

DECEMBER 1972/FIFTY CENTS

Popular Electronics

INCLUDING **Electronics World**

BUILD:

Crystal-controlled Musical Instrument Tuner

Sound-actuated Photoflash Attachment

Hirsch-Houck Tests

PORTABLE SHORTWAVE RECEIVERS

ALPHA BRAIN WAVES and Biofeedback Training

Report on PROPOSED CLASS E CB BAND

What's in a COLOR-TV SIGNAL?

TEST REPORTS:

Heath AR-1500 Stereo Receiver

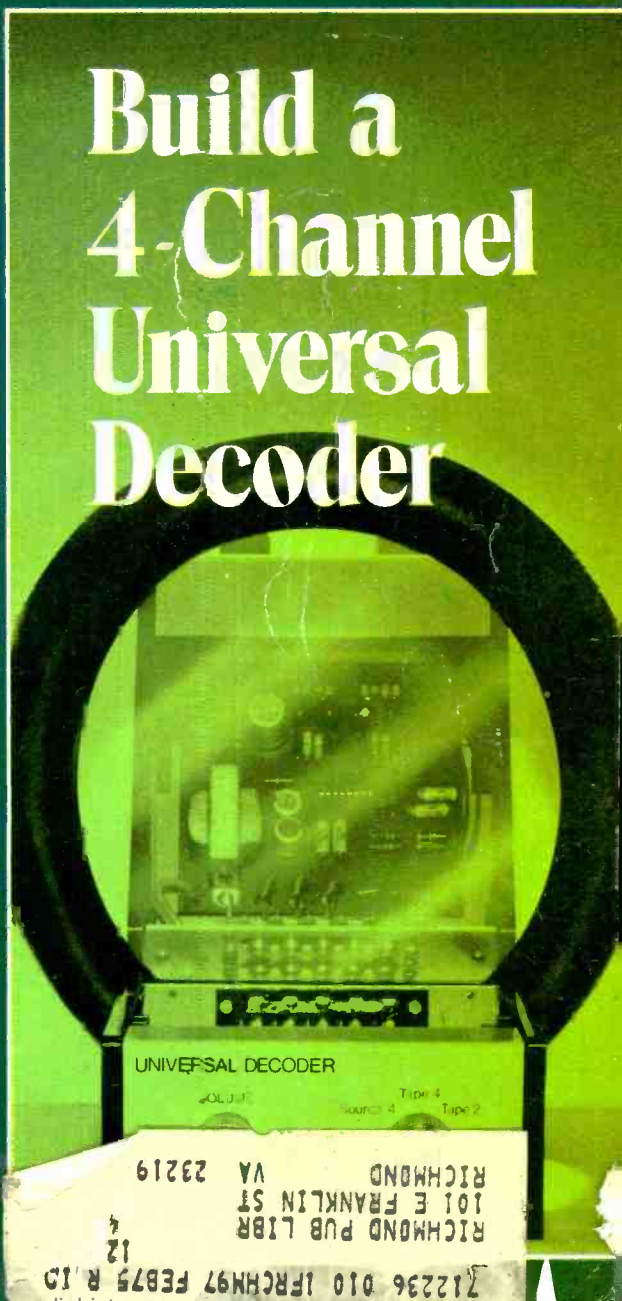
Lafayette SQ-M 4-Channel Decoder

Sencore CG-22 Color Bar Generator

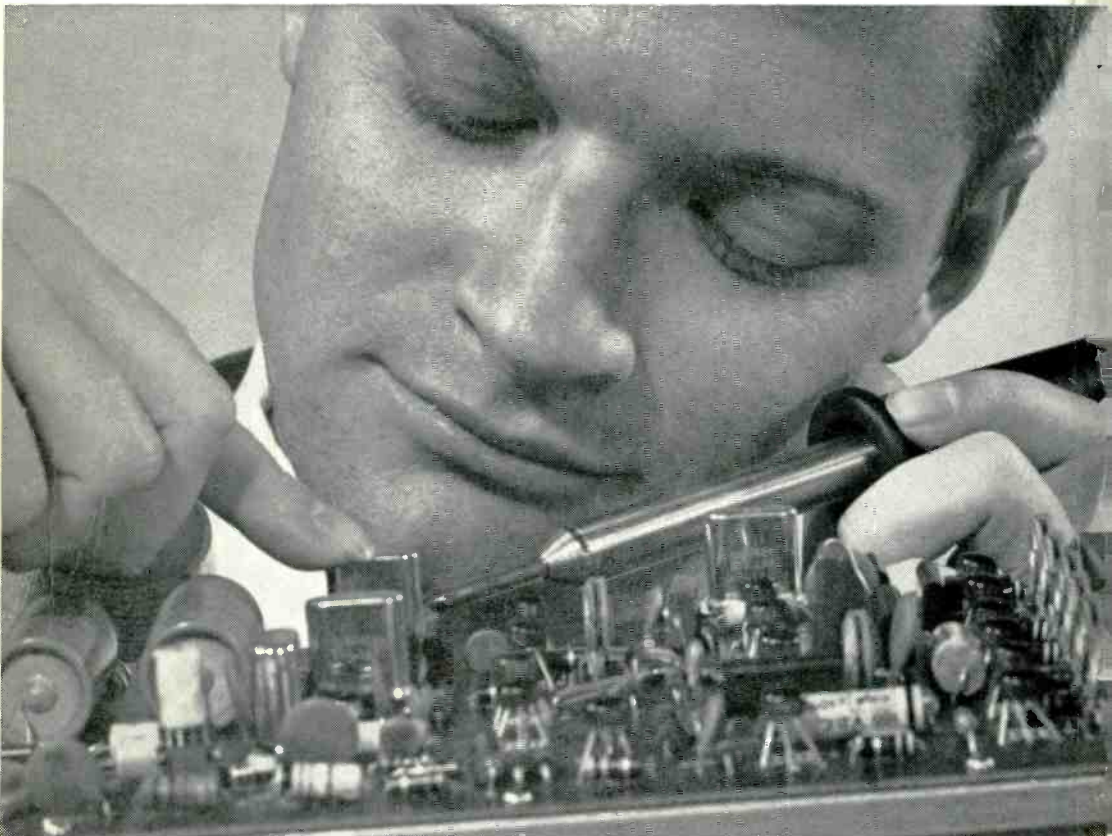
A.A.E. T-101 Transistor Tester

Kurz-Kasch LP-520-GM Logic Probe

Build a 4-Channel Universal Decoder



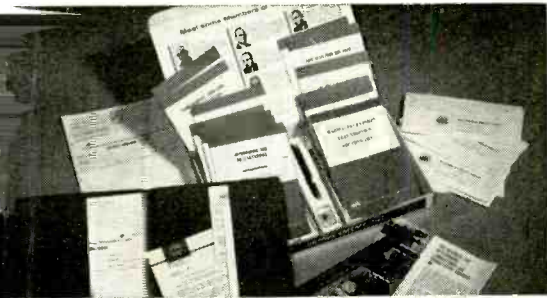
**NRI “hands-on” training in
Television, Communications,
Electronics and Computers
can give you as much
as 2 years of on-the-job
experience.**



EARN YOUR FCC LICENSE – OR YOUR MONEY BACK

NRI Communications training programs will qualify you for a First Class Commercial Radiotelephone License issued by the FCC. If you fail to pass the FCC examinations for this license after successfully completing an NRI Communications course we will, on request, refund in full the tuition you have paid. This agreement is valid for the period of your active student membership and for six months after completion of your training. No school offers a more liberal FCC License agreement.

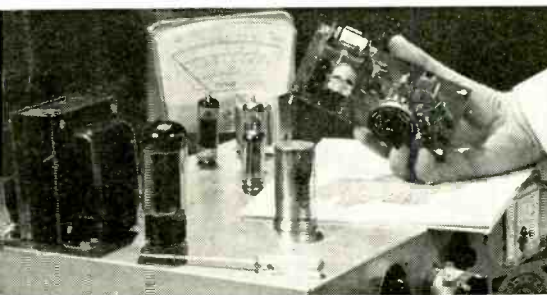
Experience is still your best teacher



NRI Achievement Kit is educator-acclaimed and the original "starter" kit in home study training. Imitated but never duplicated, this kit is designed and personalized for you and your training objective. It has one purpose — to get you started quickly and easily.



"Bite-Size" Texts average an easily-digested 40 pages of well-illustrated, scientifically prepared subject matter in the course of your choice. Questions in each book are carefully hand-graded and returned to you with helpful instructional notes. You get unlimited personal help from the day you enroll.



Designed-For-Learning Equipment

Like this phone-cw transmitter (Kit #7 in the Communications course) is engineered from chassis up to demonstrate principles you must know. NRI does not use modified hobby kits for training, but the finest parts money can buy, professionally and educationally applied.

...here's how you get it with unique NRI training at home

Ask any teacher, job counselor, engineer, technician or prospective employer about the need for practical application of theory in Electronics. He'll tell you Electronics is as much a "hands-on" profession as dentistry or chemistry. That's how you learn at home with NRI. You prove the theory you read in "bite-size" texts, by actual experimentation with the type of solid-state, transistor and tube circuits you'll find on the job today — *not* hardware or hobby kits. You introduce circuit defects, analyze results, discover quickly the kind of trouble-shooting and design techniques that will make you employable in Electronics.

