequency without storing it in a memory channel you simply press a hold button.

Let's look at another example. Assume you want to receive your local police department; you don't know



As complex as the programming and search functions are, they are easily user-programmed through this simplified keyboard. The blackout window directly behind the keyboard conceals the LED digital display for the channel selected and the frequency. To enter a frequency you simply press the appropriate keys—such as 146.550—and then press the "E" key. That's all there is to programming any of the ten available channels. Circle Number 59 on the Readers Service Coupon for more information.



The rear apron has jacks for an external all-frequency antenna, remote speaker, DC power input and AC power input. The telescopic antenna shown sticking up out of the cabinet top is removed when using an external antenna by simply unscrewing it from an internal socket.

their exact frequency but you are certain they are operating in the 155.415 to 156.030 MHz frequency range reserved for police and local government radio service. You simply enter these frequencies as the low and high limits and the 210 will scan the range until it senses a signal. You might locate several police systems within the band. But keep in mind that the scanning action isn't instantaneous; there is a definite time delay (though extremely short) as the 210 changes frequency. The greater the frequency range the longer it takes to scan from the low to high limits. If the range is sufficiently large it might skip over a "police" call the first few times because police transmissions are usually brief, but eventually the Bearcat will ferret out all transmissions in the programmed search range.

The Package. The Bearcat 210 is housed in a computer-style cabinet 7-in. wide x 3.5-in. high x 9-in. deep. It can be powered by 120 VAC or 13.8 VDC (12 volt car battery); both power cords are provided along with a mobile mounting bracket and an "all band" telescopic antenna. The tuning range is broken up into five automatically switched bands of 32 to 50 MHz, 146 to 175 MHz. 416 to 450 MHz (the government's UHF band), 450 to 470 MHz, and 470 to 512 MHz (the UHF "T" band).

Unlike many other scanners which can be peaked for maximum sensitivity for only a segment of each band, the Bearcat 210 has electronic front end tuning so that sensitivity is more or less maximized over each complete band of frequencies.

The supplied telescopic antenna sticks up out of the cabinet top. A coaxial antenna jack is provided on the rear apron for a base or mobile external antenna.

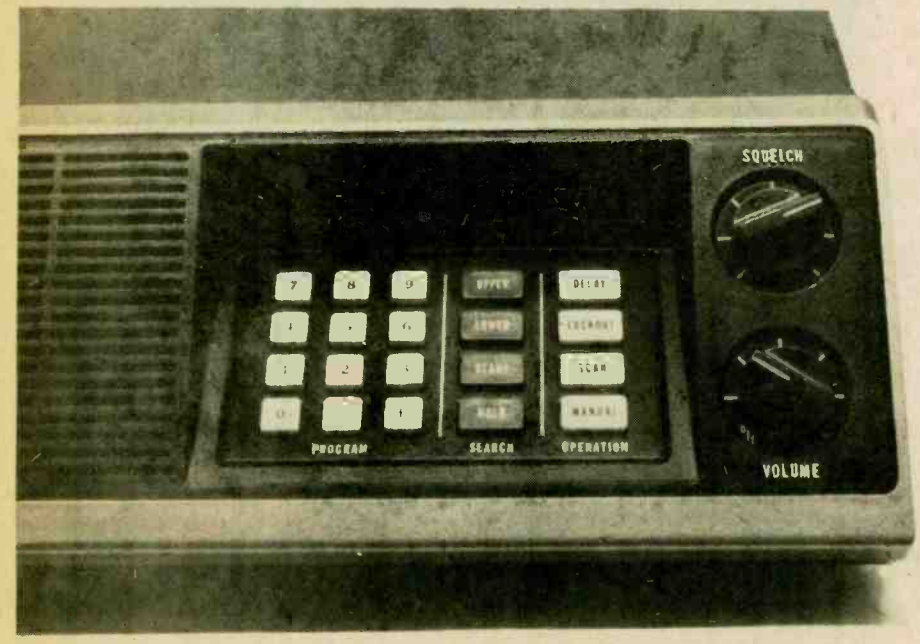
Standard operating controls are provided for volume and squelch. From here on out everything is new and different.

A sloping section of the front panel has twelve keys numbered 1 through 10, decimal, and "E." These keys are used to program the desired frequency and to enter them (E-key for *enter*). Four keys color-coded blue and labled *hold*, *start*, *lower* and *upper* control the search function we described previously. Then there are four keys color-coded yellow labled *manual*, *scan*, *lockout*, and *delay*. We'll get to these keys next. A blackout window above the keys conceals an LED digital display that provides the channel and frequency information. The left two digits indicate which of the 10 channels has been selected by the *manual* key. The *scan* key sets the Bearcat to scanning all channels that haven't been locked out. For example, if you have the weather service punched into channel 8 you don't want the scan stopping on weather each time it comes around. If channel 8 is selected with the *manual* key, and then the *lockout* key is depressed, the scan will ignore channel 8, which can be later reentered into scan or manually selected. Any of the ten channels can be locked out.

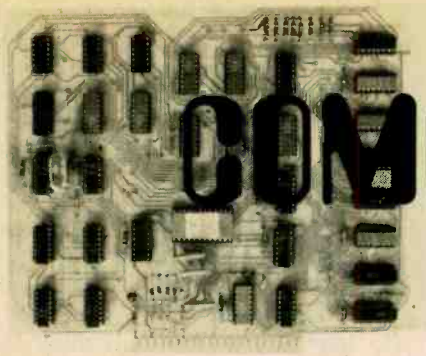
To prevent the scan from resuming during the dead air between transmissions of two or more stations using the same channel, a pause of approximately two seconds before scan resumes can be programmed by pressing the *delay* key. A symbol shows in the LED digital display to indicate a pause has been programmed.

Depending on your particular needs, from one to ten channels can be programmed for reception, or one channel can be reserved for search on any band, or one channel can be used for search and the located frequency can then be punched into a different channel. The proper tuning equipment is automatically selected by the frequency punched in; however, protective circuits do not allow frequencies to be programmed beyond the limits of the specified bands.

(Continued on page 85)



The entire receiver except for the keyboard is assembled on a printed circuit board. What appears as a small white speck is an ultraminature battery that keeps the memories active even when the power supply is turned off. The battery requires yearly replacement.



COMPUTER READOUT

by Norman Myers, Computers Editor

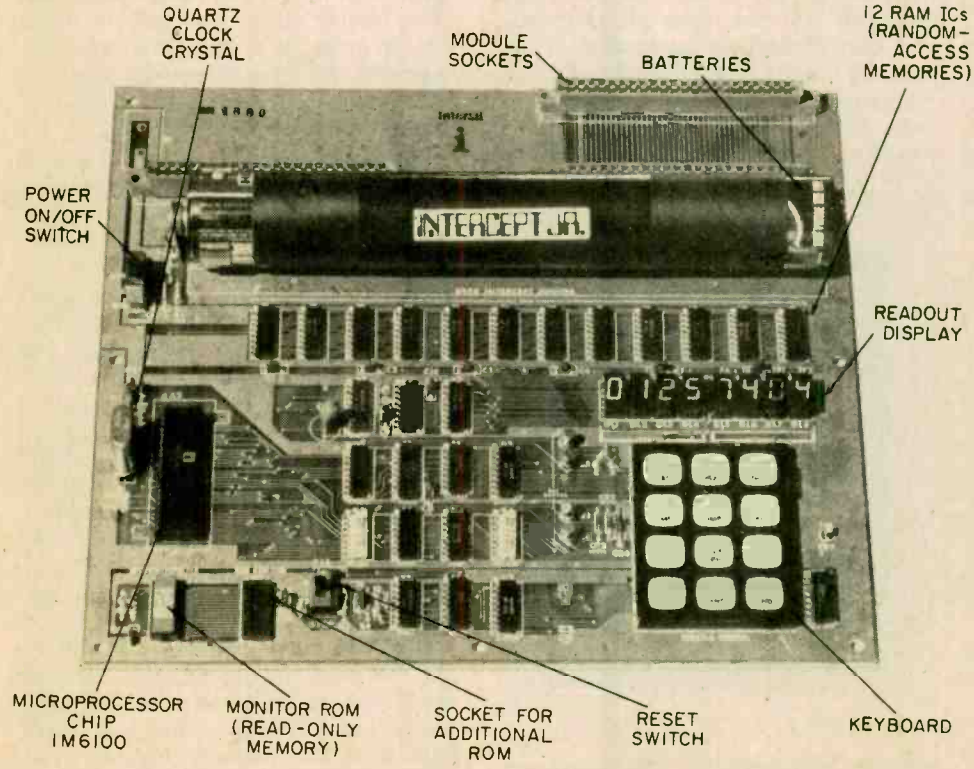
☐ In our last issue we reviewed several microcomputer books, showed which were best for beginning as well as advanced computer buffs, and got some good ideas on several facets of microprocessor/computers. This time we will take a good look at a rather remarkable computer that uses four flashlight batteries and has a twelve button keypad with instructions printed on the keys that let you use it like a Teletype. Imagine sitting in a car or at your kitchen table with this 10 x 11 inch board, no wires attached, and there you are programming it with Teletype code words like HALT, RESET, and DIS (for "display"). The readout is via eight LEDs, each showing a digit from 0 to 7. This computer is the Intercept, Jr. and is made by the ten-year old Intersil Corporation located in California.

What It Can Do. The brain of Intercept, Jr. is Intersil's IM6100 microprocessor which uses 12 bit words (most processors use 8) and has a complementary - metal - oxide - silicon (CMOS) fabrication for very low power consumption—thus the batteries. This microbrain is able to use the instruction set of a Digital Equipment Corporation (DEC) PDP8 computer, which is nearly a standard in many industries having computers controlling big machines. So if you want to start developing computer skills, you can't go wrong with this unit. The microprocessor can perform an *Add* instruction in only 5 microseconds, and it has 6 twelve-bit registers. One such register is the good old accumulater which is used during arithmetic operations (+, −) and acts as a buffer between the memory and the outside world. Another important register is the program counter which, while your program is running, points to the next memory location that your program must examine for data or instruction.

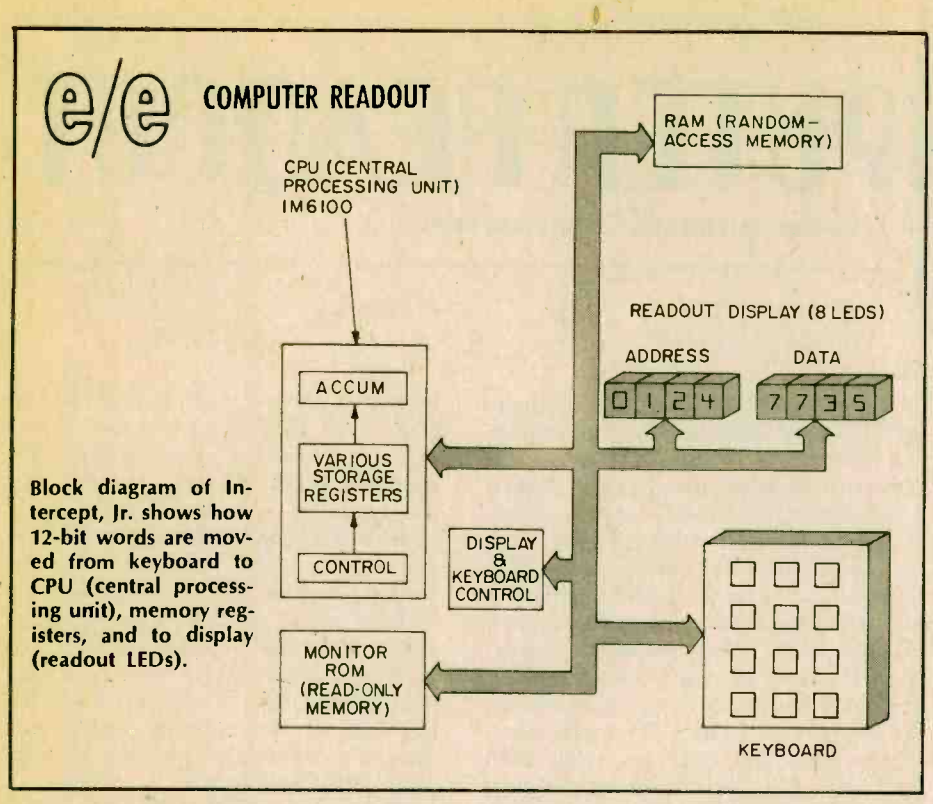
How Big Can It Get? The IM6100 can address 4096 (2^{12}) memory locations, and it can be expanded to address up to 32 thousand locations. In addition, this processor does a fine bookkeeping job as it keeps track of data flowing into its registers from the keyboard or from memory, and of data flowing from registers to the LED display. That bookkeeping is done by a control unit inside the processor which runs in rhythm (computereze; it's clocked) with a quartz-crystal clock mounted in a small metal can on the 10 x 11-inch computer board.

What You Can See. If you pick up Intercept, Jr. and look closer, you will find the keyboard has "touch" switches just like some elevators. The buttons work on the capacitive effect of your body because nothing moves—each button is just a recessed square of plastic. The lower left button is red and marked *Control* because it is important for programming, the lower right one is yellow and is used for special functions, and the remaining ten are white. Each of the ten have three programming commands printed on them, and the commands are in colors that correspond to how they are used. Further, eight of these ten white keys have a number (0 through 7) printed in soft yellow underneath the commands. So there is a wealth of coding on this compact keyboard and once you learn where the commands are and how they work, you can key in a program about as fast as you could read it aloud.

As for the display, the four left-most LEDs show the memory location being used and the four right-most LEDs show what is in that location, which can either be data or an instruction. Octal coding is used so 0007 is 7 base ten, but eight is displayed as 0010, sixteen as 0020, 64 as 0100, etc. It would be more convenient if an ROM (read-only memory) programmed to



Intercept, Jr.'s main components are shown above. In computer language this is Hardware. Software refers to the instructions and to the computer programs. For more information circle number 67 on the Reader Service coupon.



Block diagram of Intercept, Jr. shows how 12-bit words are moved from keyboard to CPU (central processing unit), memory registers, and to display (readout LEDs).

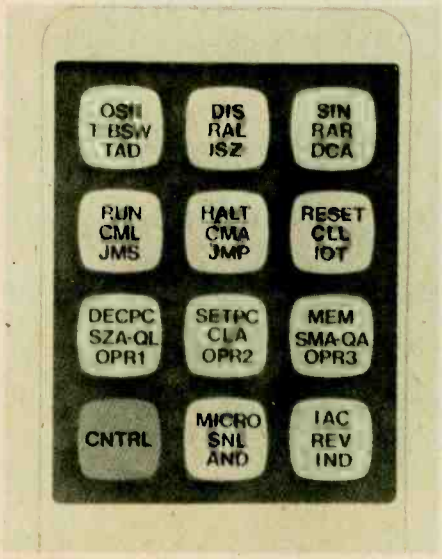
translate octal had been provided, so that base-ten digits could be keyed and displayed, but I don't know of any hobbyist computer that does this.

The Monitor ROM in the lower left corner of the board has a fixed program which accepts the word-like commands you see on the keyboard buttons and converts them into octal-numbered commands which the microprocessor can understand. It's similar to the use of an English-like computer language such as BASIC, which can be typed onto a teletypewriter keyboard which then, through use of an assembler program (included in many slightly-more sophisticated computers than Intercept, Jr.) can command the computer's operations. Monitor ROM's program is analogous to such an assembler program.

Monitor ROM's program recognizes the keyboard buttons you press and turns commands like *Halt*, *JMP*, etc., into the octal code that the microprocessor understands. This saves you the trouble of memorizing lots of octal-coded instructions. You have only to learn to speak to the computer in special, short-worded commands. The program in the Monitor ROM is called a *micro-interpreter*, and as it comes up with the appropriate octal instructions it causes them to be displayed on the four right-most LEDs.

The socket for the user-generated ROM permits an advanced programmer to plug in his own micro-interpreter. The reset switch permits you to set everything (all the software as well as the hardware) back to the beginning conditions when you want to start anew.