Train with the leader — NRI

NRI lab equipment is designed from chassis up for effective, fascinating training — not for entertainment. The fact that end results are usable, quality products is a bonus. In Communications, for example, you build and analyze, stage by stage, your own 25-watt phone/cw transmitter. It's suitable for use on the 80-meter amateur band, if you have an interest in ham radio. In TV-Radio Servicing your practical training gives you your choice of monochrome or color TV sets. All training equipment is included in the low tuition — you pay nothing extra. Discover for yourself the ease, excitement and *value* of NRI training. Mail postage-free card today for new NRI Catalog . . . or use the coupon below. No obligation. No salesman will call on you. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

APPROVED UNDER NEW GI BILL

If you have served since January 31, 1955, or are in service now, check GI line on postage-free card or in coupon.

MAIL THIS COUPON IF CARD IS GONE



NATIONAL RADIO INSTITUTE

Washington, D.C. 20016

1-122

Please send me your new NRI Catalog. I understand no salesman will call and there is no obligation.

Name _____ Age _____

Address _____

City _____ State _____ Zip _____

Check for facts on new GI Bill

ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL

Popular Electronics

WORLD'S
LARGEST-SELLING
ELECTRONICS MAGAZINE

INCLUDING **Electronics World**

FEATURE ARTICLES

- 33 ALPHA BRAIN WAVES & BIOFEEDBACK TRAINING** *Mitchell Waite*
New ways of extending influence of mind over body.
- 44 WHAT'S IN A COLOR-TV SIGNAL?** *Forest H. Belt*
Much information for testing, programming, etc.
- 49 RECEIVERS FOR THE SHORTWAVE LISTENER** *Julian D. Hirsch*
Part 2—Table and portable models.
- 54 RADIO EMERGENCY CALL BOXES**
- 62 NUCLEAR RADIATION & DETECTION** *J. G. Ello*
Part 3—Radiological survey meters.
- 67 REPORT ON PROPOSED CLASS "E" CB BAND** *Richard Humphrey*
- 90 A NEW TV ANTENNA** *John T. Frye*
Design concept promises improved reception.
- 98 AMPERE'S LAW** *David L. Heiserman*

CONSTRUCTION STORIES

- 28 BUILD A 4-CHANNEL UNIVERSAL DECODER** *Fred Nichols*
Plays back CBS "SQ," Sansui, and E-V material.
- 55 BUILD A CRYSTAL-CONTROLLED MUSICAL INSTRUMENT TUNER** *Hank Olson*
Accurate source of 440 or 220 Hz.
- 74 SOUND-ACTIVATED PHOTOFLASH ATTACHMENT** *Vic Leshkowitz*
- 104 BUILD AN AUDIO LEVEL METER** *Samuel C. Milbourne*
Add range to low-cost dB meter.
- 105 ADD A COMPRESSION AMPLIFIER TO YOUR ELECTRONIC ORGAN** *James E. Rohen*

ZIFF-DAVIS PUBLISHING COMPANY
Editorial and Executive Offices
One Park Avenue, New York, New York 10016
212 679-7200

William Ziff, President
W. Bradford Briggs, Executive Vice President
Hershel B. Sarbin, Senior Vice President and Secretary
Philip Sine, Financial Vice President and Treasurer
Phillip T. Heffernan, Vice President, Marketing
Frank Pomerantz, Vice President, Creative Services
Arthur W. Butzow, Vice President, Production
Edward D. Muhlfeld, Vice President, Aviation Division
Irwin Robinson, Vice President, Travel Division
George Morrissey, Vice President
Sydney H. Rogers, Vice President
Sidney Holtz, Vice President
Lawrence Sporn, Circulation Director

POPULAR ELECTRONICS Including ELECTRONICS WORLD, December, 1972, Volume 2, Number 6. Published monthly at One Park Ave., New York, NY 10016. One year subscription rate for U.S., U.S. Possessions and Canada, \$6.00; all other countries, \$7.00. Second class postage paid at New York, N.Y. and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada and for payment of postage in cash. Subscription service and Forms 3579: P.O. Box 2774, Boulder, CO 80302. Editorial offices for manuscript contributions, reader inquiries, etc.: One Park Ave., New York, NY 10016.

POPULAR ELECTRONICS Including ELECTRONICS WORLD is indexed in the Reader's Guide to Periodical Literature.

Copyright © 1972 by ZIFF-DAVIS PUBLISHING COMPANY. All rights reserved.

EDGAR W. HOPPER
Publisher
WM. A. STOCKLIN
Editorial Director
MILTON S. SNITZER
Editor
LESLIE SOLOMON
Technical Editor
JOHN R. RIGGS
Managing Editor
EDWARD I. BUxbaUM
Art Director

ALEXANDER W. BURAWA
Associate Editor
ANDRE DUZANT
Technical Illustrator
JUDITH L. HOGAN
Editorial Assistant
FOREST H. BELT
JOHN T. FRYE
DAVID L. HEISERMAN
J. GORDON HOLT
RICHARD HUMPHREY
Contributing Editors

JOSEPH E. HALLORAN
Advertising Director
JOHN J. CORTON
Advertising Sales
MADELEINE LITTMAN
Advertising Service Manager
STANLEY NEUFELD
Associate Publisher
FURMAN H. HEBB
Group Vice President
Electronics and Photographic

THE SCENES

- 12 STEREO SCENE** *J. Gordon Holt*
Gadgets for the audiophile.
- 100 TEST EQUIPMENT SCENE** *Leslie Solomon*
Semiconductor testing.
- 119 SURPLUS SCENE** *Alexander W. Burawa*
New York's walk-in dealers.

PRODUCT TEST REPORTS

- 80 HEATHKIT AR-1500 AM/STEREO FM RECEIVER**
- 84 LAFAYETTE SQ-M 4-CHANNEL DECODER**
- 86 KURZ-KASCH LP-520-GM LOGIC PROBE**
- 87 SENCORE CG-22 COLOR-BAR GENERATOR**
- 88 A. A. E. MODEL T-101 TRANSISTOR TESTER**

DEPARTMENTS

- 6 EDITORIAL** *Milton S. Snitzer*
Video Cartridges, Cassettes, and Compatibility
- 8 LETTERS**
- 25 NEWS HIGHLIGHTS**
- 106 NEW PRODUCTS**
- 110 ELECTRONICS LIBRARY**
- 111 NEW LITERATURE**
- 116 EDITORIAL INDEX**
TO VOLS. 1 AND 2

READER SERVICE CARD ON BACK COVER

COMING NEXT MONTH

Matrixing Methods for 4-Channel Sound
Build an Alpha Brain-Wave Monitor
Liquid Crystals—How They Work
How to Select a CB Antenna

Midwestern Office
The Pattis Group, 4761 West Touhy Ave.,
Lincolnwood, Illinois 60644, 312 679-1100
GERALD E. WOLFE, DICK POWELL
DICK GOVATSKI, MANLEY LUDWIG

Western Office
9025 Wilshire Boulevard, Beverly Hills, California 90211
213 273-8050; BRADSHAW 2-1161
Western Advertising Manager, BUD DEAN

Japan: James Yaqi
Oji Palace Aoyama; 6-25, Minami Aoyama
6 Chome, Minato-Ku, Tokyo 407-1930/6821

Ziff-Davis also publishes Boating, Car and Driver, Cycle, Flying, Modern Bride, Popular Photography, Skiing, and Stereo Review.

Forms 3579 and all subscription correspondence should be addressed to POPULAR ELECTRONICS Including ELECTRONICS WORLD, Circulation Department, P.O. Box 2774, Boulder, CO 80302, Please allow at least eight weeks for change of address. Include your old address, as well as new—enclosing, if possible, an address label from a recent issue.

Editorial contributions must be accompanied by return postage and will be handled with reasonable care; however, publisher assumes no responsibility for return or safety of art work, photographs or manuscripts.



Member Audit Bureau of Circulations



Editorial

By Milton S. Snitzer, Editor

VIDEO CARTRIDGES, CASSETTES AND COMPATIBILITY

Cartridge Television Inc. has introduced a video playback unit for pre-recorded and self-recorded tape cartridges on any color-TV receiver. They have already received orders for Cartrivision subassemblies for inclusion in color-TV sets made by Warwick Electronics (for Sears Roebuck); Admiral Corp. (which also supplies sets to Montgomery Ward and National Union, distributor of Emerson and Dumont sets), and Teledyne Packard-Bell. Sears is charging \$1600 for its top-of-the-line console with Cartrivision and camera.

The Cartrivision units that we have seen are outboard players that can be used with any manufacturer's color-TV set. It is only necessary to connect the output of the video player to the antenna terminals of the TV set and, *voila*, the set will play back the picture and sound recorded on the cartridge. The r-f output of the player can be connected to four separate TV sets at the same time; with preamplification, a much greater number of sets can be driven.

The separate playback units, which are expected to be made available early next year to set makers, will sell for around \$700. A playback unit that will also record will be about \$900. A handheld TV camera for making video recordings will cost around \$250.

The tape cartridges, containing $\frac{1}{2}$ -in. tape on two reels atop each other, come in several sizes and tape lengths. A blank 15-minute cartridge will cost \$12, while a 100-minute blank cartridge will sell for \$37. A library of several hundred pre-recorded cartridges is available at prices from \$13 to \$40, depending on length. There is also a number of feature films available at prices from \$3 to \$6 for a one-time playing. (The user cannot rewind the cartridge.)

The Cartrivision player/recorder operates at a tape speed of 3.8 in./second. Three video heads mounted on a drum rotating at 1200 r/min helically scan the $\frac{1}{2}$ -in. magnetic tape. And herein lies the problem. Cartrivision cartridges can only be played back on Cartrivision players. They cannot be played back on Sony's video cassette machines, RCA's video tape units, Kodak's video players, Norelco's units, or any other player. The system, in other words, is not compatible. Once someone buys a player, he is stuck with the tape library for that particular system.

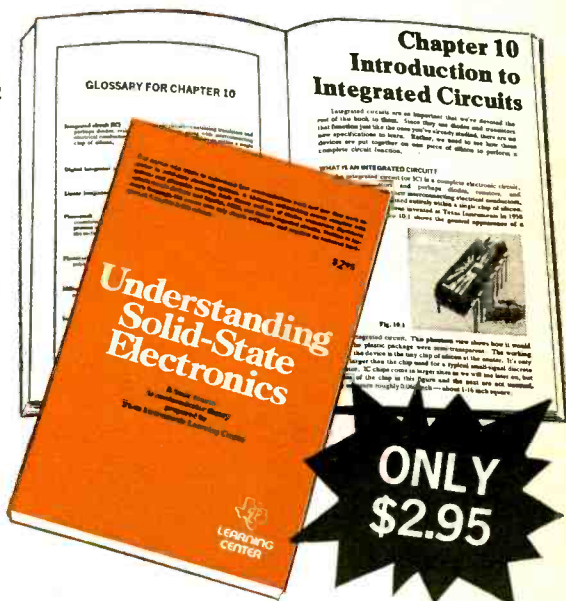
This does not seem to bother the Cartrivision people, however. They are proceeding to acquire titles for their cartridges; and they feel that the public is ready for video tape in the home right now. This is in contrast to Sony's view, for example, that video tape will be used first in industry, schools, and institutions before getting into the home consumer market.

We think that, unless or until there can be real standardization and a more attractive (low) price, the public will justifiably be a little hesitant about putting any hard-earned dollars into such equipment for home use.

“This pocket-sized masterpiece explains what electronics is all about...a marvelous little book...” **Electronic Buyers' News**

“For \$2.95, it will take a novice from basic electricity through MOS and linear ICs... as good a basic book as we've seen.”

Electronics magazine



Understanding Solid-State Electronics is a self-teaching text which begins at the beginning and explains every new idea and technical subject in terms you can understand.

This book was created for anyone who wants or needs to understand solid-state electronics, but can't devote years to the study.

Texas Instruments prepared the course for its own non-engineering employees and customers — and thousands have proven its effectiveness.

It's a practical course. Engineering concepts are explained without using mathematics — just a little simple arithmetic. Technical terms are used, but each one is explained — in plain English.

12 lessons plus quizzes, glossaries — 250 pages

The lessons cover: What Electricity Does in Every Electrical System • Basic Circuit Functions • How Circuits Make Decisions • Relating Semiconductors to Systems • Diodes: What They Do and How They Work • Transistors: How They Work, How They Are Made • Transistor Specifications

• Thyristors • Optoelectronics • Introduction to Integrated Circuits • Digital Integrated Circuits • MOS and Linear Integrated Circuits.

Award-winning course

Tens of thousands of readers have followed the serialization of this book in *Electro-Procurement* magazine — for which it won the 1972 Jesse H. Neal Editorial Achievement Award, the “Pulitzer Prize” of the business press.



Send coupon today for your copy

LEARNING CENTER

Texas Instruments Learning Center
P.O. Box 3640 • Dallas, Texas 75222

Please send _____ copies of **Understanding Solid-State Electronics**. I have enclosed \$2.95 for each copy ordered (check or money order only). Total amount enclosed is \$_____.

NAME _____

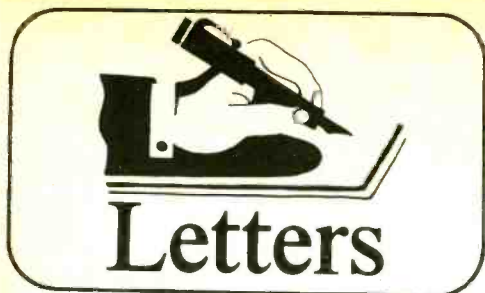
ADDRESS _____

CITY _____ STATE _____ ZIP _____

P.E.

TEXAS INSTRUMENTS
INCORPORATED

11120



CIRCUIT BOARDS USING TAPE

Regarding the article "Constructing PC Boards" (September 1972), it is not necessary to go to photoresist boards and mess around with negatives. I have made up literally hundreds of experimental boards using Scotch tape directly on unsensitized boards. Adhesive tape in widths from 1/32" up is available from electronics supply houses.

Intricate designs (transistor terminals, integrated circuits) can be made using regular scotch tape and carving out the design using the point of a pen knife. This procedure may not be convenient if you are making dozens of similar boards, but what experimenter does?

Besides, unsensitized boards are a whole lot cheaper!

H. N. CAMPBELL
Moravia, N.Y.

ONE FOR ECOLOGY

The article "Constructing PC Boards" was very interesting and informative. However, the method suggested to dispose of the etchant is not a very good one. There are enough people pouring chemical waste into our water supplies without your openly encouraging such pollution.

B. DAKIN, WAIGIR
Burlington, Vermont

Bravo! And thanks for the admonishment. The etchant is an acid and should be treated with respect. Once it is used, however, it is partially neutralized. And you will note that we said to put it down the drain with a lot of running water (to protect not only the ecology but the drain pipes). Further neutralization and dilution would reduce the danger of contamination.

IDENTIFICATION IS GOOD

I have just read your article "Automatic Identification of Transmitters" ("Communications Scene," August 1972); and, for what it's worth, I'd like to give my full support to the FCC proposal.

Of course the loudest squawk will probably be heard from the CB'ers, since their total neglect of the law has made them feel that they are something special. Unfortunately, those few CB'ers who try to observe the law are dwarfed by those who have only a personal interest. I

*the tape that
turned the
cassette into
a high-fidelity
medium*



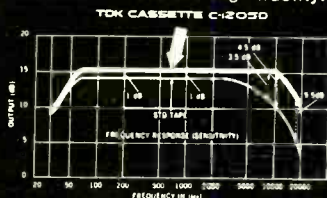
TDK SUPER DYNAMIC (SD) TAPE



TDK

Until TDK developed *gamma ferric oxide*, cassette recorders were fine for taping lectures, conferences, verbal memos and family fun—but not for serious high fidelity.

Today you can choose among high-quality stereo cassette decks.



The new magnetic oxide used in TDK Super Dynamic tape distinctively differs from standard formulations in such important properties as coercive force, hysteresis-loop squareness, average particle length (only 0.4 micron!) and particle width/length ratio. These add up to meaningful performance differences: response capability from 30 to 20,000 Hz, drastically reduced background hiss, higher output level, decreased distortion and expanded dynamic range. In response alone, there's about 4 to 10 db more output in the region above 10,000 Hz—and this is immediately evident on any cassette recorder, including older types not designed for high performance. There's a difference in clarity and crispness you can hear.

Available in C30SD, C60SD, C90SD and C120SD length

TDK ELECTRONICS CORP.
LONG ISLAND CITY, NEW YORK 11103

CIRCLE NO. 40 ON READER SERVICE CARD

have often been criticized for refusing to "soup up" a CB rig or to "hike up" the antenna for a class D radio.

The only question I have is: How will the serious amateur or the licensed experimenter who builds his own transmitter be affected? I'm sure that, if this problem can be overcome, there will be wide acceptance of the proposal.

GEORGE ECHOHAWK
Sand Springs, Okla.

BACK ISSUES FOR SALE

I have a considerable collection of POPULAR ELECTRONICS and ELECTRONICS WORLD magazines that I have to get rid of because I am moving. I have a complete set of PE (77 issues) from May 1966 through Sept. 1972 and an incomplete set (64 out of 69) of EW from April 1966 through Dec. 1971. Make an offer for either or both sets. Include estimate for shipping or pay shipping charges collect.

WILLIAM H. RAUCKMANN
1314 Osgood Road
Colorado Springs, CO 80915

METAL DETECTOR PRICES

We enjoyed your article "Treasure Detectors for Land Use" (September 1972) but would like to point out an error in price for the White's Electronics Model 66T. The price given in the table is for a basic model which does not include the loops indicated. The 7½" and 10½" loops are part of a deluxe group package that lists for \$359 retail.