More On Expanding It. Behind the four flashlight batteries are three sockets which point up another nice feature of Intercept. Jr. When you can spare the cash, you can order plug-in modules that expand its capabilities. Four modules are available: 6951 is an RAM (random-access memory) which provides 1024 words of extra storage. Two pen-light (AA type) batteries on the module keep data in the RAMs from being lost when you turn off the main computer. 6952 is a programmable ROM for the advancing hobbyist giving 2048 words of permanent storage. The 6953 provide input/output connection for teletype or data transmission. And the 6953 Audio Visual Module has twelve LED indicators, four LED digits, twelve switches, and a small loudspeaker. This module can be used in countless interesting ways not only to simulate interfacing with real industrial process, but also to play interesting games and to even generate computer "music." Your program runs inside Intercept, Jr. and through special commands interacts with the Audio Visual Module to either read the twelve switches (*Off*-0, *On*-1), or to send signals to the LEDs or to the speaker. The twelve switches may be pre-set to simulate for example, the temperature of an engine; the computer would respond by controlling the speed of a cooling fan, with the speed of the fan shown by the rate a dot moves across the twelve LED bulbs while the fan sound could be simulated via the speaker. This module also plays a fine paddle tennis game. The "ball" moves across the twelve LEDs, you hit it at the last LED by pressing a button, and if your timing is right the speaker clicks after which the ball comes back again, but faster and faster—until you miss. Intersil shows you how to write this program in a special booklet for beginners. (Ask for Microprocessor 1A, priced at $7.50.) Intersil's address is given at the end of this column.



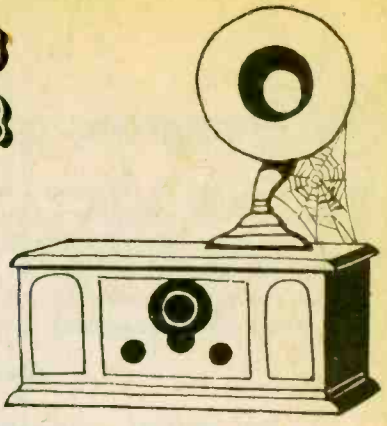
Intercept Jr.'s keyboard. Commands are similar to those on big-league computers commanded by Teletypewriter. Operator can choose any of three separate commands on each touch-button.

Button, Button. Let's get a better idea of what these super keyboard buttons can do. All but one of the buttons CNTRL (control) has three micro-commands displayed on it. Since we cannot go into all the details of each, let's look at some of the more straightforward commands. The buttons are identified here by the first (top) command displayed, unless otherwise noted.

The CNTRL key tells the computer that a command is coming. That command may result from a single key or from several keys in succession. For example, to increment (increase) the contents of the accumulator by 1, you press CNTRL, OPR 1 (meaning operator 1 and printed at the bottom of the DECPC key), then IAC. The SETPC (set program counter) key lets you select the memory location key you want. The MEM key lets you enter data into the memory location you select via the SEAPC key. RUN causes the program to be executed. Of course HALT stops the program and is used

(Continued on page 85)

ANTIQUE RADIO CORNER



by James A. Fred

☐ Hello, out there in Radioland! I hope you have collected a large number of radios this year. I haven't had much of a chance to look for radios since I have been busy around home. My readers have been sending many helpful ideas on restoring radios which I would like to share with you.

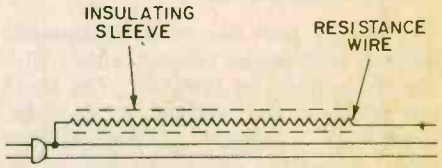
Many collectors are picking up early AC-DC radios in wooden cabinets. These radios were made in the early 1930s in large numbers. In an effort to make lower-priced radios that more people could afford the sets were designed without power transformers. Vacuum tube filaments became known as heaters because they operated on alternating current. In the new sets the heaters were connected in series much like the early strings of Christmas tree lights. If one tube heater burned out all the tube heaters would go out and the set would not play.

Computing the Values. You may wonder how the tube heater voltages added up to equal the line voltage. It was quite simple: new rectifier and audio power output tubes were designed with higher heater voltages, even going as high as 50 volts. They would use either three or four 6.3 volt tubes in series with two 25 volt tubes and use a resistor to use up the remaining voltage. For instance suppose you have a set with three 6.3 and two 25 volt heaters in series, what size resistor would you need? By subtracting the 69 volts needed for the tubes from the 115 volt line voltage we find that we have an excess of 46 volts. If we look in an old tube manual we find that the type of tubes used in most sets were a 6A7, 6K7, 6Q7, 25L6, and 25Z5, and they drew .3 amperes of heater current. By ohms law we find that 46 volts divided by .3 amperes equals 153 ohms. The closest size commercial resistor is 150 ohms.

We also need to know how much power will be wasted in the resistor so we can use a large enough resistor that it will not burn up. By using the power equation we find that watts equal 46 volts times .3 amperes: 13.8 watts. The nearest commercial size would be 15 watts, but it would be better to use a larger resistor like a 25 watt size since it would not get as hot as the 15 watt size. Thus we would need a 150 ohm, 25 watt resistor in series with the 5 tubes specified to connect the whole series string across the line voltage. Each heater would receive the correct voltage to produce the right number of electrons to make the set operate properly.

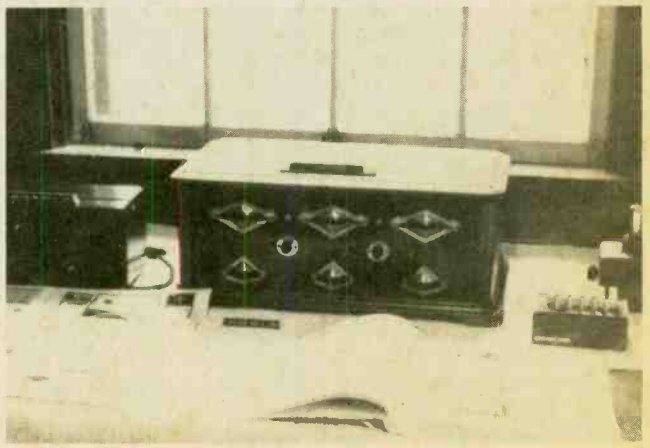
A Little Fraud. There was a drawback to this arrangement. The resistor generated a great deal of heat and this dried out filter capacitors and later when plastic cabinets became popular there was a possibility that a large hole could be melted in the cabinet top. Some radio set makers simply put resistance wire inside a glass bulb and mounted it in a tube base. It could be plugged into a tube socket and if an opaque paint was put inside the glass bulb anyone might think it was an additional tube. Set manfacturers began to count resistance tubes, usually called ballast tubes, in their advertising. Soon less honest manufacturers were putting as many as 3 ballast tubes in a set. Thus a set with 3 ballast tubes and 5 operating tubes became an 8 tube radio. After a few years of this practice the Federal Government made it illegal to include ballast tubes when advertising the tube count in a radio.

It was still necessary to get the heat out of the cabinet, so an engineer designed the resistor line cord. From the drawing you can see two wires connected to the plug plus a resistor. The



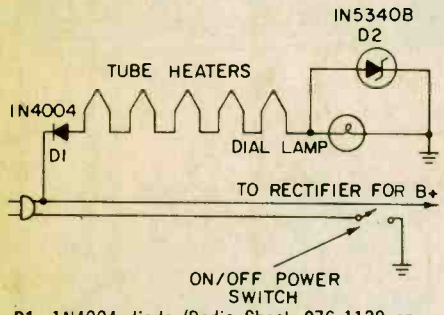
resistor was wound on an asbestos cord and covered with an insulating sleeve. This was combined with the other two wires, covered with a rubber sheath and enclosed in a woven cotton cover. While the set was playing the cord would get very warm since it was now disipating the wasted heat. Even though the line cord was approved by UL many people worried about the warm cord.

A Modern Replacement. Most of the radios found that use this resistor cord need new cords because the heat and age has deteriorated them and they need to be replaced. I recently received a suggestion on how to substitute a silicon diode to lower the line voltage instead of using the series resistor. Here is what William H. Brams of



These old receivers are, from left to right, an Atwater Kent, a Grebe Synchrophase, and a Crosley Pup—all on display at a recent meeting of the Historical Radio Society.

Berkley, CA had to say, and I quote: "Line cords with a built-in resistor for old series string AC-DC sets with three or four 6.3 volt and two 25 volt tubes are not readily available. Using a fixed resistor would be dangerous as about



D1—1N4004 diode (Radio Shack 276-1139 or equiv.)
D2—6-VDC, 5-watt Zener diode (Allied Electronics 5785340 or equiv.)

15 watts of heat has to be dissipated. Instead, replace the resistor with a silicon diode (such as 1N4004). The heating effect of the rectified AC on the heaters is adequate to operate the tubes normally. Add a 6 volt Zener diode across the dial lamp to prevent it burning out due to current surges when the set is turned on. See the circuit diagram for all details."

Correction! We try as hard as we can, but every now and then a stray line will appear in one of our circuit diagrams. Such a mistake appears in the power supply diagram on page 48 of the January-February 1977 issue of ELEMENTARY ELECTRONICS magazine. The line from the bottom of R1 to the – terminal and transistor emitter should be deleted. The wire from R1 actually goes to the junction of the transistor collector, capacitor –, and bridge rectifier –. The correct wiring diagram is shown.

Restoring Plastics. I have discovered an excellent cleaner and polish for plastics. I had a 0 to 100 *u*A meter I was restoring and after cleaning and adjusting the meter movement I installed a new glass in the case. The meter had been laying around for a few years and the case was covered with a dull, gray film of oxide and dirt. The case was molded from a black plastic. I took a paper towel, applied some cleaner and vigorously rubbed the meter case as recommended in the instructions. Carefull application of the cleaner removed all the oxide and dirt from the plastic case. I wiped off all traces of the cleaner and then with a face tissue I used the plastic polish as directed. After the polish dried, a light buffing, produced a sparkling meter case you couldn't tell from a new one. The plastic cleaner and polish is available as catalog number P-2762 from Brookstone, Company, 125 Vose Farm Road, Peterborough, NH 03458.

Some More Notes. If you are a collector who is specializing in Crosley radios you may be interested in a book written by Joe Rice. The book tells about Powel Crosley the man, his radio stations, and the radios he manufactured. The book consists of 94 pages in an 8½ by 11 inch format. It may be obtained by sending $3.00 to Joe Rice, 916 Western Ave., Covington, KY 41011.

A new collectors club has been formed in California. It is called the Southern California Antique Radio Society. Anyone interested should write to Alan Smith, 6712 Bisby Lake Ave., San Diego, CA 92119.

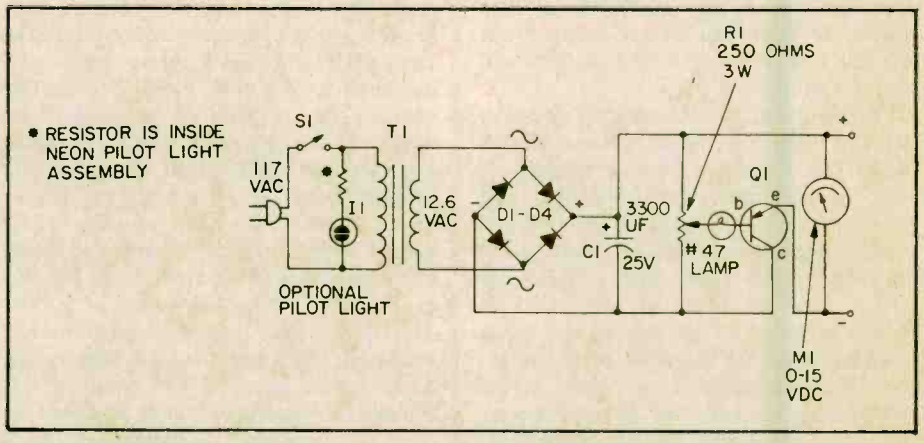
Bypassing Transformers. George Hausske, a collector from Wheaton, IL suggested a way to get the old radios going again when the power transformer is burned out and there is no replacement available. His suggestion is to substitute tubes that are direct replacements except they have 6.3 volt filaments or heaters. It is possible to buy power transformers with 5 volt rectifier windings, 6.3 volt heater windings, and suitable high voltage windings that will physically fit most old radio chassis. In the future you may find the needed transformer and then all you need do is replace the temporary substitute transformer, pull out the substitute tubes and reinstall the proper tubes and transformer.

To give you some examples of how this might work out lets consider a radio that had 24s or 35s, 27s, a 47, and an 80. In place of the 24 you could use a type 36 tube. In place of a 35 you could use a 39/44. In place of the type 27 you could use a 76. A 76 needs a little less negative grid voltage and has a higher amplification factor. This

This may well be one of the first clock radios ever made. It is part of the collection of Frank Heathcote of Logansport.

shouldn't pose any problems. Now the replacement for the 47 is a little harder to find. You can use a 6A4 tube also known as "LA" by some manufacturers. The 6A4 was made to operate on a lower plate voltage than the 47. The 80 can be used with no changes.

Now suppose your radio uses 2A7s 57s, 58s, 55s, and either 47s, or a 2A5 and an 80 rectifier. This tube lineup was very popular in the early 1930s. For the 2A7 tube you can substitute a 6A7 which is identical except for the heater voltage. For the 57 tube you can use either the 77 or the 6C6 tube, and for the 58 you can use either the 78 or the 6D6 tube. The 55 is identical to the type 85 except for the heater rating. For the 2A5 you can use a type 42, or the 41 which is similar except for its power capabilities.



This takes care of most of the common tube substitutions. There are a few more places you may find tubes harder to replace. Let us look at them for a minute. You may find a radio, juke box amplifier, or public address amplifier using 2A3s in the output stages. A 6A3 is a direct replacement if you have 6.3 volts available.

You may find a radio using a 2B7, if so replace it with a 6B7. A 2E5 magic eye tube can be replaced with either a 6E5 or a 6AB5/6N5. If you come across a radio or an amplifier using a

53 you can replace it with a 6A6. If you need a 55 or 85 and cannot find one you may be able to replace it with a 6C7 tube.

If you cannot find 80 type rectifier tubes you may be able to find 5Z3s or maybe you could use an 83 mercury vapor rectifier. The ionization of the mercury may produce background noise in a radio receiver. The 5Z3 and the 83 both require 5 volts at 3 amperes for the filaments.

Your author is trying to restore this ancient volt-ohm meter made by the Radio City Products Company. If any reader has the wiring diagram for this model 445 multi-tester please send a copy to Jim Fred in care of this magazine.

Finding Schematics. Many radio collectors are having problems finding circuit diagrams for the radios they are restoring. There were books of circuit diagrams published starting about 1930. The two most complete sets are Gernsback's *Official Radio Service Manuals*, and Rider's *Pereptual Trouble Shooters Manuals*. Gernsback only published 7 volumes from 1930 to 1937 while Rider published radio manuals from 1930 to 1953. Gernsback manuals are nearly impossible to find while the Rider's manuals keep turning up all the time.

There are several persons selling copies of circuit diagrams from these books. They charge from 25¢ per page to $3.50 for all the information available for each model. The information available for each set runs from a one page schematic to as many as 19 pages for a Scott radio. Some big city libraries have complete sets of Rider's manuals. You may also find them in old radio repair shops in your city. There is also a chance that you may find one or more books in an antique store or used book store.

It isn't too early to start making plans to attend the annual Antique Wireless Association annual conference. The AWA has received an invitation to hold the 1977 Conference at the Ford Museum in Dearborn, Michigan. Final details will be made at the annual Board Meeting. Tentative date: 2nd weekend in October. As soon as I receive definite word as to the dates I will let you know. ■

SAVE YOUR VOLTMETER

And neaten up your bench area too, with these coiled leads.

☐ To be truly useful your bench volt-ohmeter usually comes equipped with two pretty long test leads—up to three or so feet. But most of the time you're using that black and red pair of leads to measure some resistance or voltages right under your nose, and only a few inches or so from the meter.

What can you do about those long messy leads which tend to tangle and curl around things, including the meter itself? How can you keep from constantly trying to untangle the leads, with the attendant danger of pulling the meter off the bench onto the floor?

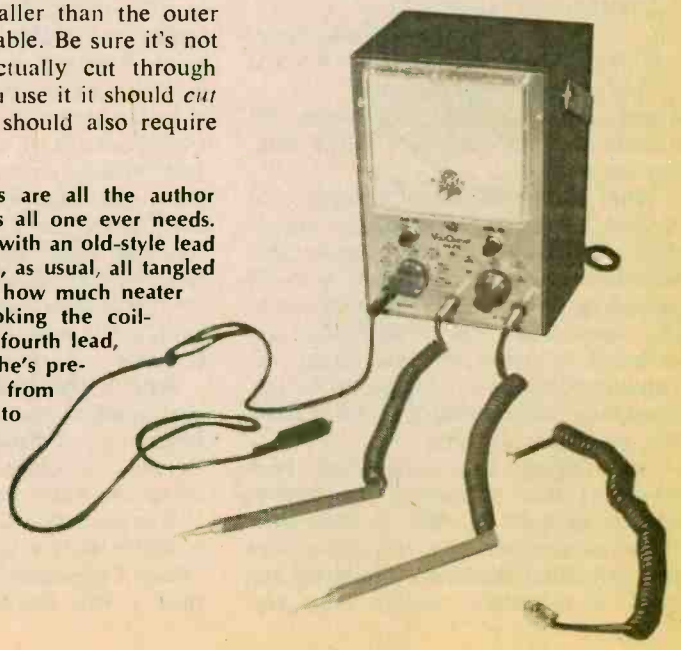
Make Coil-Cord Leads. Here's a good answer to this problem, sent in by Harry Miller of Sarasota, Florida. Substitute a coil-cord lead pair, made for flashgun-and-camera use, for the separate cables which came with your test meter. You'll have to remove the camera and/or flashgun fitting from the ends of the coiled cable first. Then cut off the short plug-in tips which go into the meter jacks. Finally, cut the two red and black cables about eight inches below the ends of the test probes.

Now comes the only tricky part of this job. You have to strip the black plastic outer covering of the coiled cable away from the two inner wires. I tried several ways to do this, and the best one is as follows. Use a pair of adjustable wire strippers, and set the size of the stripping hole, very carefully, just a bit smaller than the outer size of the plastic cable. Be sure it's not small enough to actually cut through the cable. When you use it it should *cut into* the cable, but should also require you to exert considerable force to tear the final bit of plastic off.

Wire These Connections. After stripping about two inches of the outer covering back from the inner wires, solder the black inner wire to the black cable (8-inches) coming from the black test probe. Similarly connect the white inner wire to the red cable coming from the red test probe. Wrap both joints carefully and securely with black plastic tape. Now tape them both together and double them over against the main cable to keep the strain away from the small inner wires.

Make the connections at the meter end of the cable similarly. You'll find you can unscrew the red and black plastic bodies of the plugs from the metal ends. Unsolder the short pieces (red and black leads) remaining and replace them with the white and black inner wires of the new cable. Tape for security. Finally, secure your meter with heavy masking tape or by other means so it won't jump off the bench when you extend the coiled cord to read something 2½ to three feet from the meter. That's it.

The Deluxe Version. If you want to do a really deluxe job, use two separate camera-to-flashgun coil-cords. Parallel the inner wires of each pair. It'll cost more, and take up a bit more space, but they'll last a lot longer. ■



Two coil-cord leads are all the author made because that's all one ever needs. Here they're shown with an old-style lead on the left, which is, as usual, all tangled and twisted. Notice how much neater and professional-looking the coil-cord leads are. The fourth lead, at the right, is one he's preparing to convert from photographic use to the new function of voltmeter lead.

Radio Moscow's Mystery Noisemaker

Powerful radio signals are being beamed at us from the USSR, and no one knows why

by Don Jensen

☐ QRM is radio jargon for noise, specifically, man-made noise. QRM is a royal pain in the receiver for SWLs (shortwave listeners). Interference, of course, makes it tough, sometimes impossible, to tune in the SW signals you want to hear. SWLs hate QRM!

But let's face it, the typical American couldn't care less. He doesn't know QRM from raspberry yogurt. Normally the general public has no interest at all in the fact that shortwave broadcasts are being wiped out by all sorts of man-made interference sources.

Therefore, it was startling to find recent headlines like these in the daily newspapers:

RADIO SIGNAL, APPARENTLY SOVIET, IS SAID TO DISRUPT COMMUNICATIONS
—New York *Times*

RUSS BEAM MYSTERY RADIO SIGNAL—Chicago *Tribune*

There it was, in black and white, the unusual case of shortwave QRM making the news.

What It Sounds Like. According to United Press International, the signals were "a mysterious radio noise that sounds like machine-gun fire, possibly caused by a secret Soviet operation near the Black Sea." The Washington *Star* called it "a powerful radio signal, apparently coming from the Soviet Union, disrupting communications throughout the world for months."

But DXers, of course, had been aware of that maddening interference source for quite a while, at least since early last summer. Not only did it wipe out individual shortwave broadcast stations, it sometimes zapped huge segments of a shortwave band!

The machine-gun-like noise consists of pulses, heard about ten times each second. The interference is a very wide band signal that sweeps a broad range of frequencies, estimated at between 500 and 1,000 kHz. These large chunks of frequencies blocked by the QRM can be found anywhere in the shortwave spectrum between about 5 and 18 MHz, varying depending on the time of day and propagation conditions. Usually the signal is spotted close to the maximum usable frequency (MUF) over a North Atlantic path.

Complaints Unanswered. Radio hams in Sweden, Norway, West Germany, England, Australia and the United States have reported this interference to the International Amateur Radio Union, according to Colin Thomas, Leeds, England, worldwide coordinator of interference reports.

On August 25, 1976, the Federal Communications Commission filed its first formal protest with the Ministry of Posts and Telecommunications in Moscow. In the next two months, Washington sent three more complaints to the Soviets. The Russians replied to none of them. The Russians seem to have simply buttoned up their lips, refusing to even acknowledge the complaints.

What's the Point? If there is little real question that the interfering signal originates in Russia, there are many unanswered questions about just what these transmissions are.

It is suggested that behind the scenes, military leaders in the North Atlantic Treaty Organization (NATO) are more than a little interested in the problem and it is possible that much of what is publicly known about the mystery transmissions has been leaked by military sources.

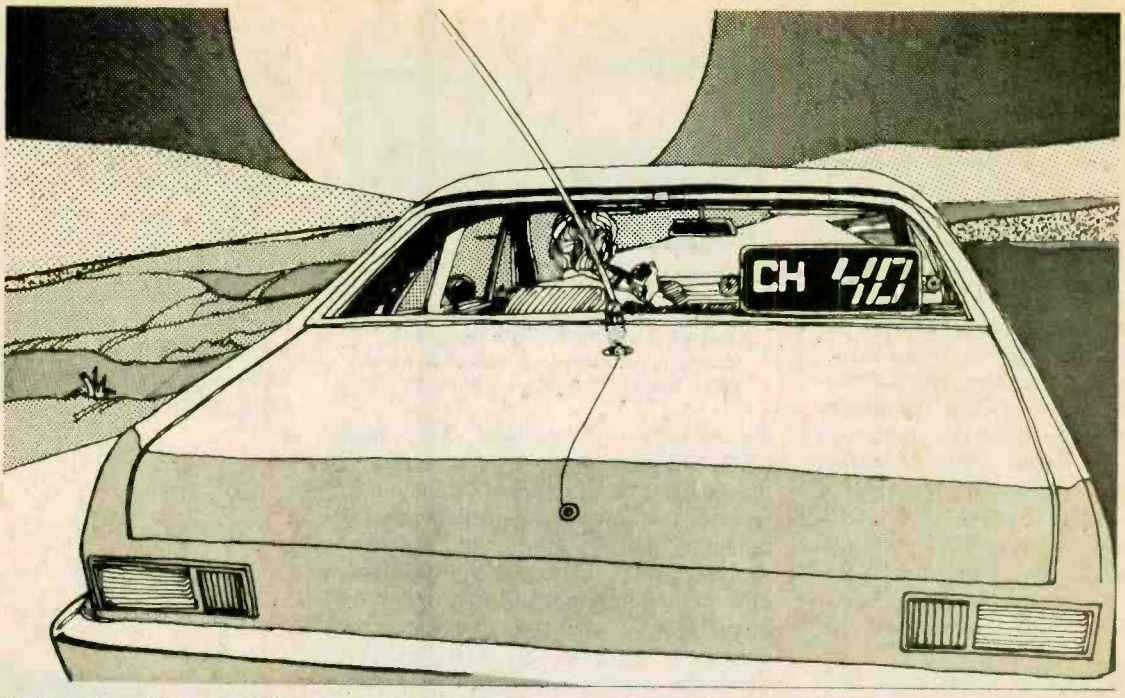
Extent of the Disruption. The signals have an exceptionally long reach. King T. Hall, chief watch officer at the Federal Communication Commission's monitoring branch, reports the FCC has been getting almost daily complaints since the first of July. Those complaints have come from every class of shortwave radio user. The noise has disrupted air to ground communications, maritime radio signals and overseas fixed radio services, known to SWLs as point-to-point utility transmissions.

On a Canadian Broadcasting Corporation program, John Hutchinson, communications director for the Canadian Steamship Lines in Montreal, said that maritime contacts in Rome had quoted Italian newspapers as saying the Soviet intent may have been to jam NATO military communications during naval maneuvers off Scandinavia.

Another possibility has been suggested by Dr. Milton M. Zaret, a controversial researcher who, since 1959, has been probing for possible harmful effects of microwave radiation on human beings. Dr. Zaret also has expressed concern about radiation in the radio frequency range. That there could be some mind-bending aspects to the Soviet shortwave experiments is his scary suggestion.

Quoted by author Paul Bordeur in a recent *New Yorker* magazine article, Dr. Zaret says, "This broadband signal is being pulsed at an on-off rate of ten times per second. When I analyzed the Soviet literature for Project Pandora (a government study of the biological effects on employees of the U.S. Embassy in Moscow of a bombardment of microwave radiation, caused by a presumed Soviet "bugging" operation) back in the 1960's, it was very clear that such an encoding impressed onto carrier wavelengths could have a central nervous system effect."

"In the case of the present signal, I would not be surprised to find that the on-off code at a repetition rate of ten per second could have an effect on the brain's inherent alpha rhythm. So whatever purpose the Russians may have for continuing this transmission, the potential effect on human beings from altering their alpha rhythm cannot be discounted." So it is a little unnerving to find that hints from western European intelligence sources suggest a power for the transmitters of these signals of 2,000,000 watts! ■



CITIZENS BAND GOES DIGITAL

With the new equipment, the numbers are up front, bright and clear.

by Jorma Hyypia

Digital readout equipment was associated only with such exotic activities as space flights and ultra-sophisticated scientific research a short decade ago. But during the past few years the devices have become increasingly common consumer items, especially in the form of clocks, watches and some hi-fi equipment. Now even Citizens Band radio is going the digital route in a big way!

If you have shopped for new CB equipment during the past few months, you know that many transceivers already sport digital style channel selectors. That's only the beginning. Equipment manufacturers are discovering other ways to play the numbers game with CBers who want to upgrade their rigs for greater operating convenience, for more efficient and reliable communications, or simply to hold claim on being true avant-garde afficionados by sporting the latest in CB status symbols.

What Channel? We'd guess that a gadget like CHAN-L-ERT made by C. B. King Products could hit the sales jackpot for two reasons: the device provides a solution to a truly practical need, and the suggested retail price is a modest $39.95. A display unit measuring 3-in. x 8-in. x 3-in. mounts on the rear window of your car to provide an illuminated 3-in.-high digital display advertising the channel to which your mobile unit is tuned. As you dial up and down the CB band, the digital display changes automatically. Thus anyone following you, who wishes to make contact, doesn't have to hunt for you through the 40 channels, but can give you a shout on the particular channel you are monitoring.

The second part of CHAN-L-ERT is a control head measuring less than four inches in its longest dimension. It mounts under the car dash to tell *you* what channel is being used. No longer need you risk running off the road while peering at tiny channel numbers on the transceiver dial. The system operates on the car's 12 VDC power supply, the display units mount quickly with vacuum cups, and only two wires are used to make connections.

Digital Frequency Counters. If you are more interested in checking and monitoring the operational accuracy of your CB rig than in advertising the channel you are using, you need a digital frequency counter that does more than merely flash channel numbers. It stands to reason that a CBer

CIRCLE 72 ON READER SERVICE COUPON

The Simpson Model 461 multimeter has .3-inch LEDs in a 3½-digit display and features include automatic polarity and zeroing. $130.00.

CIRCLE 66 ON READER SERVICE COUPON

Hickok's Model 388 CB In-Line Tester provides digital readout of SWR, power, percent modulation, and frequency. The 388 sells for $349.00.

CB GOES DIGITAL

equipped with a sophisticated digital counter will win a lot more arguments about whose rig is on or off frequency when modulation is on the ragged side. If you dig the digital frequency scene, shop around carefully for just the right features and price for you because a real spate of number-boxes has hit the market during the past few months.

For starters, consider B&K-Precision's Model 1827 6-digit frequency counter that retails for $120. Although it's not much larger than a pocket calculator, the 1827 offers guaranteed operation to 30 MHz with 1Hz resolution. An optional signal tap permits continual monitoring of the output frequency of a 23- or 40-channel CB transceiver without affecting normal set operation.

The 1827 provides a minimum of 8 hours normal use from one set of AA batteries or before need to re-charge optional Ni-Cad batteries. The counter can also be tapped into an external 6.7 to 9.7 VDC or a 110 VAC power supply. With an external power supply the display is continuous. When batteries are used, a battery-saver feature shuts off the LED display after 15 seconds of operation, until a "Display" button is touched to bring the readout to life for another 15 seconds. The decimal point remains visible at all times to show that the counter is operational.

The visual display of the 1827 features six .3-inch high LED digits with overflow indicator (flashing indicates range is exceeded), an automatically positioned decimal point, and LED kHz and MHz indicators. The guaranteed frequency range is 100 Hz to 30 MHz, with 50 MHz typical. A function switch selects kHz or AUTO display reading. The one-pound unit measures 1.75-in. x 3.75-in. x 6.6-in.

Digital Sport Systems' Model 5000B Digital Readout Frequency Counter can be used in your car, on 8-20 VDC; or with your base CB rig or on the test bench with an optional AC power supply adapter. It provides .3-in. high LED, 7-digit readout with accuracy to the nearest 10 Hz. Features include a remote pickup head which makes mounting easy by eliminating the need to hide bulky RF cables and connectors. Optional equipment includes a remote pickup head for extending the frequency range to 250 MHz, well beyond the normal 10 Hz to 35 MHz range. Sensitivity is 65 MV, and the total current draw is less than 1 ampere at 12 volts. Size: 4¾-in. x 4¾-in. x 1⅞-in. Price: $139.95.

CIRCLE 47 ON READER SERVICE COUPON

Teknik offers the Model FC-106C with 6-digit display and memory for $149.98. A more sensitive version, the Model FC-106CB, features a built-in NiCad charger and sells for $179.98.

CIRCLE 55 ON READER SERVICE COUPON

Wawasee Electronics' JB-2000SW has a 6-digit, 3 kHz to 50 MHz frequency counter, peak-reading wattmeter, and SWR bridge, and sells for $162.95.

The EICO 700 Digital Frequency Counter (EICO Electronics Instrument Co.) retails for $99.95 fully assembled. It indicates frequencies from 5 Hz to 27 MHz by means of a .5-inch high LED, 5-digit display. Either a kHz or MHz reading can be had at the flick of a switch, and only the decimal point remains lit, to conserve power, when the unit is in standby mode. The EICO 700 operates on 8-14 VDC at 1.2 amps, and off 117 VAC when used with a regulated power supply having a minimum 1.5 amp rating. Measures 2⅜-in. x 5-5/16-in. x 6⅛-in. and weighs 1.6 lbs.

You'll have to pay somewhat more for the Model FC-40 frequency counter offered by Palomar Electronics. The $199.95 retail tab buys a 6-digit LED display unit with a frequency range of 1000 Hz to 40 MHz. Accuracy is rated at plus or minus 100 Hz. A front panel connector makes bench-testing applications convenient. The FC-40 operates off 117 VAC only, but AC/DC model is also said to be in the works. Size: 2.5-in. x 8.5-in. x 9.5-in.

For a slightly lighter squeeze on the family budget, consider the Model FC-1 digital frequency counter by the Siltronix Division of Cubic Corp. This $169.95 unit offers one-half inch high LED numbers and a two-crystal controlled time-based switch. It indicates the frequency of any signal in the 5 kHz to 40 MHz range that has a sensitivity of 50 microvolts or more.

On the other hand, if budget-watching is a minor concern, you might like to put out for an instrument that can do more than just count frequencies. For example, the Hickok Model 388 CB In-Line Tester, costing $349, provides digital readout of SWR, power. percent modulation and frequency. The 7-digit frequency counter is accurate to 10 ppm with 10 Hz resolution. The 3-digit power output readout, in two ranges, offers resolution to 0.1 watt. Continuous 4-digit SWR readout is accurate regardless of a changing power level, and 3-digit percent of modulation readings go from 0 percent to 100 percent in 1 percent increments. No Cal/Set is required for either SWR or percent modulation functions.

CIRCLE 75 ON READER SERVICE COUPON

B&K-Precision's Model 1827 6-digit frequency counter reads to 30 MHz with high resolution. $120.00.

If all you need is a frequency counter, Hickok's Model 380 counter ($269) with a range from 1 Hz to 80 MHz, or Model 385 ($499) with a range from 1 Hz to 512 MHz might fill the bill. Other models are priced as high as $699, but there's also a Model 38 for $279 that provides 6-digit frequency counting *plus* power and SWR.