R. C. RITTENHOUSE
The Jerry Martin Co.
Gurnee, Ill.

SIMPLIFIED LIGHT MINDER

I like the "Light Minder" (September 1972) but I think it can be simplified by leaving out three of the four parts. The diodes can be done away with by connecting the Sonalert from the tail-light line (which is on whenever parking lights or head lights are on) and the oil pressure switch. This system has been used in my VW for three years.

J. D. YOUNG, WA8KNE
San Diego, Calif.

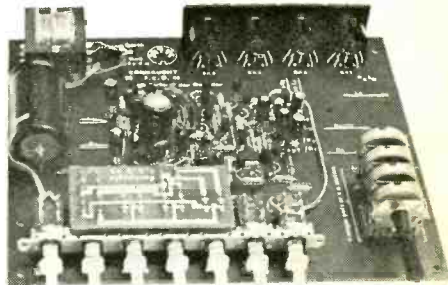
ATWATER KENT MANUAL FOR SALE

I have a technician's repair manual that covers all of Atwater Kent's radio models. It includes schematics, parts lists, price lists, and instructions. The date of the manual is June 1931.

CHARLES E. BAKER
2520 Victor Place
Everett, Wash.

Anyone interested? Please write directly to Charles.

HIGH PERFORMANCE SQ* from Audionics



AUDIONICS SQ 106B

Until now there have been two basic types of SQ decoders available -- the simple *matrix* type or the far more expensive *logic* units. Now there is a third alternative -- the 106 series from Audionics.

There are several technical reasons why the 106 series offers superior performance and these require the best part of two pages to explain but simply stated:

A 17 transistor circuit (patent pending) which provides logic type performance with a Wider Phase Differential Bandwidth, lower total harmonic distortion and higher overload capability PLUS the option of updating to FULL LOGIC performance upon the availability of low cost logic ICs for SQ.

The 106 series is available in three versions: The 106A, a basic SQ decode circuit in module form -- you add the external power supply, input/output jacks and controls. The 106B, with all the above mounted on one circuit board along with the SQ decode components but less enclosure. The 106C, a complete component version, assembled and ready for use.

Whether you are a hobbyist or a serious audiophile with the latest components, you'll find the 106 series offer high performance with no sonic degradation of fidelity. Series 106 decoders may be ordered directly from Audionics, Inc., or write for a list of dealers and detailed technical specifications.

Phase Differential Bandwidth 20 HZ to 17kHz @ 90° ± 10°
Frequency Response ± 1 dB 5HZ to 100kHz
THD @ 60HZ at 1.5 volts output -- typically .08%
@ 1kHz at 1.5 volts output -- typically .08%
Hum level (module form) - 69 dB
Noise Level (module form) - 80 dB
Size: 106A 2½" x 3¼" x 1" 106B 6½" x 5½" x 1"
Price: 106A \$39.95PP 106B \$74.95PP 106C \$99.95PP
*TM CBS, Inc.

AUDIONICS, INC.

8600 NE Sandy Blvd.
Portland, Oregon 97220

Please send ___ SQ 106A @ 39.95 PP
___ SQ 106B @ 74.95 PP
___ SQ 106C @ 99.95 PP
___ Free technical information

Name _____
Address _____
City _____ State _____ Zip _____

A NEW STANDARD!... THE 7400 SCIENTIFIC & ENGINEERING CALCULATOR

FROM
MITS®

THE MOST POWERFUL SCIENTIFIC CALCULATOR FOR UNDER \$500.00

The price of the 7400 is low enough to make a desk top computer available to almost anyone.

SIGNIFICANT FEATURES NOT FOUND IN MOST COMPETITIVE MACHINES

- DYNAMIC RANGE: 10⁻⁹⁹ to 10⁹⁹
- DATA STORAGE: 2 Auxiliary Storage Registers plus up to 7 push-up Stack Registers.
- Roll up and roll down keys for complete control of operational stack
- Interfacing provisions for printer and programmer
- Correct X (Allows the operator to correct one digit, without re-entering the whole problem)
- Polar to Rectangular conversion and Retangular to Polar conversion

DISPLAY: Either full floating or scientific notation, 14 large, easy-to-read digits.

SIZE: 8½" x 12" x 3½"

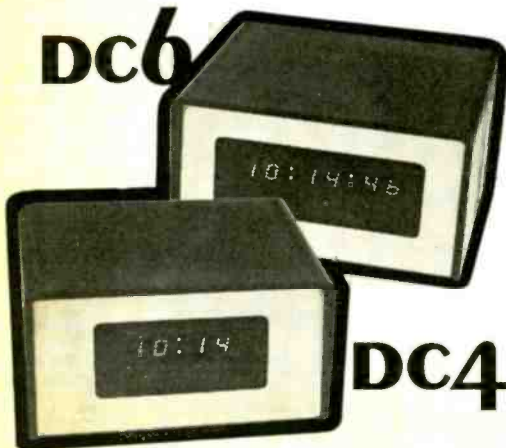
WEIGHT: 4 lbs.



7400A 3 Registers	Kit \$299.95
	Assembled \$379.95
7400B 5 Registers	Kit \$319.95
	Assembled \$399.95
7400C 7 Registers	Kit \$339.95
	Assembled \$419.95

PRICES INCLUDE CARRYING CASE

MITS will repair any 7400 for a fee of \$25.00 for a 5-year period after the normal 1-year warranty has expired.



MITS DIGITAL CLOCKS feature large LED displays, 12 or 24 hour operation, 50/60 HZ operation, and individual time set buttons.

6 DIGIT [hours, minutes, seconds]

DC6-E [electronics only]	\$49.50
DC6-K [complete kit]	\$58.50
DC6-M [assembled unit]	\$99.50

4 DIGIT [hours, minutes, and 1 sec. pulsed colon]

DC4-E [electronics only]	\$39.50
DC4-K [complete kit]	\$48.50
DC4-M [assembled unit]	\$89.50

Specify 12 or 24-Hour Operation on Assembled Units



1440

Square root and fourteen digit LED display makes the 1440 the choice of those who want the very best.

Sophisticated functions (made possible by unique MOS-LSI circuitry) include constant operation, 14 digit data memory, negative number entry, and operand exchange . . . all one touch operations!

Printer and programmer add-ons will be available soon to convert the 1440 and 816 to impressive desk top computers.

1440 Kit . . . \$199.95 Assembled . . . \$249.95

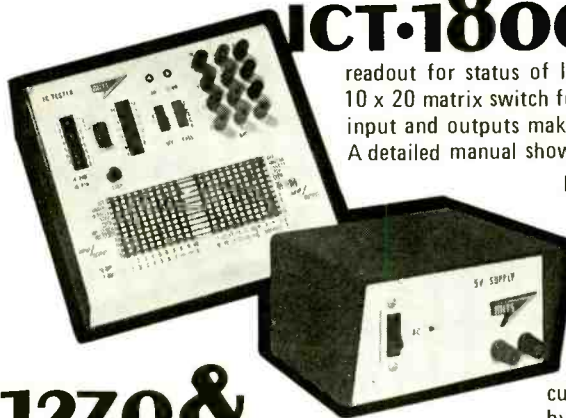


816

16 digit output capacity is available on the 816 models. Constant operation and computed fixed decimal system makes the 816 useful for business or home use.

Human-engineered keyboard and large electro-flourescent display gives both 816 models an operating ease and flexibility unmatched in machines costing hundreds more.

816A Kit . . . \$149.95 816B Kit . . . \$159.95
816A Assembled \$179.95 816B Assembled \$189.95



ICT-1800

The ICT-1800 is to IC's as the tube tester was to vacuum tubes. Features are LED readout for status of IC under test, 2-speed clock, single step capability, 10 x 20 matrix switch for complete programming of IC under test. Remote input and outputs make the 1800 a valuable tool for breadboarding.

A detailed manual showing diagrams of all common digital IC's is included.

ICT-1800 Kit: \$119.95 Assembled: \$169.95

PS500

The PS500 has a fixed 5-volt output at one ampere with a typical line regulation of .005% and load regulation of .6%. The integrated circuit voltage regulator provides both overtemperature and over-current shutdown capability. Power status is shown by an LED indicator.

PS500 Kit: \$29.95 Assembled: \$39.95

1230 & 1240

Send for our newest 4-function calculators, the 1230 & 1240 - both are 12-digit desk top models featuring Sperry gas discharge displays, true credit balance sign display with leading zeros suppressed, and automatic overflow indication. In addition to the standard functions, the 1240 has a memory storage register and fixed decimal point from 0 to 5 places.