Simpson Electric's Model 710 compact 60 MHz digital frequency counter will set you back only $150. This job

CIRCLE 69 ON READER SERVICE COUPON

EICO's Model 700 features .5-inch LEDs in a 5-digit display and measures from 5 Hz to 27 MHz. $99.95.

CIRCLE 73 ON READER SERVICE COUPON

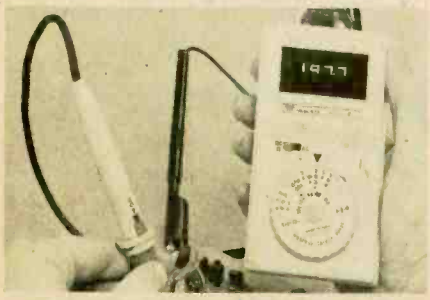
The Palomar Model FC-40 has a six-digit display and covers a frequency range of 1000 Hz to 40 MHz. $199.00.

offers a 6-digit, 0.35-inch LED readout with overrange indicator; both Hz and MHz ranges, accuracy of ± 1 count (± time base accuracy), resolution to 1 Hz. There's a switchable low-pass filter to eliminate input noise that could cause erroneous readings. The price includes a 120 VAC adapter, but you'll have to pay extra for such options as RF connecting cables, dummy load, 12 VDC auto cigarette lighter adapter, carrying case, and probes. The very compact unit measures only 2-in. x 5.6-in. x 4.6-in.

Teknik offers several digital frequency counters, beginning at $149.98 for Model FC-106C which includes a "memory" switch used to store a displayed frequency for as long as you like. The 6-digit display covers a frequency range from 100 Hz to 32 MHz. It has 100 Hz resolution, 0.0001 percent accuracy, and operates on either 12 VDC or 110 VAC.

Model FC-106CB has pretty much the same specs but offers higher sensitivity and comes with a built-in battery charger for 8 NiCad batteries that can be used when you don't have a 12 VDC or 110 VAC power source handy. This model costs $179.98.

The next step up the Teknik price scale brings you Model FC-106BA ($189.98) which boasts a built-in 12- or 24-hour digital *clock* as well as frequency counter. Just flip a front panel switch to activate either the frequency counter or clock readout consisting of a 6-digit display. The clock is crystal controlled for "exceptional accuracy," and frequencies can be read from 100 Hz to 32 MHz. Power requirements: 12 VDC or 110 VAC.

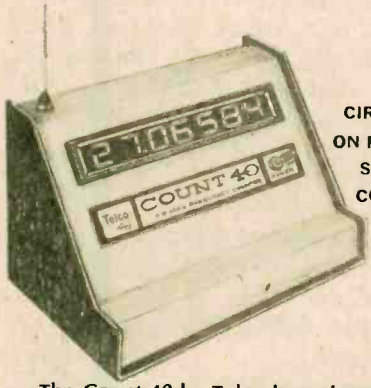


CIRCLE 60 ON READER SERVICE COUPON

Triplett's Model 3000 hand-sized 3½-digit DVOM (digital volt-ohmmeter) offers five functions in 22 ranges. Test leads, insulated alligator clips, rechargeable NiCad batteries, and an AC adptor/charger are included in the Model 3000's price of $140.00.

Teknik's top-of-the-line unit, Model FC-106BB priced at $219.98, combines versatility equal to that of the FC-106CB with the added convenience of a crystal timebase clock. Power this with eight AA NiCad batteries, 12 VDC or 110 VAC.

One of the least expensive frequency counters we've spotted is The Count-40 by Telco Products; it's retail priced at $99. The half-inch high, 7-digit display is seen through a polarizing lens for easy viewing under all lighting conditions, according to the manufacturer. Crystal control provides accuracy up to 40 MHz, and the 1 MV sensitivity provides pick-up and display of low power transmissions without need of coax connections. The C-40 operates on 12 VDC, but also comes with a 117 VAC adapter. Measures 7½-in. x 4½-in. x 5-in.



CIRCLE 62 ON READER SERVICE COUPON

The Count-40 by Telco has a large, 7-digit display, 1-MV sensitivity, and reads to 40 MHz. Priced at $99.00.

Wawasee Electronics offers a multipurpose instrument consisting of a 6-digit, 3 kHz to 50 MHz frequency counter (100 Hz accuracy), a true peak-reading wattmeter (3 scales: 0-20, 0-200, 0-2000 watts), and an SWR bridge. The JB-2000SW-Counter is priced at $162.95.

A more elaborate instrument ($279.95) offers the same functions plus a monitor scope that measures RF output and shows modulation patterns. On the other hand, if you are not turned on by frequency counts and scope patterns you might opt for the Model JB-2000SW-Clock ($89.95) which combines a wattmeter and SWR bridge with a 4-digit clock featuring an AM/PM indicator and pulsing dots between the minute and hour digits to indicate seconds. The clock operates on 117 VAC and may be wired for either 12 or 24 hour time.

CIRCLE 50 ON READER SERVICE COUPON

The Model FC-1 digital frequency counter by Siltronix features half-inch LEDs and a frequency range of 5 kHz to 40 MHz. Priced at $169.95.

Digital Multimeters. All the equipment discussed so far is used to monitor the performance of CB and other electronic equipment. When something is amiss, you will of course whip out your digital VOM to track down the cause of the problem.

What? You don't have a digital multimeter? Small problem. There are plenty of models to choose from. For example, Triplett Corporation's hand-sized 3½ digit Model 3000 DVOM (Digital Volt-Ohmmeter) is battery operated for handy usage anywhere. A single selector switch provides five functions and 22 ranges. The high-intensity LED display has blinking overrange indication, auto-zeroing and auto-polarity indication. All decimal points are simultaneously displayed when battery power runs low. The $140 price includes 48-inch long test leads, insulated alligator clips, four rechargeable NiCad batteries, and an AC adapter/charger.

Simpson's Model 461 digital multimeter costs $130 and comes complete with NiCad batteries, AC charger/adapter, test leads and manual. Features include automatic polarity and zeroing, 3½ digit .3-inch LED display, recessed insulated jacks on test leads and pushbutton selection of ranges and functions. Ranges: 5 DC voltage ranges to 1 KV; 5 AC voltage ranges to 600 V; 6 resistance ranges to 20 megohms; 5 DC current ranges to 2 A; 5 AC current ranges to 2 A.

Simpson's Model 465A Autoranging DMM, which costs $295, is powered by 120/240 VAC. The similar 465B model, priced at $332, can also be powered by batteries. You get automatic range selection, range "Hold" for fast repeated tests, floating decimal and zero blanking.

Hickok's Model 334 digital multimeter ($234) also provides 3½ digit display, flashing nondeceptive out-of-range indication, auto-polarity and automatic decimal point. There are 5 ranges of AC and DC voltage and current plus 6 resistance ranges. ■

CB XCVR CHECKOUT

- COURIER CENTURION PLL 40
- MOTOROLA 4000 (MOCAT 40)
- SPARKOMATIC CB-1140
- STANDARD HORIZON 29A

☐ ELEMENTARY ELECTRONICS has been able to obtain more of the new 40-channel CB transceivers for review, and presents the test reports here. These units are not prototypes, but are "stock standard," the same as the transceivers that you can buy over the counter. If you don't find the particular unit you are interested in reported on here, check the newsstands for the 1977 edition of the CB BUYERS GUIDE.

• COURIER CENTURION PLL 40

$569.95 (Fanon/Courier Corp.)

General Description: A 40-channel AM/SSB transceiver for mobile, PA, fixed operation. Fine tuning ±1.5 kHz provided. Power supply 12 to 13.8 VDC with positive or negative ground and 120 VAC. Features digital clock. Overall dimensions are 7-in. h x 15-9/16-in. w x 12¼-in. d. Front panel controls and switches for Channel Selector, Volume, Squelch, Clarifier, RF Gain, SWR Meter Calibrate, Power, AM/LSB/USB, PA/CB, Noise Blanker, SWR Meter Calibrate. Standard accessories are microphone, DC power cable, AC power cable.

Receiver Section Test:

Input Sensitivity	0.5 μV
Adjacent Channel Rejection	59 dB
AGC Action	5 dB
SSB Opposite Sideband Rejection	60 dB
Input Level for S9	110 μV

Transmitter Section Test:

AM RF Output	3.7 watts
SSB RF Output	15 watts PEP
Modulation to 85%	yes
Relative Sensitivity for 85% Modulation	—31 dB
Modulation Limited to 100%	yes

Editorial Remarks: The Courier Centurion PLL 40 has a relative reading S-meter, double conversion receiver, external and PA speaker jacks, front panel headphone jack, SWR meter, and S/RF output meter. The digital clock can turn receiver on at preset time. ■

• MOTOROLA 4000 (MOCAT 40)

$149.95 (Motorola, Inc).

General Description: A 40-channel AM transceiver for mobile, PA operation. Power supply 12 to 13.8 VDC with negative or positive ground. Overall dimensions are 2½-in. h x 7¼-in. w x 9½-in. d. Front panel controls and switch for Channel Selector, Volume, Squelch, PA/CB. Standard accessories are microphone, mobile mount, DC power cable.

Receiver Section Test:

Input Sensitivity	0.35 μV
Adjacent Channel Rejection	50 dB
AGC Action	4 dB
Input Level for S9	6,000 μV

Transmitter Section Test:

RF Output	3.5 watts
Modulation to 85%	yes
Relative Sensitivity for 85% Modulation	—20 dB
Modulation Limited to 100%	no

Editorial Remarks: The Motorola 4000 has a relative reading S-meter, double conversion receiver, external and PA speaker jacks, and S/RF meter. Internal speaker mounted on top facing driver. ■

• SPARKOMATIC CB-1140

$129.95 (Sparkomatic Corp.)

General Description: A 40-channel AM transceiver for mobile, PA operation. Power supply 12 to 13.8 VDC with negative or positive ground. Overall dimensions are 2-in. h x 5½-in. w x 7-in. d. Front panel controls and switches for Channel Selector, Volume, Squelch, ANL, PA/CB. Standard accessories are microphone, mobile mount, DC power cable.

Receiver Section Test:

Input Sensitivity	0.3 μV
Adjacent Channel Rejection	55 dB
AGC Action	7 dB
Input Level for S9	35 μV

Transmitter Section Test:

RF Output	3.9 watts
Modulation to 85%	yes
Relative Sensitivity for 85% Modulation	—18 dB
Modulation Limited to 100%	yes

Editorial Remarks: The Sparkomatic CB-1140 has a relative reading S-meter, double conversion receiver, external and PA speaker jacks, and S/RF output meter. ■

• STANDARD HORIZON 29A

$229.95 (Standard Communications)

General Description: A 40-channel AM transceiver for mobile, PA operation. Fine tuning ± 1.5 kHz is provided. Power supply 12 to 13.8 VDC with negative or positive ground. Overall dimensions are 2.9-in. h x 6.9-in. w x 8.6-in. d. Front panel controls and switches for Channel Selector, Volume, Squelch, RF Gain, Fine Tuning, CB/PA (Hail), Noise Blanker, ANL. Standard accessories are microphone, mobile mount, DC power cable.

Receiver Section Test:

Input Sensitivity	0.6 μV
Adjacent Channel Rejection	63 dB
AGC Action	10 dB
Input Level for S9	95 μV

Transmitter Section Test:

RF Output	3.8 watts
Modulation to 85%	yes
Relative Sensitivity for 85% Modulation	—18 dB

Editorial Remarks: The Standard Horizon 29A has an S-meter that reads 5 dB per S-unit, a double conversion receiver, jacks for external and PA speakers (the PA jack and switching is labeled "hailer"), a control built into the microphone that adjusts the modulation level from almost full off to maximum, and S/RF output meter. ■

e/e checks out the...

JERROLD TRC-82 ALL-CHANNEL TV REMOTE CONTROL

Electronic varactor tuning replaces your old clunker for trouble-free, programmable channel selection.

☐ "Why didn't they invent it sooner?" was our reaction after using it.

You too will probably ask Jerrold Electronics that question if you add this All-Channel TV Remote Control to your TV set. Not only will you appreciate the convenience of *fast* (it's *instantaneous!*), remote, channel switching—and smooth fine-tuning for maximum picture sharpness, but you may well be delighted to discover a significant improvement of image quality across the VHF and UHF bands if you live in a fringe area where your reception has been less than perfect.

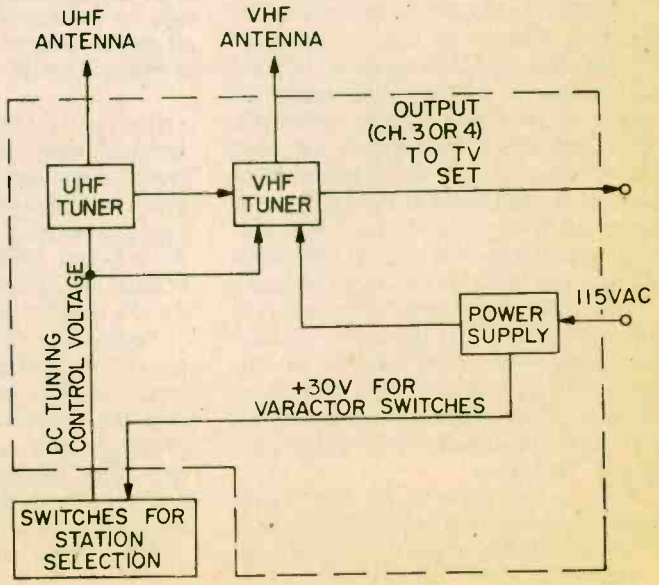
Do some of your TV channels now appear excessively contrasty while others always look washed out? Do you have to fiddle with the contrast control every time you change channels? If so, the signal amplification (6 dB minimum) provided by this control unit may be just the answer to your problem, as it was in our installation. For the first time, ELEMENTARY ELECTRONICS' test setup enjoy's excellent and uniform contrast all across the VHF band. What's more, it now receives several UHF channels—still snowy, but watchable—that had formerly been total losses.

This improvement of image quality through signal amplification is a bonus because the primary purpose of this TV control unit is to provide the convenience of *remote* control. It's especially useful for elderly, infirm, or bedridden people. But even the healthiest person tires of running across the room to switch channels while peering at hard-to-see channel numbers. You can turn your set on or off from your easy chair, switch instantly from one channel to any other channel without click-clicking your way through several intermediate channels, and fine tune the image while observing it from your usual viewing position.

Tuner Lasts Longer. Instant channel selection is achieved without the use of motors or any other moving parts, other than the channel selector switches. The tuner inside your TV set never moves—which means it will last almost indefinitely. It's all done by means of a *varactor* (variable-capacitance diode) tuning circuit that changes the frequency when its control voltage is changed.

Varactor Tuning and How It Works. A few years ago some smart engineers developed a new device called, variously, varactor, varactor diode, voltage-controlled capacitor, or voltage-variable capacitor. They all mean the same thing—a special kind of capacitor whose effective capacitance can be changed by applying a changed DC voltage across it.

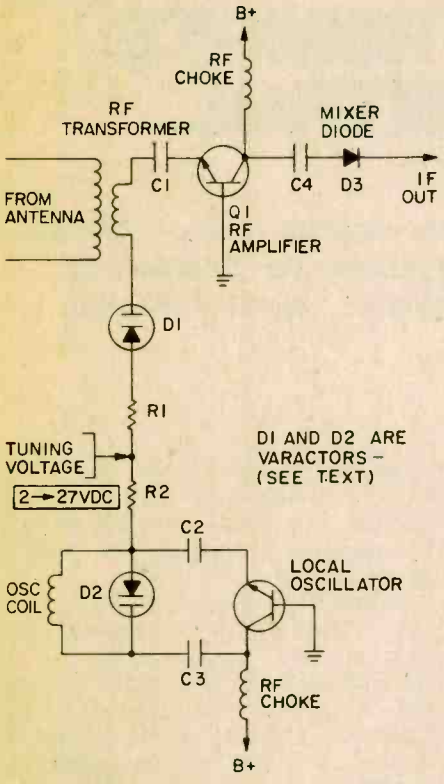
In the UHF tuner of the Jerrold Remote TV Control the DC voltage used to control the Varactors which tune in the UHF stations vary, according to the desired stations, between about 2 and 27 VDC. The DC control voltage is applied to several varactors, including the RF amplifier and the local oscillator. Together, you'll recall, the local oscillator's frequency and the incoming RF signal create the IF (intermediate frequency) which is then amplified through several IF amplifier stages until it's strong enough. It's then rectified into a video signal which is applied to the control grid of the picture tube



Simplified block diagram of Remote TV Control. The control box, lower left, has the selector switches which choose the desired station by sending various DC voltages to the varactors in the UHF (or the VHF) tuner.

along with the sweep sychronizing signals.