1230 Kit: \$89.95
1240 Kit: \$119.95

Assembled: \$99.95
Assembled: \$149.95

Use Your BankAmericard or Master Charge

MITS®

WRITE OR MAIL COUPON FOR
ADDITIONAL INFORMATION:

**Micro Instrumentation &
Telemetry Systems, Inc.**

5404 Coal Ave., S.E., Albuquerque, New Mexico 87108
505/266-2330

ENCLOSED IS CHECK	<input type="checkbox"/> Kit	PT12-2
FOR MODEL # _____	<input type="checkbox"/> Assembled	
AMOUNT OF CHECK \$ _____		
(Include \$5.00 for postage & handling)		
<input type="checkbox"/> Please send information on entire MITS line.		
NAME _____		
ADDRESS _____		
CITY _____		
STATE & ZIP _____		

CIRCLE NO. 26 ON READER SERVICE CARD



Stereo Scene

By J. Gordon Holt

SOME years ago, a cartoon in one of the photography magazines depicted an amateur photographer leaving his home burdened down by tripods, flash attachments, floodlights, exposure meters, filter cases, auxiliary lenses, and a shoulder bag that was presumably full of smaller items. He was looking over his shoulder at his wife, who was running after him, holding something aloft, and yelling "Wait a minute, you forgot your camera."

Of all hobbyists, photographers probably have the best-known reputation for being gadget-crazy, but there are two other groups that are equally deserving of the reputation: car buffs and audiophiles. And while the audiophile may sneer at the transistorized ignition system and dash-mounted tachometer in the car buff's vehicle, the car buff might be equally disparaging about the little brush that wipes an audiophile's discs clean while they're playing, or the multi-knobbed control center that allows him to rearrange the sound to suit his taste.

A gadget is, almost by definition, something that you acquire after the main object of your hobby (camera, car or hi-fi system) has satisfied you that it does what it should do. Most gadgets, then, are intended to make it do *more* than it should, or do it better. Gadgetry is thus rather a badge of sophistication—evidence for all the world to see that you have graduated from the level of a mere owner of something to an advanced user or appreciator. This is not to

say that gadgetry buyers buy their gadgets to achieve status, or even that they are aware that status is involved. In fact, most of us buy gadgets because: (1) they promise to do something we want done and do it better or more easily than anything we already own; (2) because they (the gadgets) *look* as if they will enhance performance; and (3) because it's fun to spend money on your hobby. While you can't buy a new camera or car or hi-fi system every week, you *can* buy gadgets that often if you care to.

According to our definition, anything that is not absolutely necessary in order for a reproducing system to make sound can be considered a gadget, and the range of gadgets runs the price gamut from little plastic clips that prevent tape from unwinding from a reel, through stylus gauges and test records and head demagnetizers, up to multi-channel mike mixers, noise-reduction devices, and four-channel decoders with built-in logic sensing and enhancing.

It should be noted that small, inexpensive audio accessories are rarely listed in the directories of audio equipment that appear on newsstands every year, probably because there are just too many to list. The best sources of information about what's available are those big, fat catalogs issued by the large mail-order electronics supply houses like Allied/Radio Shack and Lafayette Radio, and the catalogs available from the firms that supply much of their gadgetry, like Robins Industries, Audiotex, and Nortronics. Robins and Audiotex run the gamut, while Nortronics is exclusively in the tape-equipment field. In more specific areas, such as microphone or headphone accessories, the manufacturers of the devices also make available a wide selection of gadgets for use with them, and catalogs are available directly from the factories. For

A Galaxy of Gadgetry

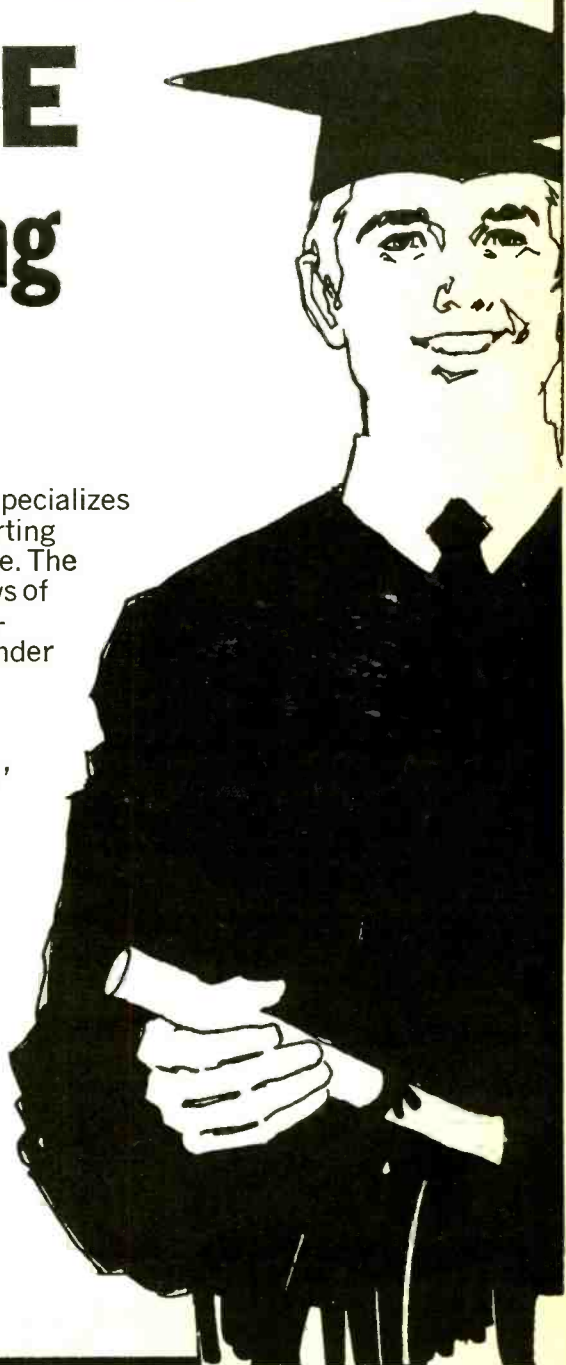
Earn Your Electronics DEGREE by studying at home.

Grantham School of Engineering specializes in teaching electronics and supporting subjects, mainly by correspondence. The School is authorized under the laws of the State of California to grant academic degrees, and is approved under the G.I. Bill.

The A. S. E. T. Degree is offered in four "correspondence semesters" plus a two-week residential seminar. Then, the B. S. E. E. Degree is obtainable through further residential training in engineering subjects and transfer credits in the humanities. For complete information, write for our free BULLETIN P-73.

GRANTHAM
School of Engineering

1505 N. Western Avenue
Hollywood, CA 90027



CIRCLE NO. 19 ON READER SERVICE CARD

example, Shure and Electro-Voice make almost as many mike accessories as mikes, while Koss produces many headphone accessories as well as their long line of phones. A collection of these catalogs, plus the big ones from the mail-order houses, is a veritable goldmine of gadgetry. Such as . . .

GADGETS FOR TAPES

We have already mentioned **reel clips**, which fasten to the edge of a tape reel to prevent the tape from unwinding when it is subjected to shaking, as in transit through the mail. These work, but only with a full reel of tape. With a partially full reel (or even a full one, for that matter), the same objective can be accomplished by folding the end of the tape over the reel flange and fastening it with a bit of Scotch mending tape.

Gummed-paper **title labels** for identifying recorded reels are available from hi-fi gadget suppliers, but equally suitable labels can be bought at much lower cost from stationery stores. The same goes for those bright red "china-marking" pencils that are sold for marking the cutting points on a tape that you're editing. They're cheaper when they aren't sold specifically for editing tape. And they can also be used for putting temporary identifying information on plastic or metal reels; the writing is removed from the reels with an alcohol-soaked rag.

Tape splicers come in all shapes and sizes, and are one of the few things in the hi-fi field about which it can be said that you get exactly what you pay for. The cheapest ones will do a slightly better job than you can do with scissors and your bare hands; the most expensive ones—bars of cast aluminum several inches long with a slightly undercut channel along them to hold the tape—make the quietest, strongest splices, and will allow you to assemble bits of tape a fraction of an inch long into a smooth perfectly strong splice if the need for this should ever arise. The semi-automatic splicers are less flexible than the professional-type editing blocks, but require less manual dexterity and less skill to use. If your recorder is a 4-track type, though, try to get a splicer that trims a minimal amount from the width of the tape, for the left-channel tracks extend to the edges of the tape, and excessive trimming here will cause a momentary loss of left-channel signal level.

Cassette editors are available, but are best used only for repairing broken tapes.

Cassette splices are likely to be conspicuously audible. Cartridge tapes can be edited on an open-reel editor, but since it is almost impossible to get the tape back into the cartridge, my suggestion here is to forget it.

Editing pencils, which allow you to erase small segments of tape, are of limited value, as the same thing can usually be accomplished more effectively by editing with a splicer.

Bulk erasers, for cleaning off old recordings without unwinding the tape, are also variable in their efficacy. Some don't erase completely, so try your prospective purchase with an *old* recorded tape. Recordings tend to "harden" with age, becoming more difficult to erase, so a bulk eraser that will clean off a recording several years old will cope with practically anything. The exception here is in the cassette field, where some of the new high-potency oxides are even harder to erase than a "hardened" ferrous-oxide tape. Before buying a cassette eraser try it with chromium-dioxide tape.

Hand-held erasers, if of sufficient potency, are usable on open-reel, cassette, or cartridge tapes, but don't try degaussing recorder heads with them, as they may weaken the magnets in the recording-level meters.



Magnesonics, Corp. cassette eraser.

Induction-type **telephone pickups**, for recording phone conversations without making a direct line tap, vary widely in their performance and their sensitivity. Many will hum loudly with most tape recorders, while some have too much output to feed a microphone input and too little to feed a high-level line input. Your best bet here is to try

BE AMAZED! ADD STARTLING FOUR-CHANNEL SOUND TO ANY STEREO ... HOME OR CAR ... THE EASY, LOW-COST RADIO SHACK WAY!



HOME ADD-ON SYSTEM

Your stereo system is ready and waiting for easy changeover to the "Sound of the Seventies": Our Quatravox four-channel synthesizer and two Solo-103 speakers recover ambient sound previously "hidden" in ordinary stereo records, FM and tapes ... from right, left, front and rear, just as it's "reflected" in theaters, clubs, concert halls. No internal rewiring. Six audio cables and plugs are included. Save 5%! \$54.95

Realistic Quatravox™ Alone.
Add quatravox and two extra speakers to your present system for four-channel enhancement of all stereo. \$24.95

AND "ONE FOR THE ROAD"

If you already have stereo in your car, there's no need to miss out on the joys of four-channel. Our Auto Quatravox, plus two flush-mount speakers, connects easily to your present stereo radio or tape player for startling four-channel enhancement of any program or recording. Listen to front speakers only, rear only, or balance all four. 18-foot cables, hardware included. Save 10%! \$16.11

Above system with "Hang-On" Speakers.
Just hang speakers anywhere in car without installation. Save 10%! \$15.21

Realistic Auto Quatravox Alone.
Just add two speakers of your choice. Takes minimum space, only 5½ x 2½ x 1-3/4" \$9.95



Built-In



Hang-On



FREE 1973 CATALOG
See What's REALLY New in Electronics! Stereo, Communications, Hobby, Parts, Kits, Antennas, Tools, Much More. At Your Nearby Store or Write.

Exclusive at 1600 Stores in 50 States.

Radio Shack

and ALLIED RADIO STORES

A TANDY CORPORATION COMPANY

P. O. Box 1052, Fort Worth, Texas 76107

CIRCLE NO. 33 ON READER SERVICE CARD

Introducing Pickering Headsets



**They make the difference for
those who can hear it.**

You will hear the difference the moment you put them on. For Pickering has engineered a remarkable difference into these fine headsets.

Their sound is unmistakably natural, imparting a fuller sense of realism to the music. And Pickering's attention to important details goes even beyond the electro-mechanical innovations which result in their extraordinary reproduction performance.

Nothing has been done in a perfunctory manner in the new Pickering headsets. Their matchless styling is the result of tasteful employment of color dynamics, making their appearance as impressive as their sound. They can be comfortably worn over long listening periods. From the natural conforming adjustable headband, to the softly comfortable ear cushions, right on down to the flexible heavy-duty plug — every detail is special with Pickering.

When it comes to headphones, however, words simply can't do it. Demonstration does. Put ours to the test against any other comparable units at your local dealer... you'll hear the difference.

ILLUSTRATED: Pickering Model PH-4955, a true two-way reproduction system with individual woofer and tweeter and L-C crossover network in each ear-piece. Frequency Response: 22-20,000 Hz. Hand-stitched foam-filled headband and ear cushions, coil cord and flexible heavy-duty plug. Only \$59.95. Also available, Model PH-4933, with single full-range speakers. Only \$39.95.

For complete information write Pickering & Co., Inc., Dept. PE, 101 Sunnyside Boulevard, Plainview, New York 11803.



PICKERING

"for those who can hear the difference"

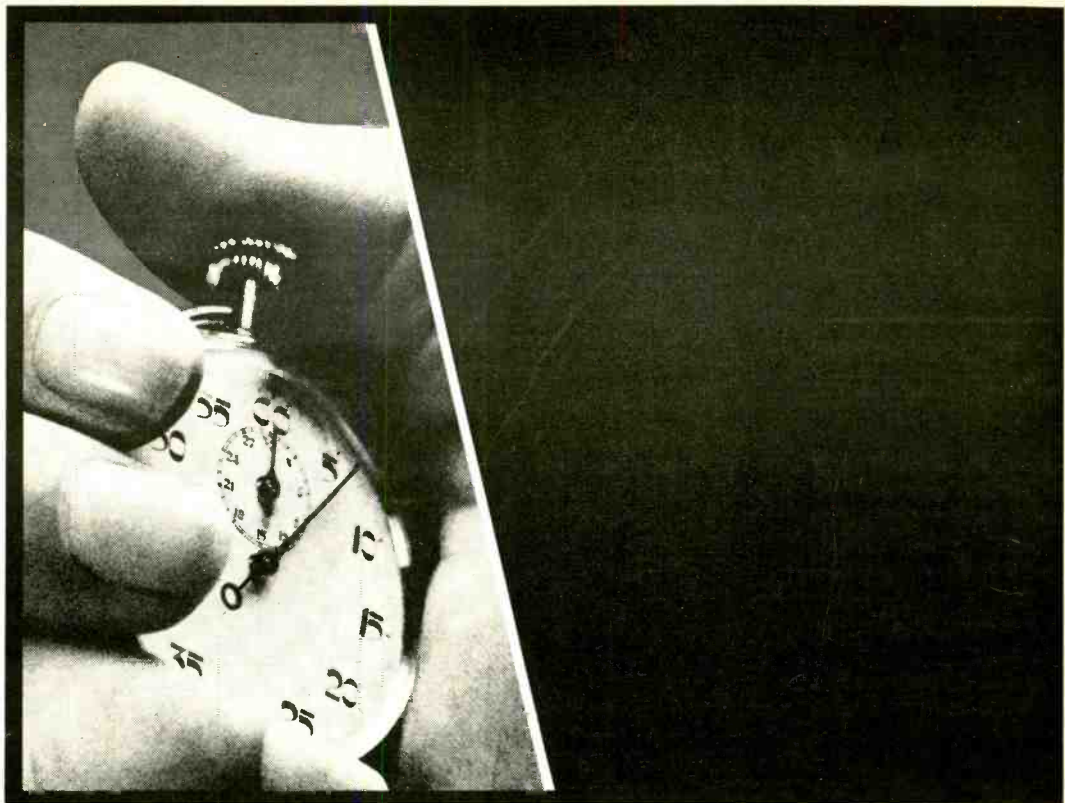
CIRCLE NO. 47 ON READER SERVICE CARD

the one you're thinking of buying, using a telephone in the store, or buy with the understanding that you can return it for credit or a refund if it doesn't work with your recorder. And remember: without a court order, it is a federal offense to record a phone conversation without informing both parties that a recording is being made.

There are several kinds of **noise-reduction devices** available, the best-known of which is of course the Dolby B, intended for home tape recording. Increasing numbers of recorders are now being made with built-in Dolby circuits, but several add-on Dolbys are available for use with existing recorders. These will be usable for de-Dolbying Dolby FM transmissions as they become the rule rather than the exception. All Dolby licensees must meet minimum-performance requirements set up by Dolby Labs, so the actual noise-reduction performance of all available Dolby units is about the same. Where the units differ is in accuracy of adjustment, which affects high-end response, and in the noise and distortion characteristics of the circuitry other than the Dolby parts. In addition, at least one available unit, the Advent 100A, has built-in provision for switching the Dolby playback sections directly in series with the main system preamp, so the Dolby can be used for deprocessing FM as well as any other incoming signal sources.

Dolby noise-reduction in playback is effective only with program material that was Dolby-processed during the recording phase. Most other noise-reduction systems can be used with any program material (except pre-Dolbyed material), but these devices do differ widely in their effectiveness and in the detrimental effects they have on the signal. Many add unacceptable amounts of distortion; many produce audible changes in frequency response or interruptions of low-level passages in the sound; and some add thumping or "swelling" modulations during wide-dynamic-range programs. So check out your prospective purchase with a recording having a wide range of dynamics on it. If it performs okay with that, it will be satisfactory with any kind of program material.

The advanced live-recording enthusiast almost invariably finds eventually that two mikes are not always enough to do a job properly, and starts investigating input mixers. These range from relatively inexpensive all the way up to astronomical prices



Solve 7 problems...in seconds.



Something totally new to add to your bag of tricks! We call them *Plug-in Problem Solvers*. They're designed to provide seven common modifications in microphone and sound system setups without soldering or rewiring—just plug them in! The Model A15A Microphone Attenuator that prevents input overload; Model A15PR balanced line Phase Reverser; and A15HP High Pass and A15LP Low Pass Filters to modify low and high frequency response; A15PR Presence Adapter to add brilliance; A15RS Response Shaper to filter sibilance and flatten response; and the A15LA Line Adapter that converts low impedance microphone inputs to line level inputs. Carry them on every job. It's a lot easier than carrying a studio console with you!

Shure Brothers Inc.,
222 Hartrey Ave., Evanston, Ill. 60204.