In the diagram shown here, which is a highly simplified version of a varactor front end, only two varactors, D1 and



D2, are employed, for the sake of clarity. The tuning voltage is applied by the various pushbutton switches in the Jerrold Remote Control, and the desired stations are tuned in as quickly as you can push the buttons—no channel-selector switching through six or seven positions any more.

Equally remarkable is the ease of installation. There's no need to open the TV set and risk electrocution because the system is quickly and easily attached to your set's antenna terminals. After installation you simply set your TV set channel selector to either channel 3 or 4, whichever is unused in your area, and leave it in that position permanently. All station signals will thereafter be fed into this one tuner channel.

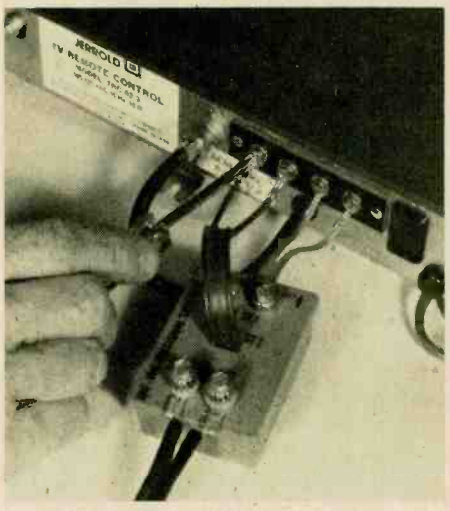
When you purchase your remote control unit be sure that the model number terminates with the number of the channel that is unused in your area. If channel 3 is unused, obtain Model TRC-82-3. If channel 4 is unused, get Model TRC-82-4.

The system consists of two major units: a *control* unit having 12 channel-selector switches, a tuning control, and a 3-position OFF/VHF/UHF switch; there's also a *converter* unit which attaches to the rear panel of the TV set, or is placed in some convenient location near the set's antenna terminals.

Installing It. First we disconnected the TV antenna lead-in from the set's antenna terminals. Because we had a VHF/UHF splitter at the end of the antenna lead-in, we moved it along with the lead-in and connected to the clearly marked VHF and UHF terminals on the rear of the converter unit.

Notice the short coax jumper cable that emerges from an opening just below the converter antenna terminal strip. This was left connected to the nearby *Input VHF Only* because we had a 300-ohm antenna system. If yours is a 75-ohm system, you'd disconnect the jumper from the input end and connect your 75-ohm lead-in cable in its place.

The converter power cord was plugged into a regular AC wall receptacle, and the TV power cord went into a receptacle on the rear of the con-



If your set has external UHF/VHF splitter at its antenna terminals it is moved to the input of the Remote Control converter. TV set gets its power from the AC receptacle at right of Control.

verter, just to the right of the antenna terminal strip. Incidentally, the installation directions that came with our unit state that the converter reaches proper operating temperature in about 30 minutes. Don't let that scare you because it obviously is a misprint; it should read 30 *seconds*.

You'll note two more sockets at the left end of the converter panel. A short length of coax cable was used to connect the "Output to TV" socket to a small cylindrical transformer having two short pigtails terminating in lugs that are attached to the VHF antenna terminals of the TV set.

The second socket accepts the 25-foot cable leading to the control unit next to an easy chair. We ran this cable along base boards, tucking it under carpet edges where feasible, to keep it out of sight as much as possible. If the cable isn't long enough for your setup buy a 25-foot extension cord for $8.95. Any extra cable should be formed into a coil at the control end of the line so that it can be uncoiled should you wish to move the control box to some other room location on occasion.

The converter unit includes hardware for easy mounting onto the rear panel of the TV set. *Caution*: do not allow the converter to obstruct any ventilation holes.

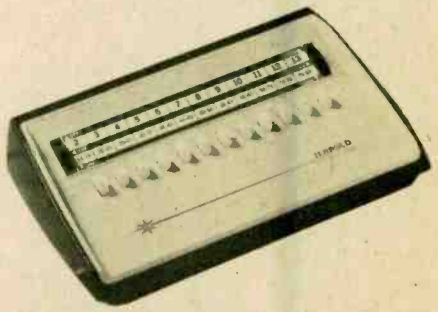
If your TV set has an "Instant On" feature and you wish to keep it functional, you would plug the TV set power cord as well as the converter power cord directly into a wall socket. However, this would defeat the remote On/Off switch and you must continue to use the TV set On/Off switch. Most people would agree that the usual half-minute warm-up period is a small price to pay for the convenience of remote On/Off switching. Test the system with the TV set power cord plugged into the converter.

Once your control is installed all you need do is turn the TV set switch to its *On* position and leave it there. Check to see that the receiver channel selector is set at either 3 or 4. You are now in business as far as VHF reception is concerned.

Tweaking the UHF. If you want the best possible reception of UHF channels as well, you can custom tune the control unit. Using a small Philips screwdriver, remove the two screws underneath the control unit and carefully remove the bottom panel. You will see two rows of screwdriver-adjustable tuning controls—one for VHF channels, the other for UHF channels. Study the installation literature provided with the equipment to be sure you touch only the UHF controls.

Place the fine-tuning control (top panel) in its mid position. Refer to your TV Guide to determine what UHF

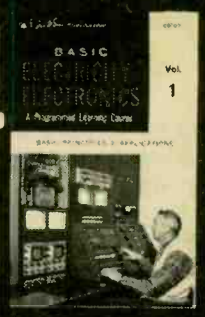
(Continued on page 85)



Jerrold's remote control instantaneously chooses up to 12 VHF and 12 UHF stations. Circle 63 on Reader Service coupon.

e/e BASIC COURSE IN ELECTRICITY & ELECTRONICS

RECOMMENDED THEORY FOR ALL CB OPERATORS



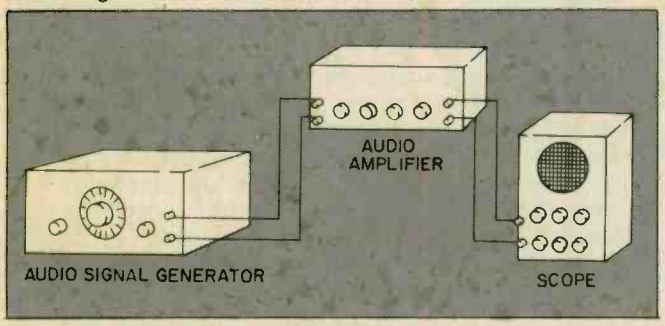
This series is based on BASIC ELECTRICITY/ELECTRONICS, Vol. 4, published by HOWARD W. SAMS & CO., INC.

HOW TO USE SIGNAL GENERATORS

WHAT YOU WILL LEARN. In this article you will learn how to use signal generators, both audio-frequency generators and radio frequency generators. You will learn how to measure the frequency response of audio equipment with an audio signal generator. In addition you will learn how to connect an RF (radio frequency) signal generator to a radio receiver in order to align it. You will also get an introduction to trouble-shooting radio receivers with a signal generator.

USING AN AF SIGNAL GENERATOR

An audio-frequency signal generator (sometimes called an audio oscillator) has several useful test purposes. Within the range of its frequency coverage (genrally 20 Hz to 20 kHz) it can be used as a signal source to check equipment or circuits designed to pass an audio signal.



Frequency Response and Fidelity

An audio amplifier used with a record player, hi-fi system, or stereo system must have a good **frequency response** through the audible frequency range. Most people have a range of hearing between 15 and 15,000 Hertz. Audio equipment with flat frequency response between these limits is called high fidelity. The word **fidelity** is often used with reference to sound equipment. Good fidelity and flat frequency response both refer to the accuracy with which an input signal is reproduced at the output of a circuit or piece of equipment.

QUESTIONS

Q1. What is the normal frequency range of an AF signal generator?

Q2. What is meant by fidelity, and by flat frequency response?

ANSWERS

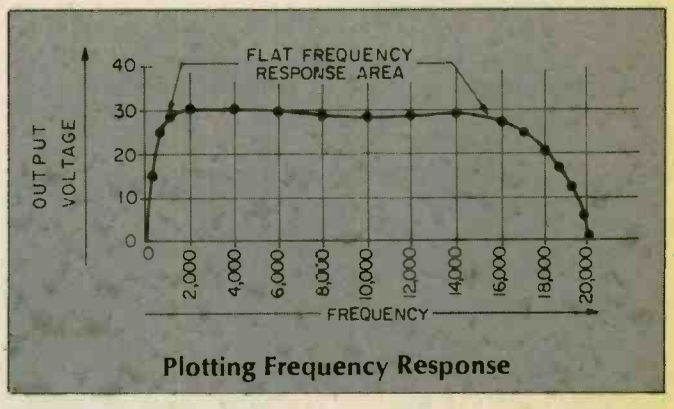
A1. 20 to 20,000 kHz.

A2. They are both a **measure of the accuracy** with which the input characteristis of a signal are reproduced at the output of a circuit.

Frequency Response in the Audio Range

Evaluation of fidelity or plotting a frequency-response curve is accomplished by the equipment setup shown. If an oscilloscope is used as the output indicator, it should have a **graticule** and be calibrated to measure AC voltage accurately.

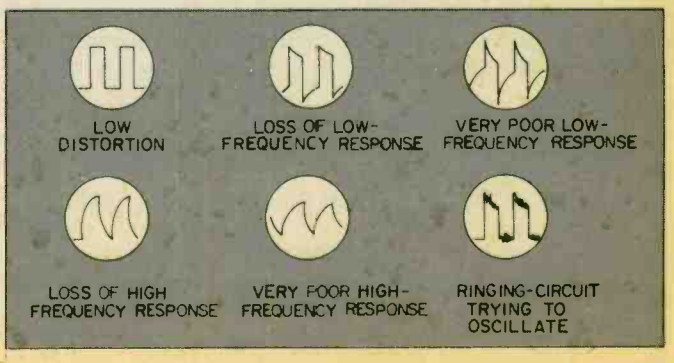
Allow a few minutes for the signal generator and



Plotting Frequency Response

amplifier to warm up. After each new frequency setting, plot the voltage reading on a graph as shown. Generator settings for readings in the rising and falling portions of the curve should be made in multiples of 500 Hz. Intervals of 2,000 Hz. are satisfactory along the top part of the curve.

A frequency response curve is a line drawn through the dots plotted on the graph. It will reveal the fidelity of the amplifier for which it has been made. Do not



adjust the gain of any equipment (generator, amplifier, or scope) during the test. If you do, output readings will be in error.

Determining Response at High Frequencies

A square wave includes many harmonics. Depending on the steepness of the slope and flatness of the peak, the square wave can contain harmonics with frequencies 10 to 100 times the frequency of the fundamental sine wave. Because of this, the square wave can reveal frequency response when it is applied to the input of a circuit and its output is observed on a scope. Typical response indications are shown as they appear on the screen of an oscilloscope.

QUESTION

Q3. Why should you not adjust the setting (other than frequency) of equipment during a frequency-response check?

ANSWER

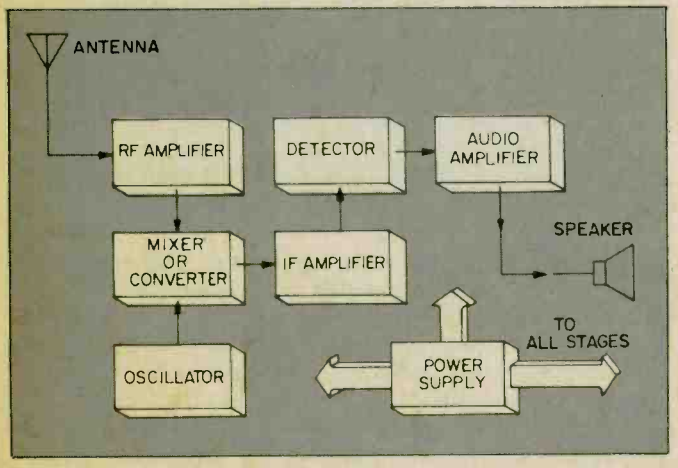
A3. If gain or similar adjustments are made to equipment during a frequency-response check, **false amplitude** readings will be obtained.

USING AN RF SIGNAL GENERATOR

The main use of an RF signal generator is in tuning, aligning, and troubleshooting radio receivers and other equipment.

Superheterodyne Receiver

A **superhet** (common name for superheterodyne) receiver amplifies the weak signal of a selected RF carrier and its audio modulation, removes the audio component from the carrier, and then amplifies the audio so that it can be heard clearly on a speaker.



Antenna—The antenna is usually a coil around a ferrite rod, attached to the back of the cabinet. The antenna picks up carrier signals from transmitters within range of the receiver and feeds signals to the first stage.

QUESTIONS

Q4. What is the purpose of the gain control on the RF signal generator?

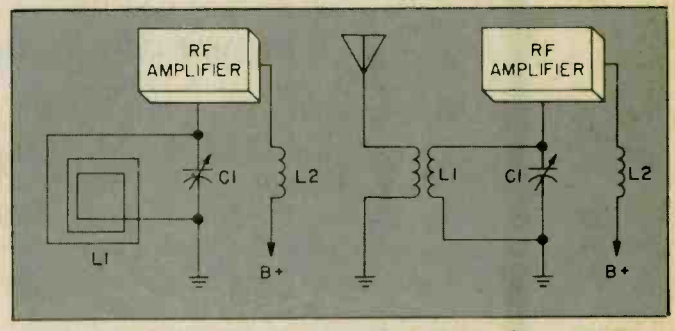
Q5. What is the RF signal generator used most frequently for?

ANSWERS

A4. The gain control regulates the **amplitude** of the carrier signal.

A5. Tuning, aligning, and **troubleshooting** equipment are the main uses for the RF signal generator.

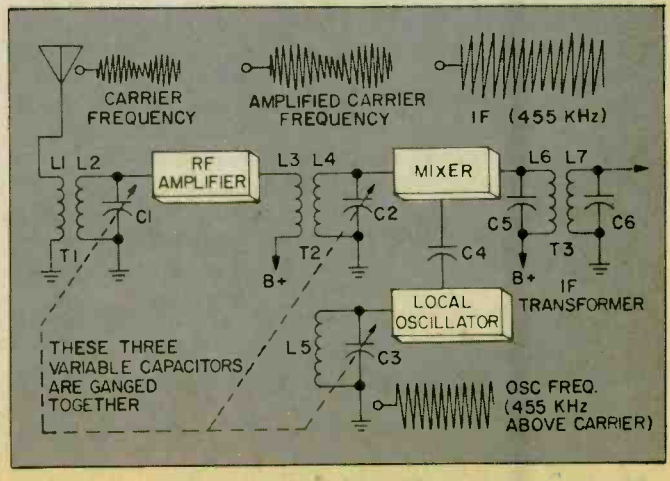
RF Amplifier—In some sets the antenna, in addition to picking up the signal, serves as the coil in a resonant circuit with a capacitor. In other sets, a separate coil is used for this purpose. By varying the capacitor, L1 and C1 can be made resonant to a specific carrier frequency among the many appearing at the antenna. The selected frequency develops its voltage across the tank. The voltage is fed to the input of the RF amplifier. The amplified signal (carrier plus audio modulation) is applied across L2, the primary of a transformer connecting the amplifier to the next stage. In some receivers that do not have an RF amplifier, the antenna coil is fed to the mixer stage.



Local Oscillator—This stage is designed in accordance with the basic principles of any oscillator—a stage of amplification, a means of signal feedback, and a method of frequency control. In this case, frequency is controlled by a tuned resonant circuit similar to the type used in the RF amplifier.

Mixer—Carrier and local-oscillator frequencies are heterodyned together in the mixer. **Heterodyning** is the mixing together of two signals to produce two additional frequencies which are the sum and difference of the originals: The purpose is to develop an **intermediate frequency**—the difference between the RF-carrier and the local-oscillator frequencies. Since the intermediate frequency (IF) is the same for all broadcast frequencies, the IF amplifier and its frequency-selecting networks need only be capable of passing and amplifying one frequency.

This is the task accomplished by the mixer. It **beats** (another word for heterodyning) the oscillator and RF



frequencies together and passes a total of four frequencies to the plate—carrier frequency, local-oscillator frequency, a **sum** frequency (carrier plus oscillator), and a **difference** frequency (oscillator minus carrier). In most sets, the value of the difference frequency is 455 kHz. It is obtained by tuning the oscillator tank ciruit to a value always 455 kHz above any setting of the carrier-selecting circuits.

A similar circuit called the **converter** is often employed. It combines the functions of the local oscillator and the mixer into **one** circuit.