SHURE

CIRCLE NO. 36 ON READER SERVICE CARD

(for professional consoles to feed dozens of mikes to 16 tape tracks); and, again, you get pretty much what you pay for. For under \$100, you're likely to get some audible hum and hiss as well as rather high distortion. About \$115 will buy you a semi-professional unit like the Shure M-688, with four inputs, panning provision in one input, and good performance; while \$300 or more can buy a variety of compact professional mixers with six or more inputs. One model—the Gately Prokit SM-6—is available in kit form at a substantial cost saving, but it's hardly a job for a novice kit-builder to tackle.

The Advent 100A Dolby unit has mixing provisions for two line-level inputs per channel, and many tape recorders offer mixing between mike and line inputs in each channel. With these, all that is necessary to get four mixable mike channels is to add the necessary preamplifiers. Advent has a high-performance, externally powered (15 to 20 volts dc) MPR-1 preamp, accepting a pair of professional-type balanced-line, low-impedance mikes, and the 100A has two outlets on it to power two of the preamps. Alternatively, the preamps can be battery powered or fed from a suitable dc takeoff from any associated component. Some inexpensive preamps that will do an adequate job have been sold by Lafayette, Fisher and others but these accept only high-impedance microphones. For using low-impedance mikes, which are necessary for live recording in concert halls, churches and so on, Shure, Electro-Voice and Beyer make available low-to-high-impedance matching transformers.

RECORDER MAINTENANCE GADGETS

All of the available **head degaussers** are potent enough to do their job, but some may not be suitably shaped to reach your recorder's heads, so check this before buying. Special degaussers are available for use in cassette or cartridge machines, and at least one (from Ampex) combines cassette degaussing with a head-cleaning cycle.

The most worthwhile **alignment tapes** are those made for professional users and service technicians, and not only are these quite costly, they also require the use of suitable test equipment and a certain level of technical sophistication. Test tapes designed for "ear evaluation" of recorders are likely to give a recordist more unnecessary worry than enlightenment.

The best of the tape **head cleaners** is a cotton-tipped "Q-tip" swab saturated with a suitable solvent, and both are sold as hi-fi accessories. The cotton swabs are available at lower cost from drug stores, but I don't know of an alternate source of suitable solvent. (Carbon tetrachloride works fine, but inhaling the fumes causes liver damage, so that solvent is in disfavor these days.) Although overpriced, all of the head-clean-



Advent Dolby system for record/playback.

ing solvents sold as such do a good job, if you can reach your recorder's heads with the cotton swabs. If you can't, which is often the case with cassette and cartridge machines, you can buy special cassettes and cartridges loaded with a slightly abrasive cleaning tape that will do almost as good a cleaning job on heads and guides as a Q-tip. The capstan and pinch wheel must sometimes still be cleaned with a solvent in order to keep wow and flutter within specs.

Be careful with the solvents, though. The plastic trim on many tape recorders will readily dissolve in most head-cleaning fluids.

I don't recommend **silicone lubricants** for tape any more than for discs, and for the same reasons: they combine with dust to form an abrasive gunk, and they tend to foul the head surfaces, necessitating frequent cleaning. Most tapes are already suitably lubricated, and no more is required.

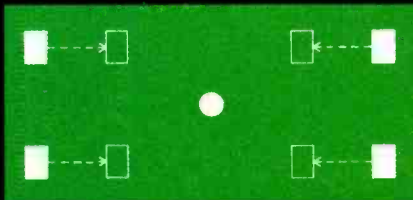
Tape stroboscopes are of value mainly to professional users and service technicians who are in a position to do something about a case of speed inaccuracy. For home recordists, periodic cleaning of the transport, plus an occasional pitch comparison (by ear) between the beginning and the end of a commercially recorded tape, will serve to ensure that constant speed is being maintained. To determine speed *accuracy*, compare the pitch of a pre-recorded tape with its equivalent disc release (making sure the disc is actually running at 33 $\frac{1}{3}$ rpm). ♦

Our 4-channel receivers can change the size of your living room.

Just move one slide control. And suddenly the room seems deeper. Another slide control. And it seems wider. The sound appears to move. Until speaker separation is just right for you. No matter how big or small your room is. With Panasonic's Acoustic Field Dimension (AFD). Only in our discrete 4-channel receivers. Models SA-6800X and SA-6400X.

Panasonic feels that the discrete sound system is the best for 4-channel. Whether you're listening to 8-track tapes or Compatible Discrete 4-channel (CD-4) records. Like RCA Quadradises.

Of course, these receivers can also handle matrix. Which makes AFD even more important. Because most encoding systems for matrix records have their own op-



timal speaker separations.

Another benefit for matrix recordings is our phase shifter. It has three different settings that correspond to the phasing of the various matrix systems. So virtually any matrix recording can be played.

All our receivers also make sure that the stereo collection you've amassed won't go to waste. You can play it straight. Or enhance it. With our Quadruplex™ circuitry.

Of course, there are other features in these Panasonics. Like our single lever remote balance control. It lets you control the balance of all four channels. From your easy chair. And as for the SA-6800X specs, we think you'll find them as interesting as its special features.

Model SA-6400X gives you 150 watts IHF at 4 ohms. With many of the same specs as Model SA-6800X.

So go to your franchised Panasonic Hi-Fi dealer for your

4-channel receiver. It's the only way to make sure you get one that's the right size for your living room. Whatever its size.

MODEL SA-6800X	
Power (IHF)	300 watts at 4 ohms
Harmonic distortion	0.5%
Power bandwidth	7Hz-40kHz, -3dB
FM usable sensitivity	1.8µV
Capture ratio (IHF)	1.5dB

FOR YOUR NEAREST FRANCHISED PANASONIC HI-FI DEALER, CALL TOLL FREE 800 243-6000. IN CONN., 1-800 882-6500

Panasonic® Hi-Fi 4-Channel Receivers



CIRCLE NO. 20 ON READER SERVICE CARD

www.americanradiohistory.com

USE IT ALL AS YOU GET READY FOR A NEW CAREER:

\$1,500.00 worth of two-way radio electronic communications equipment

Bell & Howell Schools announces a new learn-at-home program that gives you "hands on" experience with commercial-grade equipment—as you prepare for a business of your own in two-way radio electronic communications servicing.

You *need* "hands on" experience with a real, commercial-band FM transceiver and actual commercial-grade test equipment—to take full advantage of growing opportunities in electronic communications.

Two-way radio communications is a healthy growth area in electronics. And it's lucrative. Almost two million commercial two-way radio systems now serve as vital communications links for trucks, planes, boats and taxis. And the FCC requires each system to have its equipment serviced regularly by a licensed technician. That's where *you* come in. But you need career-oriented training—plus your FCC license.

Knowing how to put an amateur radio kit together won't help when you're "on the job"—servicing two-way radio systems for aircraft or advising trucking companies about their land-mobile communications system. For that, you need "hands on" experience with the real thing. This unique new Bell & Howell Schools learn-at-home program that gives you just that. You can work with the equipment by attending one of our special "help sessions" or by dropping by one of the Bell & Howell resident schools. If neither of these plans

is convenient, you can have the equipment shipped to your home in return for a deposit, which is refundable when you return the equipment.

Find out more about this exciting new Bell & Howell Schools program. There's no obligation.

For free facts, mail attached card today!



Let Bell & Howell Schools help you get ready for an exciting career or business of your own in two-way radio electronic communications!

Bell & Howell Schools has helped many thousands of people prepare for careers—and businesses of their own—in electronics. You can have absolute confidence in the training you get.

Expert instructors at Bell & Howell Schools plan each program to answer a single question: "What qualifications will you need to take advantage of *actual career opportunities* in electronics?" They then build each program to give you those exact qualifications.

To get ready for a business of your own in two-way radio, you need: 1) career-oriented training; 2) FCC License; 3) "hands on" experience with commercial-grade equipment. Bell & Howell Schools now offers this new at-home training program that gives you all three. (See FCC License Guarantee on attached card.)

JUST LOOK AT ALL THE EQUIPMENT YOU'LL WORK WITH DURING YOUR TRAINING PROGRAM WITH BELL & HOWELL SCHOOLS!

Commercial-Band FM Transceiver . . . exactly the kind of two-way radio you'll service throughout your career.



Deviation Meter . . . model favored by many working technicians to check modulation of transmitted signal.

Frequency Meter . . . highly sensitive instrument used to check signal frequency within precise tolerances established by government standards.

Power Output Meter . . . meter used almost universally by trained and licensed technicians to check power output—or wattage—of signal.

Alignment Generator . . . a custom-designed unit you use to generate test signals for transceiver alignment.



FCC REGULATIONS GIVE YOU THE OPPORTUNITY TO START YOUR OWN BUSINESS!

The Federal Communications Commission requires that all commercial two-way communications systems be checked and serviced by a licensed technician at regular intervals.

As a Bell & Howell Schools graduate, you'll have the technical know-how you need. With your FCC license, you can go out and eventually build your own business—signing contracts with companies that use two-way radio. FCC regulations could mean security and regular income for you!

BELL & HOWELL SCHOOLS OFFERS YOU THESE SPECIAL ADVANTAGES:

Help Sessions Scheduled regularly every few Saturdays at the Bell & Howell Schools and in many other cities throughout the U.S. and Canada. Top instructors give you personal help and guidance.