As can be seen from the diagram, C1, C2, and C3 are ganged together to a single tuning control. C1 (RF amplifier) and C2 (mixer) are tuned to the desired carrier frequency, rejecting all other carriers. C3 (local oscillator) is tuned to exactly 455 kHz (the IF that will be used in the rest of this article) above the carrier; this is true no matter which station is selected. Of the four frequencies that appear at the output of the mixer, only the difference frequency (455 kHz) will be selected by the IF transformer.

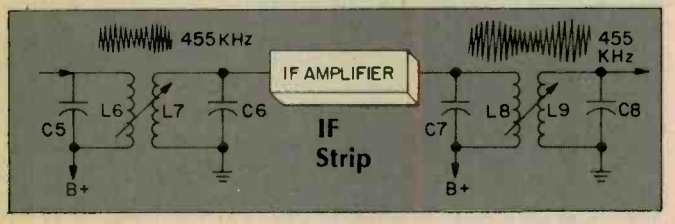
QUESTION

Q6. What is heterodyning?

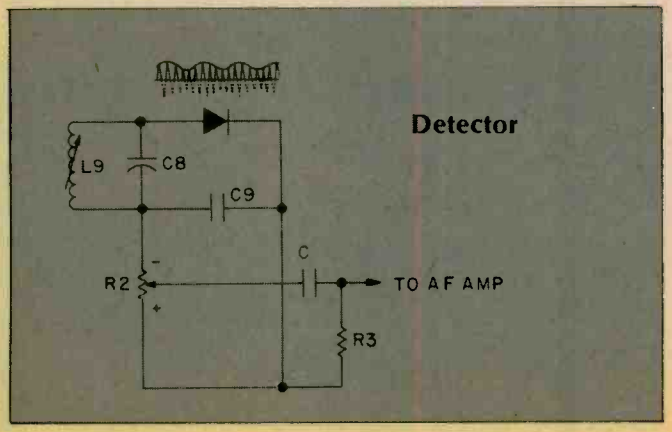
ANSWER

A6. Heterodyning is the process of **mixing** two frequencies together to produce two other frequencies equal to the sum and difference of the first two frequencies.

IF Amplifier—The IF stage consists of two transformers separated by an amplifier. More sensitive receivers may have two amplifiers and three transformers. Each of the coils in the transformers has a metallic core that can be adjusted to give the value of



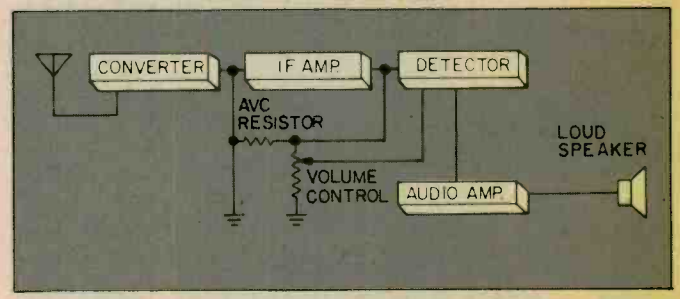
inductance necessary to make the respective tank circuits resonate at 455 kHz. By this method, only the difference frequency from the mixer or converter will be allowed to enter the IF strip. **IF strip** is a common term that includes the IF-amplifier transistors and transformers.



Detector—A small rectifier acts to pass only the positive parts of the IF signal. The time constant of R2 and C9 is long enough that the voltage across R2 follows the envelope of the carrier rather than the individual half cycles. Thus the audio signal is removed from the IF carrier.

Audio Amplifier—This stage further amplifies the audio signal and feeds it to the speaker and thus the audio originating at the broadcast studio is reproduced.

Automatic Volume Control (AVC)—AVC is a feedback circuit that takes the average value of the rectified voltage (audio component) from the detector and feeds this average voltage back to the base inputs of



the preceding transistors. This feedback voltage tends to change the bias. The gain is therefore changed to compensate for changes in received signal voltage.

QUESTION

Q7. What is the difference between a mixer and a converter stage in a superhet receiver?

ANSWER

A7. A mixer **heterodynes,** or beats, the carrier and local-oscillator frequencies together to obtain two other frequencies, called **sum-and-difference** frequencies. The converter stage performs the functions of the **mixer** and **oscillator** in one stage.

Radio Receiver

Although you may have enough background knowledge to undertake the task of receiver alignment, a word of caution is necessary. Make certain that you understand how your signal generator operates and how it is to be adjusted for use. Also, be sure you know how the receiver you are going to align works.

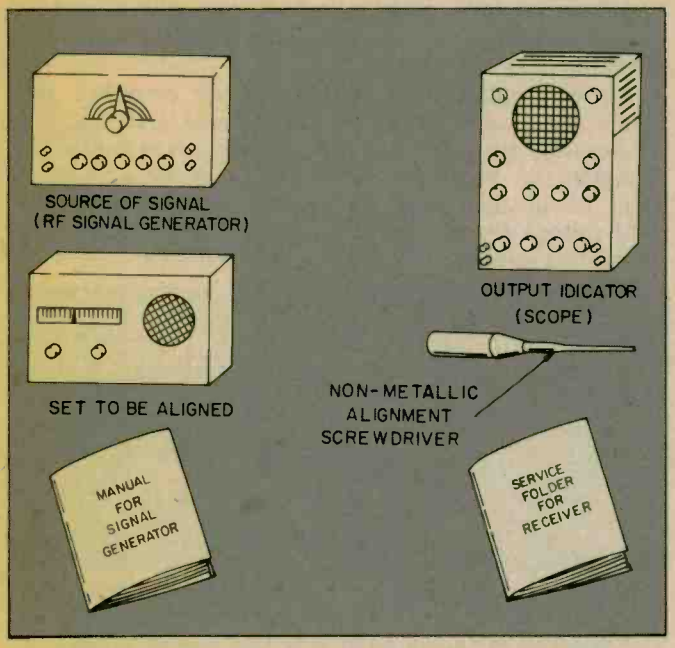
Why Should a Receiver Be Aligned?—The operating characteristics of components change with age. Periodic heating and cooling of parts is largely responsible for these changes. The change may not be great enough to make the set fail to operate, but it may be enough to throw the set out of alignment. In fact, most home receivers require at least a slight realignment every few months or years. Improper alignment results in a lower receiver output, poor separation of stations, and a decrease in tone quality.

You should work from the schematic diagram of a receiver to obtain the information needed for alignment. Unfortunately, these diagrams are not always provided with commercial equipment. However, printed service information is available at most local electronic parts supply houses. This service data always contains a clearly drawn schematic for the equipment specified, showing the values of all parts and the voltages that should be read at significant test points. A parts list,

the location of alignment test points, and photographs showing the location of all parts are also included.

Tools Required for Realignment—The bare minimum of tools is shown.

There are six items shown, and each is essential. A



few other common hand tools are also needed to remove the receiver from the cabinet. A non-metallic screwdriver is used to prevent shorting or detuning of circuits while they are being adjusted.

QUESTIONS

Q8. What is the value of the following tools when realigning a receiver?

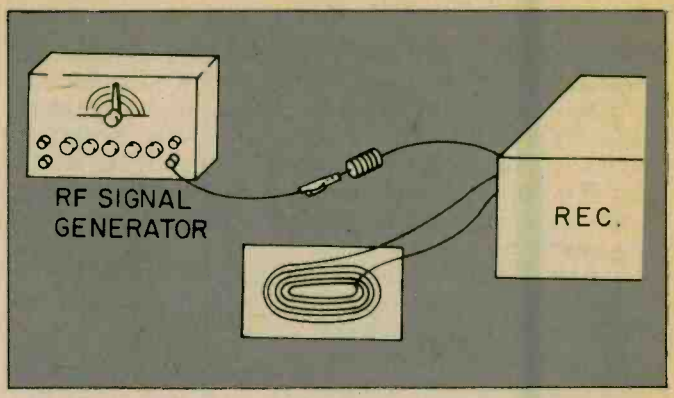
(a) RF signal generator.
(b) Output indicator.
(c) Operating manual for your signal generator.
(d) Service folder for the receiver.
(e) Common-sense application of technical knowledge.

ANSWERS

A8. (a) **Provides a carrier frequency** under controlled conditions.
(b) Permits **observation of the results of adjustments** made to produce best performance.
(c) Provides **the proper operating procedures.**
(d) Provides a schematic diagram and other **information necessary for alignment.**
(e) **Without** a common-sense application of your technical knowledge, many **unnecessary mistakes will be made.**

Calibrating the Generator

Although most generators are designed to give good accuracy, it is always best to calibrate the output of the generator with a broadcast station. After the signal generator has been turned on and the receiver has been tuned to a strong local station, hold the signal generator test clip or probe near the antenna terminal of the receiver. Adjust the signal generator dial approximately to the station frequency. If a tone or a squeal cannot be heard, connect the probe to the antenna terminal through a small-value capacitor. A noise

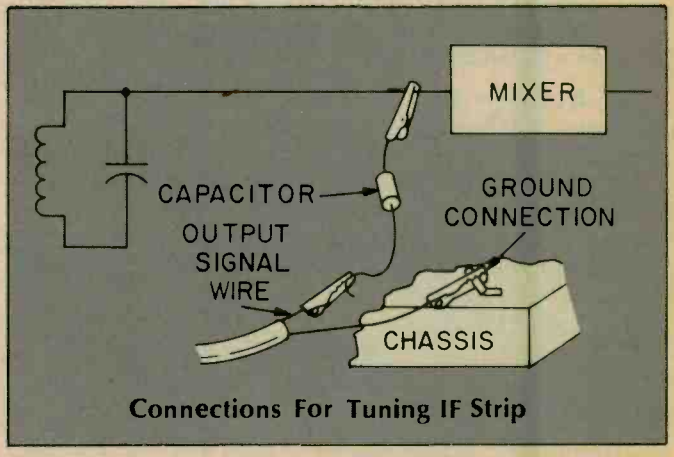


should be heard on either side of **zero beat** (a point of silence). When the generator dial is at zero beat, the generator frequency is the same as the station frequency. Without retuning the generator, adjust the generator dial to read this frequency. (Consult the generator instruction manual.)

Alignment Steps

Receiver alignment consists of two steps. The IF circuits are first tuned to 455 kHz, or whatever IF the manufacturer specifies. Then the RF, mixer, and oscillator circuits are tuned, in that order, for maximum signal. Connect the generator as shown.

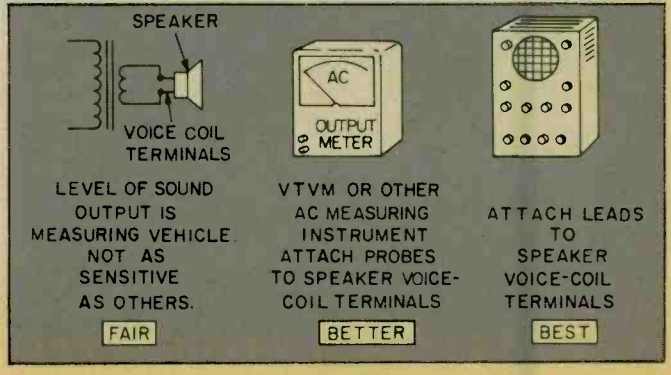
There is a choice of output indicators available.



Connections For Tuning IF Strip

Whichever you choose, adjustments are made for maximum output indication and not for a precise numerical reading.

Set the signal generator frequency to the IF of the receiver, and modulate the carrier with an audio signal. Set the receiver volume control to maximum gain. Ground the input of the local oscillator, if the set has



one, to prevent undesired signals from entering the IF strip.

QUESTION

Q9. What steps are required to align a receiver?

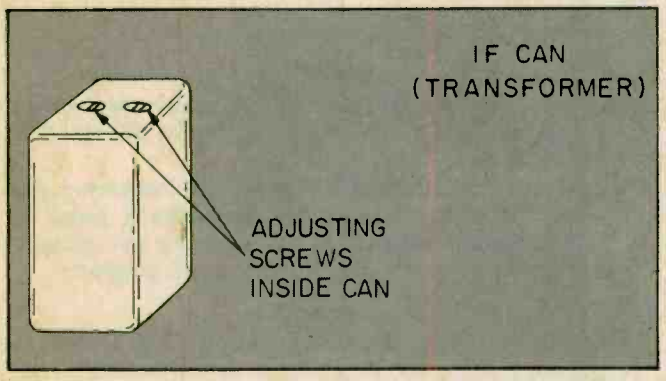
ANSWER

A9. First, the **IF circuits must be tuned to the specified IF** (normally, 455 kHz). Then, the **RF, mixer,** and **oscillator circuits are tuned for maximum signal.**

Tuning is accomplished by adjusting each of the two screws inside the top of the IF can. Be sure to use a non-metallic screwdriver for this operation.

Carefully adjust the screws for maximum reading on the output indicator. Start with the coil nearest the detector and adjust each, in turn, working toward the mixer.

During this and all following alignment steps, keep the gain of the signal generator no higher than necessary to give an indication on the output indicator used. If the gain is too high, receiver stages will overload or saturate, and output readings will be invalid. Readjust all coils until you are sure they have been peaked to maximum.



After the IF coils have been peaked for a maximum output indication, the mixer and oscillator tuning circuits also must be adjusted to give a maximum-signal indication. **Front end** is a term applied to these tuning stages. There are some sets that have an RF amplifier; the tuning circuit of the RF amplifier must be adjusted in a similar manner.

To tune the front end, attach the generator high lead with its capacitor to the antenna terminal. Unground the oscillator input if it was grounded. Tuning procedures involve adjusting the small **trimmer** capacitors attached to the main tuning capacitor and a **padder** capacitor in the oscillator tank circuit.

To arrive at the best tuning, the trimmers and padder are adjusted for a maximum reading on the output indicator. As shown in the diagram above, the trimmers are in parallel across the respective sections of the main tuning capacitor. The padder is in series with the coil and main capacitor section of the oscillator tank.

QUESTIONS

Q10. At what end of the receiver should the first IF adjustment be made?

Q11. During the tuning of IF coils, at what frequency and amplitude should the signal generator be set?

Q12. At what point in the receiver should the generator leads be connected while adjusting the IF coils?

ANSWERS

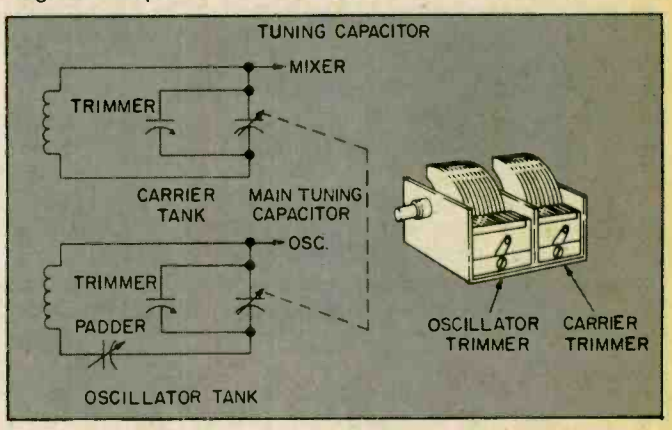
A10. The IF coil to be adjusted first is the one **nearest the detector stage.**

A11. The signal generator should be set **at the IF of the receiver,** modulated with an audio tone, and set at the **lowest amplitude that gives an output-indicator reading.**

A12. The high-side generator lead should be connected to the **mixer input** and the other lead should be connected to the chassis of the receiver.

Not only must the carrier and oscillator tank circuits be tuned for maximum performance, but their resonant frequencies must differ by 455 kHz.

First, set the signal generator to 1,500 kHz, leaving the audio modulation on. Rotate the main tuning capacitor of the receiver to the position of maximum output at the high end of the dial. Adjust both trimmers for highest output.



Now, set the generator and receiver dials to 600 kHz. **Rock-in** the padder tuning by making the same adjustment at several settings on either side of the 600-kHz dial reading. The setting at which the highest output reading is noted is the true 600-kHz position. Adjust the receiver dial pointer to indicate 600 kHz. Recheck the trimmers for maximum output again, first at 1,500 kHz and then at 600 kHz. If no change is evident, tuning is completed.

TROUBLESHOOTING A RADIO RECEIVER

A signal generator is frequently used for troubleshooting a receiver. The signal generator can supply the proper signal through all of the stages except two, the power supply and local oscillator. The local oscillator generates its own frequency, and nothing is gained by passing another signal through it.

Two different methods are used to isolate the trouble in a receiver by means of a signal generator. One is called **signal substitution,** and the other **signal tracing.**

Signal Substitution

In signal substitution, the output of the signal generator is applied to each stage in sequence. The faulty stage lies between the points at which the generator did and then did not pass a signal through the receiver.

The principle of signal substitution is simply to start at the output end of the receiver and work toward the front end, applying the appropriate signal at each stage. Use a capacitor in series with the test lead to

keep DC out of the generator. The first check is made at the output of the audio amplifier with an audio signal (only) from the generator. If a sound is heard in the speaker, the speaker and the circuitry between the speaker and audio amplifier output are not the cause of the trouble. If there is no output from the speaker, the trouble is in this area. The trouble could be in the speaker, the output transformer, or in the several connections between the speaker and amplifier.

QUESTION

Q13. What two signal-generator methods are used to isolate trouble in a radio-receiver circuit?

ANSWER

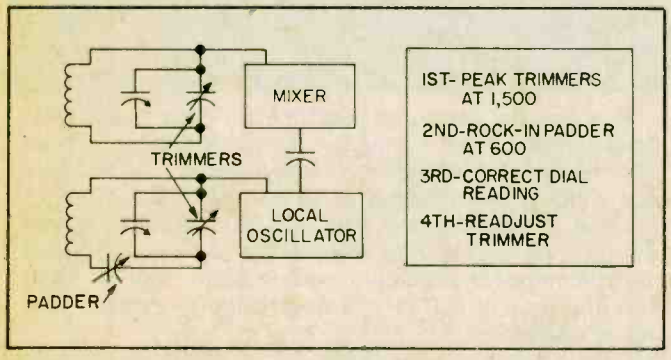
A13. The two methods used to isolate a bad circuit are **signal substitution** and **signal tracing.**

If the first check is good, apply the audio signal to the control grid of each audio stage. Audio from the speaker indicates that these stages are probably good.

Set the generator for a modulated IF, and connect its output to the output of the detector, the output and input of the IF amplifiers, and the output of the mixer. Apply modulated RF to the input of the mixer and the antenna terminal. Somewhere in the sequence, no signal will reach the speaker. The trouble is between that point and the last good check point.

Signal Tracing

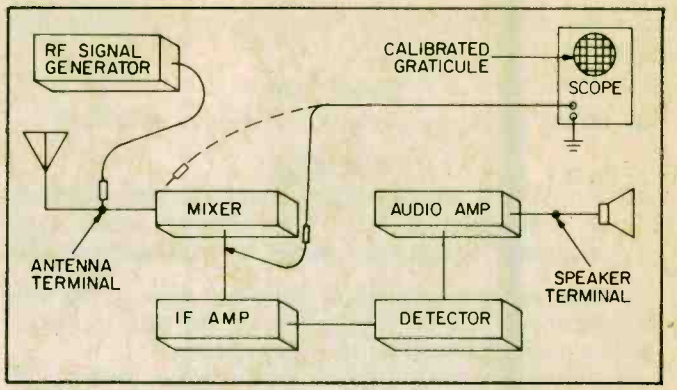
Signal tracing is almost the inverse of signal substitution. The signal generator is set up to provide a modulated RF signal within the range of the receiver; the test lead is connected to the antenna terminals. An indicating device—oscilloscope or VTVM, for example—is used to trace the signal from the front end to the output end of the receiver, making checks at the input and output of each stage.



An oscilloscope is best for signal tracing. You can use a VTVM, however, to check for the presence of a signal. You must use an RF probe with the meter when testing at points where either RF or IF signals are present.

The checks are made first at the input of its mixer, then at its output, and so on down the line from input to output to input to until no output appears at a check point. The trouble is located between this point and the previous point where an output was indicated. Use a VTVM or a multimeter in that area to find the faulty part.

The signal-tracing method can also be used for keeping a record of receiver sensitivity. At a time when the receiver is known to be in a satisfactory condition, connect the generator to the set, as indicated for signal tracing. Set the generator and receiver gain to the minimum level that will cause a readable signal to pass through the set. Record the amplitude of the signal at each check point, using a VTVM or oscilloscope. Also record the setting of the gain control and attenuator on the generator. If you wish, you can divide the output reading of each stage by its input reading to determine gain, the factor for sensitivity. These readings can be used at a later date for comparison purposes when a decrease in sensitivity is suspected. A loss of gain in a stage will indicate actual or impending trouble.



QUESTIONS

Q14. Which method of receiver troubleshooting using a signal generator is better, signal substitution or tracing?

Q15. If you were using a VTVM as the indicating device in signal tracing, at what check point in the receiver diagramed above would you change from an RF probe to the normal AC probe?

ANSWERS

A14. Both methods are equally good. The choice is merely a matter of personal preference.

A15. In the front-to-back signal-tracing method, the RF probe should be used last **at the input of the detector.**

WHAT YOU HAVE LEARNED

1. When the output of an AF signal generator is fed into an overdriven amplifier, the output will be a fairly good square wave. Since a square wave is rich in harmonics (multiples of the fundamental frequency), the frequency response of an amplifier can be studied by observing the type of distortion produced in the square wave as it passes through the circuit.
2. A typical RF generator contains an RF oscillator, an audio oscillator, a stage for mixing the two, an amplifier, a means of controlled attenuation, and an output meter. Such a generator provides an unmodulated RF signal, an audio signal, or a modulated RF signal.
3. In a superhet receiver, modulated RF and the oscillator frequency are applied to the mixer (or converter) stage. They are heterodyned to produce a sum and a difference frequency. The difference frequency, still containing the modulation envelope, is referred to as the IF and is amplified in the next stage. The detector extracts the audio signal from the IF carrier and feeds it to the audio amplifier and then to the speaker. Some superhets have an addi-

tional stage, called an RF amplifier, ahead of the mixer. A converter combines the functions of the mixer and oscillator stages into one circuit.

4. Alignment of a superhet receiver is a relatively simple task if the technician understands how his signal generator and receiver operate. Specific information for the generator is contained in the operating manual, and for the receiver, in a service folder.
5. The steps for receiver alignment are:
   (a) Tune the IF transformers first.
   (b) Tune the front end after (a).
6. An RF signal generator can also be used for isolating trouble in a receiver to one of its stages. There are two methods, signal **substitution** and signal **tracing.**

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e/e Checks Bearcat

(Continued from page 66)

Performance Plus. Though the whole programming bit might seem somewhat complicated the Bearcat 210 is actually the most easily programmable monitor receiver we have seen or used. What it actually comes down to is you simply press up to 8 keys and there's the frequency you want.

If you pull the power plug you don't lose programming because a small internal battery—about the size of a pencil eraser—keeps the memory banks alive even when the receiver's power is turned off. But make note of the most desired frequencies because every year or so the battery must be replaced, and it should not be done with the receiver's power turned on. When the battery is replaced the memories must be reprogrammed.

The only problem, one common to many digitally synthesized equipments, is reception of its own internal signals—called *birdies*. In general, however, desired stations rarely use the birdie frequencies, and when they do, all but the weakest will override the birdie.

We could use another few pages describing the Bearcat 210, but the best way to see just how truly spectacular it is is to try one yourself at a local dealer, and we strongly suggest you try a Bearcat 210 even if it costs a little more than you planned to spend on a scanner. Whatever the price difference, we feel the Bearcat 210 is worth every penny.

The Bearcat 210, complete with AC and DC power cord, a mobile mounting bracket, telescopic antenna and an instruction manual that lists the specialized communications bands that can be searched for unsual signals, is priced at $349.95.

For additional information about the Bearcat 210 and other Bearcat products circle No. 59 on the reader's service coupon. ■

Varactor TV Tuning

(Continued from page 78)

channels are operational in your area at the moment. Let's say you begin with channel 41. Depress the switch under the "38-43" range, then slowly and carefully turn the appropriate UHF control screw with the Philips screwdriver until the correct picture and sound come in as clearly as possible. Your *TV Guide* will identify the proper channel. You'll note that each control can bring in any UHF channel within reach. The objective is to tune each control so that it relates any given channel with the appropriate switch.

The controls you adjust are not numbered, but you can quickly determine which control affects which switch by counting switches and controls beginning from the same end of the control box. For example, range 38-43 uses the fifth switch from the *left*, so you count in to the fifth control from the *right* because left becomes right when you turn the box over.

What do you do if two receivable channels fall into the same range? Just move one of them to an adjacent unused range. For example, put channel 25 in the "20-25" range and tune channel 21 into the "14-19" range. When all channels are tuned in properly, cover the range numbers with the individual channel numbers on self-adhesive labels which are provided with the equipment.

The Jerrold All-Channel Remote TV Control is priced at $124.50. For additional information circle number 63 on the Reader Service coupon. ■

Computer Readout

(Continued from page 68)

at the end of all programs. RESET clears the accumulator and all other registers so your program can run again without picking up misleading data. The SIN key lets you go through your program one step at a time—one touch is one step. This is handy for finding errors in programs that will not run properly. Finally, a very important command button is MICRO, which stands for the micro-interpreter in the Monitor ROM. Pressing this key places the computer in the MICRO mode where it stays until CNTRL is pressed twice. It is in the MICRO mode that the other commands printed on the keys (not just the top commands) can be used.

CNTRL	SETPC	0	0	3	0
CNTRL	MICRO	OPR 1	CLA		
CNTRL	TAD	0	0	3	6
CNTRL	TAD	0	0	3	7
CNTRL	DCA	0	0	3	5
CNTRL	OPR 2	HALT			
CNTRL	CNTRL				

Shown here are the commands you'd punch in by touching Intercept, Jr.'s keyboard buttons to run a program adding two numbers. Program starts at upper left corner.

A simple program to add two numbers will be helpful in showing the keyboard operations. First the program is started at location (octal) 0030, then the accumulator is cleared, i.e., the contents are set to zero. Note that we are now in the MICRO mode because CNTRL and MICRO have been pressed. Next, location 0036 is read into the accumulator and the contents of 0037 are added to it. (TAD means "add contents of this location to accumulator.") The sum in the accumulator is then de-

(Continued on page 87)

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Computer Readout

(Continued from page 85)

posited (DAC) in location 0035 and will automatically be displayed on the four right-most LEDs. The program then commands HALT, then CNTRL (CNTRL takes it out of the MICRO mode). To execute program, simply set the program counter to 0030 and hit CNTRL, and then RUN.

There you have it—a battery-operated, Teletype-command micro-computer made for the hobby and education market. The Intercept, Jr. costs $281, and the 6951 RAM module is $145. The Owner's Handbook provides a great deal of information and for only $5 you can order one in case you're still not sure of whether to pay out $281. Write Intersil, 10900 North Tantau Ave., Cupertino, Calif. 95014 (408-996-5000). Join us again next issue and keep your ideas coming to me in the mail. And if you'd like more information on Intercept, Jr., circle no. 67 on the Reader Service Coupon.

HAM-COMPUTER MEET SET FOR AUGUST 21-22 NEAR DES MOINES

Camp Dodge, the home of the Iowa National Guard in the Des Moines suburb of Johnston, will be the site of a two-day meeting of radio amateurs and computer enthusiasts from 8:30 to 4:30 Saturday and Sunday August 21 and 22.

Charlie Corcoran, WBOURB, president of the sponsoring group, the Des Moines Radio Amateur Association (DMRAA) says the meet will include technical sessions, equipment and parts displays, and a massive flea market. Admission is $2.00, and people with stuff to sell at the flea market, as well as all CBers, are welcome. Come and see what the world of ham radio and computers is all about, invites the DMRAA. Free door prizes, too.

Active hams are invited to participate in the meet on the 75 meter and two-meter bands. Frequencies include 146.34-94, 146.22-82, and 146.07-67 MHz.

Ask Hank, He Knows

(Continued from page 38)

Prints Dust

I'd like to add an electronic dust precipitator to my darkroom to get rid of the dust. Got any suggestions?

—J. F., Bristol, VA

Look for an easy way that is more practical. Install an air blower which forces air into the darkroom. With the door closed, air will be forced out through door spaces and little cracks taking the dust with it. You reduce dust input to near zero by filtering the air at the blower input. A vacuum cleaner paper bag is a good filter, very cheap, and easy to replace when dirty. You see, electronics isn't always the answer.

BTU Blues

Hank, the last winter fuel bills killed me. I'm pulling all stops out to save money next winter. How can I reduce heat at night automatically, because we (my family) always forget to turn the thermostat down?

—S. L., Kenosha, WI

You can buy a clock thermostat that does the job automatically. Your local electrical supplier can help you out. The clock is driven by a 24-volt transformer which must be added. Also, if you are the kind of a guy that'll close heat registers or radiators, then parallel the thermostat with one or more at different locations. For example, you can close off the radiators in the living room and set the thermostat there to bottom- about 50° on most units. In the bedroom, you can set the thermostat to 65 or 60 for comfortable sleeping. Investigate, and see if it's wise and practical in your home.

Why Wire

I plan to wire my summer house. I'm told that it's okay provided the county okays the finished wiring. My wife tells me I'm nuts and I should write to you. She always reads ELEMENTARY ELECTRONICS.

—P. W., Denver, CO

First, forget what someone told you. get the facts in writing from the inspector's office. Next, check it out with your local electric company. They are very cooperative, besides, they have some restrictions of their own. I helped a pal wire his summer house after the shell was put up. We had an electrician bring the power to the house via overhead line and into the main fuse box. After that, you are on your own. Frankly, now that I look back, we should have let the electrician finish the job. We stretched a one-day job into four weekends. ■

AM-71

DX Central Reporting

(Continued from page 37)

away from non-English speaking stations. It is relatively easy to get at least a beginner's knowledge of a number of foreign languages. And various shortwave stations around the world will help you to learn.

Unfortunately, right now, there are no Spanish-English or Portuguese-English lessons on SW, but you can, for instance, learn to speak Afrikaans, an off-shoot of the Dutch language, via shortwave. South Africa's *Radio* RSA has Afrikaan lessons on the air. And Dutch itself can be learned through *Radio Nederland*'s own language course.

Yes, you can also learn elementary Chinese. Language lessons in this tough tongue are featured over *Radio Peking*. German lessons are presented on *West Germany's* Deutsche Welle. *Radio Japan* has Japanese language lessons. Russian courses are offered by *Radio Moscow*.

Most of these stations offer free or low-cost study books, records or guides to go along with the broadcast lessons. I suggest you write directly to the stations for more information on when the next series of lessons begin and the availablity of printed course material.

Here are the addresses of these stations:

Radio RSA, P.O. Box 4559, Johannesourg, South Africa.

Radio Nederland, P.O. Box 222, Hilversum, Netherlands.

Radio Peking, Peking, People's Republic of China.

Deutsche Welle, P.O. Box 344, Cologne 5, Federal Republic of Germany.

Radio Japan, Jinnan 221, Shibuya-ku, Tokyo 100, Japan.

Radio Moscow, Moscow, USSR.

Time Topics. It has been some time since I talked about time in DX CENTRAL REPORTING, though the mail suggests there are many of you who are finding this aspect of SWLing a bit confusing. If this is old hat to some of you, skip the next few paragraphs. But if telling time DX-style has got you stumped, stay tuned in.

First, there are two potentially confusing aspects. The first is Greenwich Mean Time (GMT) itself. The second is the use of the 24 hour clock system. GMT is the standard time reference used around the world, calculated for the zero degree meridian that passes through Greenwich, England. It is especially useful when writing reception reports to stations that both you and the station personnel understand just when you listened. When you're both using the same standard, there is less chance for confusion.

GMT is equal to: Eastern Daylight Time plus 4 hours; EST or CDT plus 5 hours; CST or MDT plus six hours; MST or PDT plus seven hours; and PST plus 8 hours. Don't forget that the date has a GMT sginificance too. It may be 10 p.m. EDT in New York City on July 20, but the GMT equivalent is 2 a.m. (written 0200) GMT on the next morning, July 21.

The 24-hour clock system is a bit puzzling, but only at first. You'll soon get the hang of using it.

Between midnight and noon there is little that is confusing. One a.m. is 0100, 2 a.m. is 0200 and so on; right up to noon, 1200. For the p.m. hours you keep on counting from 13 o'clock on up. Thus, 1:30 p.m. equals 1330, and 6:45 p.m. is 1845. Ten minutes before midnight is expressed as 2350 At midnight it becomes 0000 and we start over again.

Down the Dial. (Times in GMT, frequencies in kHz): 1205 and 1555 kHz—*Radio Cayman* uses these two split-channels on the AM medium wave band. This is a relatively new broadcasting operation that has Stateside BCBers hunting for the signals from the Gulf of Mexico. . . . 3260 and 3280—Good things come in pairs today, perhaps. If you like the exotic rhythms of the marimba, you'll enjoy looking for a pair of stations from Guatemala where the marimba is king. These stations can often be heard during our evening hours. On 3260 is *La Voz de Nahuala*. *Radio Chortis* can be heard just 20 kHz up the dial, on 3280. Programming is in Spanish, but the music is worth the listening efforts. . . . 7,260—You can hear English programs from East Germany's *Radio Berlin International* at about 2125 GMT, according to listener reports.

(Credits: Marc DeLorenzo, MA; Jim Bryan, CA; Sydney Osterman, Ontario; Guy Dunn, NY; Chester Johnson, IN; Robert Yajko, PA; National Radio Club, Box 127, Boonton, NJ 07005; North American SW Association, P.O. Box 13, Liberty, IN 47353; American SWL Club, 16182 Ballad Lane, Huntington Beach, CA 92649) ■

PHOTOS WANTED!

Would you like to see your photo in Elementary Electronics? Okay, then, send us a nice clear photo of you and your DXing equipment. Any sharp photo will do, but we prefer to see you at your rig. Along with the photo, please tell a little about you and your DXing activities and interests. Also, please identify the make and type of the receiver and other equipment shown in the photograph. Sorry, we can't return photographs.

The equipment used by Lowell Shuttleworth includes a Heath GR-64 and a Drake SSR-1. Lowell, who lives in Greenville, Ohio, is mainly interested in SW folk music and foreign news coverage. As his map indicates, he has logged about 30 countries.

Kathi's CB Carousel

(Continued from page 58)

Now I don't want you to take my word that this is one of the best mobile antennas made. I want you to test it for yourself. And I will pay you for your evaluation; for a $1 payment you will allow me or the antenna's manufacturer to quote you in their advertisements, and we will use your name so your buddies can see I value your opinion.

Here's all you have to do. Just send me $20 of "good faith" money to guarantee you will return the antenna. I will send you my $50 mobile special. Test it for thirty days and send it back. If it comes back in good condition I will refund your $20 deposit and pay you a buck for your opinion.

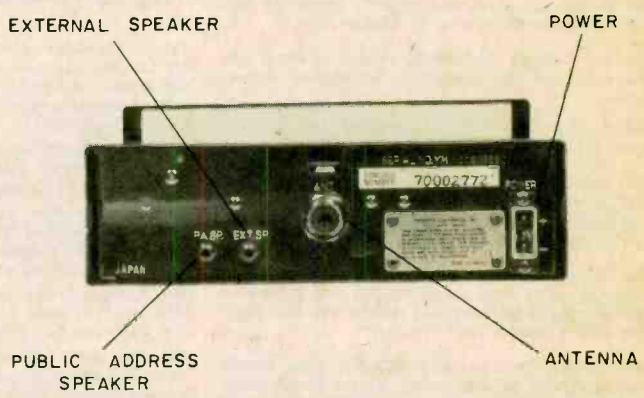
Sound good? Okay, let me tell you a few of the zingers involved. Firstly, the antenna will arrive in a package you will probably destroy getting the antenna out. Now think where you are going to find a heavy duty shipping container about 100 inches long so you can return the antenna without shipping damage. And even if you find the container, do you have any idea what it costs to ship an oversize container? Come to think of it, the package will be too long for the mail, so just how *will* you ship the antenna back to me?

You'll probably say, "The heck with it, I'll keep the darn thing." And that's what I'm counting on. You are going to pay me $20 for an antenna I'll get wholesale for about $6. Fact is, you probably can buy the same antenna in a local store for about $10.

A Bit of Advice. No, Kathi isn't trying a fast one. I'm tipping you to what's being pulled off on unwary CBers. Fact is, my antenna offer is very similar to one I received in the mail, complete with an official laboratory test report (taking a lot of words to say "yes, this is a CB antenna"), *Confidential* stamped in bright red ink, and dates all over the place so I would rush to send my money before the offer was void.

I'm telling you all right now: It's a *scam*. Any time someone offers to pay you for an opinion after you put up a hefty "security deposit"—usually called "good faith"—run like a thief. A legitimate research organization doesn't ask for "good faith" deposits. If you want to throw your money away send it to me and I'll donate it to some worthy charity. ■

When power is applied the channel numbers glow in red through the blackout window. The extra control is a microphone gain control that provides up to 20 dB extra mike gain, just about what you would get from an optional powermike. Turned all the way down it produces the "normal" microphone sensitivity level.



The rear apron has the usual assortment of connections found on the higher quality rigs: a power socket, antenna connector, and miniature jacks for the external and PA speakers. Note the careful layout of jacks and plugs, and clear labeling.

Newscan

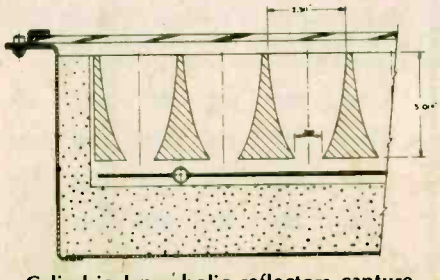
(Continued from page 24)

- The depth of the box and its construction is very important. The box must be wood because it retains heat much better and is tighter than metal. The distance between the fiberglass cover and the metal must be precisely nine inches—for the proper heat build-up.
- The insulation must be ridged glass fiberboard because the heat builds up to as much as 211 degrees Fahrenheit even on a cold, sunny, day. Foam or plastic materials will melt at these temperatures.
- All parts, inside and out, except the clear plastic cover must be coated with a flat, black, oil-based paint. Flat, black, oil-based pigments are much better retainers of heat.

For further information, or plans and specifications, write: Hadley Solar Energy Co., Box 1456, Wilmington, Del. 18999. ■

Solar Power

A breakthrough in the technology of collecting solar energy may make solar power a feasible substitute for the fossil fuels within a matter of years rather than decades. Roland Winston, professor of physics at the University of Chicago and Enrico Fermi Institute, has developed the Compound Parabolic Concentrator, a non-imaging collector of solar radiation—one that achieves the maximum concentration of energy theoretically possible.



Cylindrical parabolic reflectors capture light entering from the top and reflect the rays downward to the pipes which are heated. Light gatherer works well in sunlight and haze, and has high efficiency.

A Concentrator of this sort would have a bank of mirror-lined troughs shaped like compound parabolas with a funnel that is several times wider at the aperture than at the base. Radiation from the sun is captured at the entrance and reflected downward at several times its normal intensity, with much greater concentration of energy than had been thought possible from a collector not designed to track the sun.

Liquid flowing through a pipe at the base of the Concentrator is heated to a high temperature.

Winston and his colleagues at the University, along with Frank Kreith, of the University of Colorado, are working with the Bureau of Indian Affairs to install Compound Parabolic Concentrators for heating and cooling of a mountain school in Western New Mexico "where there is lots of sunshine and very cold weather." It is scheduled to begin operating next September. ■

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. *Regency* has a new low cost/high performance UHF/FM repeater. Also in the low price is their 10-channel monitoradio scanner that offers 5-band performance.

304. *Dynascan's* new *B & K* catalog features test eequipment 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.

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. *Avanti's* new brochure compares the quality difference between an Avanti Racer 27 base loaded mobile antenna and a typical imported base loaded antenna.

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 nearly 400 electronics kits in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo and 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 the *TAB BOOKS* catalog describes over 450 books on CB, electronics, broadcasting, do-it-yourself, hobby, radio, TV, hi-fi, and CB and TV servicing.

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* has a new 1977 full line product catalog. The 40-page, full-color catalog contains their entire new line of 40-channel AM and SSB CB transceivers, hand-helds, marine communications equipment, and antennas and accessories.

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.

359. *Electronics Book Club* has literature on how to get up to 3 electronics books (retailing at $58.70) for only 99 cents each . . . plus a sample Club News package.

360. *Cornell-Dubilier* has a 4-color, 4-page, brochure on its Ham II, CD-44, and Big Talk rotor communication systems. Exploded half tones detail interior rotor construction, and tables list specs.

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July/August 1977
Void After December 14, 1977

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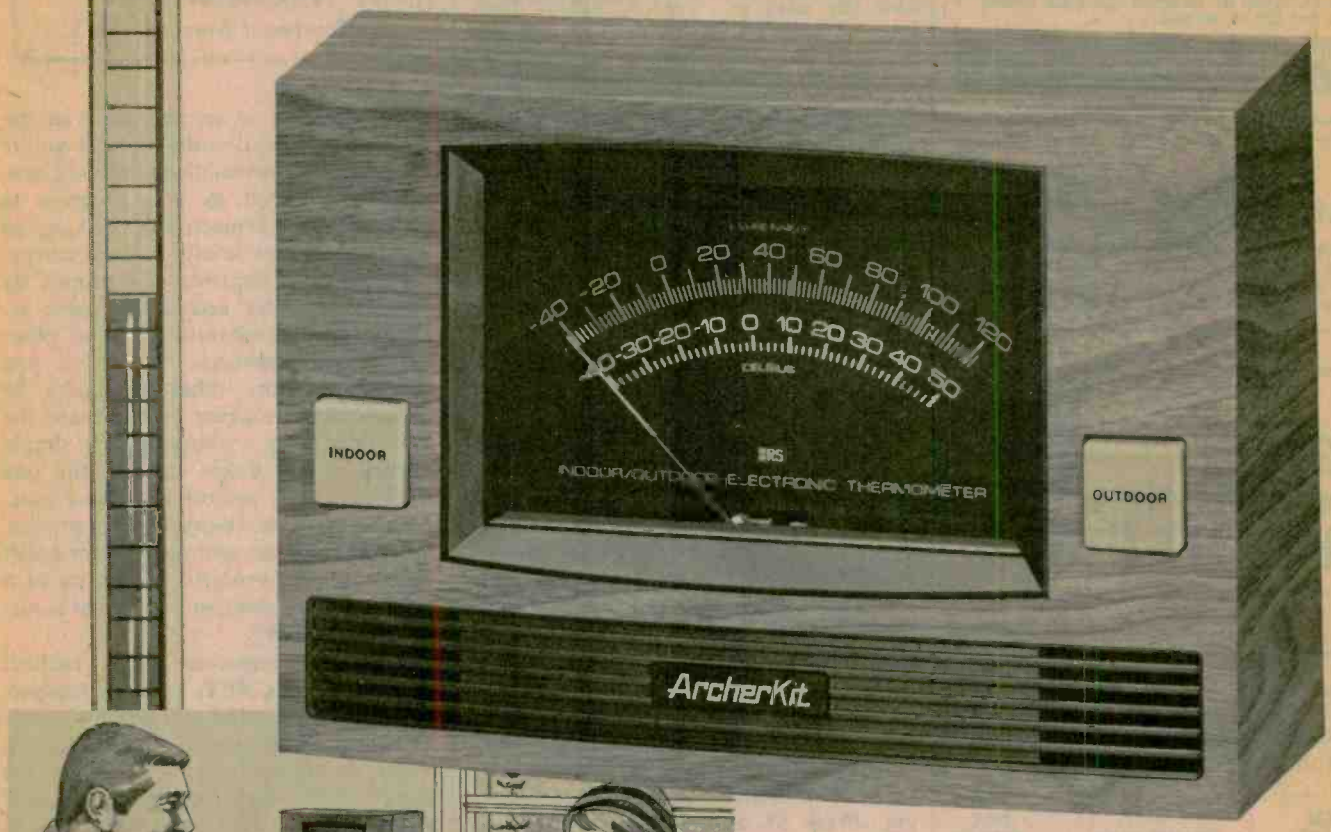

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Lone Ranger Light

(Continued from page 53)

and the case is covered. Solder the positive lead from the battery clip to one side of S1. To the other terminal of S1 solder the short lead from the circuit board. Finish off by mounting the cover and applying press-on decal labels as desired.

Calibrating Lone Ranger. Set the range selector to the low-light measurement position (the larger hole), then point the meter towards a bright light bulb and depress S1. One or more LEDs should light, depending upon the brightness of the source. If not, go back and check whether any components have been improperly oriented. When all is working well, only the calibration of the meter remains. Borrow a good light meter for this task. Choose a large, preferably blank wall and evenly illuminate it (avoid using fluorescent light sources, however). Adjust the light source and the distance until your reference meter indicates f/8 at ASA 125 and 1/30 sec. When you have obtained the correct reading on your reference meter, hold your Lone Ranger in the same spot and point it in exactly the same direction that the reference meter had been facing. Press S1 and adjust R2 so that LED4 (the one farthest) extinguishes. Now turn R2 back the other way until LED4 just comes back ON. The meter is now calibrated. To use the meter with different film and shutter speeds, consult the Table.

Film Speed ASA	Exposure Correction
400	+2
250	+1
125	0
65	−1

Shutter Time	Exposure Correction
1/125	−2
1/60	−1
1/30	0
1/15	+1
1/8	+2

ASA = 125
+ — go to higher f-stop
− — go to lower f-stop

Additional Circuit Uses. You may have noticed that the comparator circuit presented here has great potential. A thermistor might be submitted for photocell PC1 and the circuit becomes an electronic thermometer. Or mount a potentiometer so that its control shaft spins as another shaft rotates. The LED display would then indicate angular position, perhaps for an antenna rotor. The information here plus your own imagination should produce many new devices. ■

Precision Pet

(Continued from page 45)

same locations as are indicated in the components location diagram. If you're a beginner at constructing electronic projects, you'll find as you progress to more complex projects that making up a printed circuit board saves construction time and improves the project by making it neater and much more reliable (rigid mechanically) than other construction methods. However, you may, like many other beginners be hesitant about making such a board the first time. If so, making a fairly simple printed circuit board such as the one shown for this project is a good idea. Although not necessary for this project, it is good practice and training for much more complex projects, where use of a printed circuit components board is virtually mandatory.

There are numerous other practical applications for PET, such as measuring your freezer and refrigerator's temperature. (Consumer's Union recommends a temperature of 37°F in the center of the fresh food space and 0°F in the freezer) PET's variety of use is limited only by your needs, and by your imagination. ■

Computer New Products

(Continued from page 54)

putation, as an intelligent terminal, remote job entry station, graphics display, and in many other applications. The software package includes an interactive editor, assembler, monitor, cassette-based file system, and an extended form of BASIC high level language. The Micro-Mind includes a 6500A-series microprocessor, a character and graphics display processor, an input/output interface board, power supply and unique keyboard. Using an interconnect bus system, as many as 16 microprocessors can be connected together for parallel processing. Every microprocessor board has sockets for 16K bytes of dynamic random-access memory; 8K bytes are supplied with the standard system. A memory mapping option allows the Micro-Mind to have a total addressable memory area of 64 Megabytes. The display processor provides 2-point plotting graphics format on the CRT. Map format displays a bit map pattern with 128 by 160 square display, each square individually setable. This permits a wide variety of pictures and images to be displayed. ECD Corp., 196 Broadway, Cambridge, Mass. 02139. Circle number 41 on Reader Service Coupon. ■

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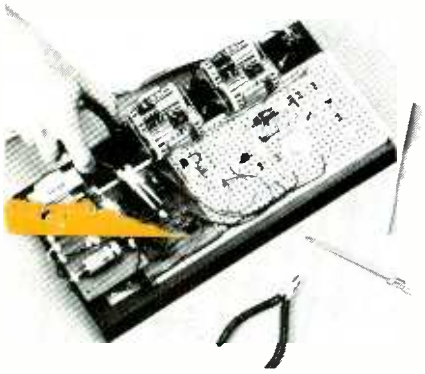

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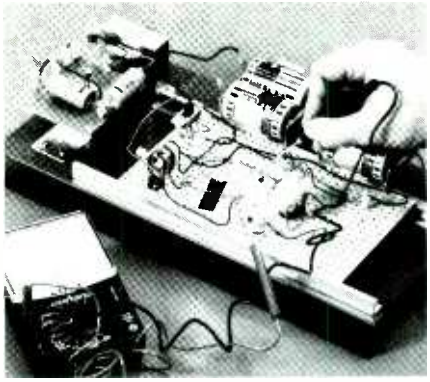

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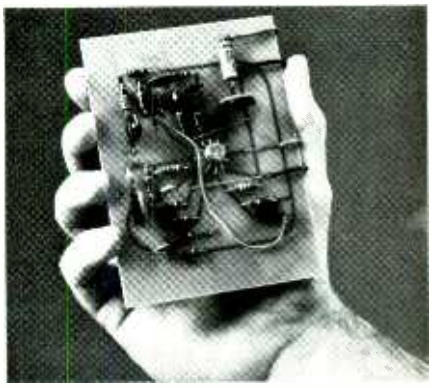

Modern space-age components like this IC (integrated circuit) are professional quality and can be used again and again in many of your projects. Lesson by lesson, piece by piece your knowledge grows!

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CIE offers a number of laboratory courses where you learn Electronics by "doing it yourself." You work with your own hands on electronics components and lab equipment. This combination of "head and hands" learning *locks in* your understanding of the crucial principles you'll use on the job in your new career.

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