Transfer Privileges After completion, you can transfer to any of the resident schools for more advanced study, if you wish.

Lifetime National Placement Assistance Helps you locate a job where you want to anytime after you complete program.

Veterans' Benefits We are approved by the state approval agency for Veterans' Benefits.

Student Financial Aid We are an eligible institution under the Federally Insured Student Loan Program.

EXCLUSIVE ELECTRO-LAB®—YOURS TO KEEP!

To make sure you get practical experience with instruments used daily by professionals, we've integrated into your program three precision instrument kits you assemble yourself and keep:

Design Console Use this to rapidly "breadboard" circuits without soldering.

Oscilloscope Offers bright, sharp screen images, 3-way jacks for leads, plugs.

Transistorized Meter Registers current, voltage and resistance.

FOR FULL INFORMATION, MAIL THE ATTACHED CARD TODAY! OR WRITE:

DEVRY INSTITUTE OF TECHNOLOGY
ONE OF THE
BELL & HOWELL SCHOOLS

4141 Belmont Avenue, Chicago, Illinois 60641

400R

NOT JUST ANOTHER PRETTY FACE.



At 6 lbs., 12 oz., there isn't an ounce of fat on the Cobra 132. It's one of the smallest SSB units ever made.

But with 15-watt P.E.P. input, 100% modulation and Dynabooast voice compression, this AM/SSB two-way radio has what it takes to send a booming signal over land or sea.

You have 23 AM and 46 SSB sending/receiving modes. Two separate

transmitters give you the best of each, with overload protection.

As for reception, this Cobra has the crispest, cleanest sound ever. Over 60 dB cross modulation interference rejection completely eliminates bleedover.

Cobra's drift-free Voice Lock lets you locate and lock-in sideband signals over a wide range. Three filters—one crystal, two

ceramic—keep adjacent channels under wraps.

And when you kick on Cobra's AM/SSB noise blanker, noise levels drop unbelievably.

In addition, the Cobra 132 has an adjustable AM/SSB RF gain control. Backlit RF output/S meter. And full-function controls.

Ask your CB dealer for the solid-state Cobra 132. Its beauty is more than skin-deep.

COBRA 132 AM/SSB \$299⁹⁵

microphone included

Product of Dynascan Corporation, 1801 West Belle Plaine Avenue, Chicago, Illinois 60613

CIRCLE NO. 7 ON READER SERVICE CARD



News Highlights

New Television Disc System

A new Video Long Play (VLP) television disc system was unveiled recently by Philips of the Netherlands. The VLP system plays color programs through an ordinary TV set via an ingenious "record-player" attachment. The record used resembles an ordinary audio disc and is pressed in the same manner. Instead of using a mechanical stylus to contact the grooves, the Philips system has a low-powered laser light source in an electro-optical pickup which plays the record without direct contact, thereby completely eliminating record wear. The VLP disc can provide color programs lasting up to 45 minutes on one side. The playback unit, slightly larger than an audio record turntable, will sell for about the same price as a color-TV set.

Three-million Transistors for Auto Ignitions

Three-million power transistors have been ordered by Chrysler Corp. from RCA for use in electronic ignition systems for the 1973 Chrysler, Plymouth and Dodge cars. The order represents RCA's largest silicon transistor order from the auto industry to date. Chrysler will install the electronic ignition system as standard equipment in all its 1973 models. Each ignition system includes two transistors, one a hermetic high-voltage device and the other a plastic device to drive the high-voltage transistor. The system is an inductive pickup type that eliminates the traditional breaker points in the distributor. The system can fire spark plugs with a carbon buildup that would prevent firing with conventional ignition systems. Engine tune-ups should be necessary only about every 50,000 miles if the car burns low-lead gasoline. In contrast, an auto with a conventional ignition system should be tuned about every 12,000 miles.

Laser Communication Experiment

Communication by laser beam from the fringes of space is the goal of a two-month long series of high altitude aircraft flights being conducted by NASA. The agency is testing an experimental communications system which includes a helium-neon laser transceiver in the aircraft and an argon laser acquisition and tracking station on the ground. The tests are being carried out through the use of a WB-57 aircraft operating at 65,000 ft, above 95 percent of the Earth's atmosphere. Most of the equipment has been developed by Gilfillan, a division of ITT, and Chrysler Corp. Space Division.

Advanced Paint-by-Numbers Kit Uses Laser and Computer

Unlike the usual paint-by-numbers kit in which the pattern originates with the kit manufacturer, this new kit includes an enlarged (16 x 20 in.) number-coded pattern custom-made from a color photo submitted by the purchaser. Just about any color print or transparency, preferably a portrait shot, is submitted beforehand; from this picture, the numbered pattern is produced. These "Personal Paintings" are produced by a system consisting of precision camera, laser,

scanner, optical card reader and computers. The submitted portrait is first re-photographed, where color correction occurs. A scanner then analyzes each point to determine the colors. This information is passed along to a computer, which stores and analyzes the findings to determine which of 100 colors and how much of each will be needed to complete the painting. Between 35 and 48 different colors are included with each painting. The computer simultaneously directs a laser beam over a sheet of photographic paper. As the laser moves, it sketches out an enlargement of what the scanner sees. Paint numbers and color guidelines are also printed by the laser. Cost of each kit is \$19.95. The automated electro-optical system was designed by Itek Corp. for Craft Master.

Admiral to Introduce Cartrivision

The Admiral Corp. is introducing its Cartrivision video tape recorder color-TV console to the Chicago consumer market. A wide range of pre-recorded and blank tapes of various lengths for recording off the air and taking home movies will be available through Admiral dealers. The units will also be introduced to the Los Angeles and New York markets later. Suggested retail price for the combination Cartrivision 25-in. color TV with black and white camera and tripod is \$1795.

Television Via Optical Fiber

Seen recently was a TV set operating with both the audio and the video channels reaching the set through a single transparent optical fiber. What's more, the reception was as free of electronic noise as though a bulky, expensive coaxial cable had been used to carry the signals. Signals were beamed into the fiber by a modulated helium-neon laser. In another instance, different colored light beams from colored light bulbs were transmitted through a single fiber, then filtered out to activate a horn and a light bulb. The fiber used was made of DuPont's Crofon plastic material, which is far less expensive but not as thin as an optical fiber made from glass. Light guides of optical fibers may one day be used to interconnect data or signal communication links.

How Many Objects in Orbit?

Here's a box score of orbiting satellites just past mid-year as reported by Goddard Space Flight Center, NORAD, and the Smithsonian Astrophysical Observatory. At the top of the list is the U.S. with 1947 objects in orbit. Next is the U.S.S.R. with a total of 801 objects. In third place is France with 44 objects. Next comes the U.K. with 7. In first place for the number of "decayed" objects (no longer in orbit) is the U.S.S.R., with 2177. This is followed by the U.S. with 1105 objects.

Serious Shortage of Engineers Predicted

The nation faces a serious shortage of engineering manpower by the mid-1970's unless immediate steps are taken to reverse the downward trend in engineering school enrollment, according to Dean Andrew Schultz, Jr. of Cornell's College of Engineering. The dean also said he feels the White House is evidently unconvinced of the urgency of the situation. Failure to move rapidly, he said, will result in the irretrievable loss of engineering education capacity, since engineering schools, as the most expensive undergraduate educational units, are targets for economy-minded academic administrations.



FREE

The World's Largest
Consumer
Electronics Catalog



468 Pages

Ready Now!

Your Complete Electronics Buying Guide

Everything In Electronics For Home, Business, Industry
PLUS The Latest in 4-Channel Stereo!

• Stereo/Hi-Fi Components • Tools • Test Equipment • Ham & CB Gear • PA Systems • Police/Fire Monitor Receivers • Electronic Security Devices • Musical Instruments & Amplifiers • Educational & Optical Equipment • Books and Parts • Plus Much More!

68 Stores In 12 States

NEW YORK	CONNECTICUT	VIRGINIA	NEW JERSEY
PENNSYLVANIA	MARYLAND	GEORGIA	ILLINOIS
MASSACHUSETTS	OHIO	INDIANA	MISSOURI

*Plus Associate
Stores From
Coast-to-Coast*

Send Today!

For Your FREE 1973
Lafayette Catalog 730

Lafayette Radio Electronics
P.O. Box 10, Dept. 35122
Syosset, L.I., N.Y. 11791

Please Send My FREE Lafayette Catalog 730

35122

NAME _____

ADDRESS _____

CITY _____

STATE _____

ZIP _____

CIRCLE NO. 24 ON READER SERVICE CARD



BUILD A 4-CHANNEL UNIVERSAL DECODER

Plays back CBS "SQ," Sansui and E-V matrixed 4-channel program material.

BY FRED NICHOLS / *Electro-Voice, Inc.*

IN the two years or so since matrix four-channel systems were introduced, an impressive degree of sophistication has been obtained. Continuing development of the Electro-Voice "Stereo-4" system has resulted in a "universal" decoder which properly decodes all commercially available encoded material. The entire decoding circuitry has been reduced to an integrated circuit, which operates with various external phase-shift networks.

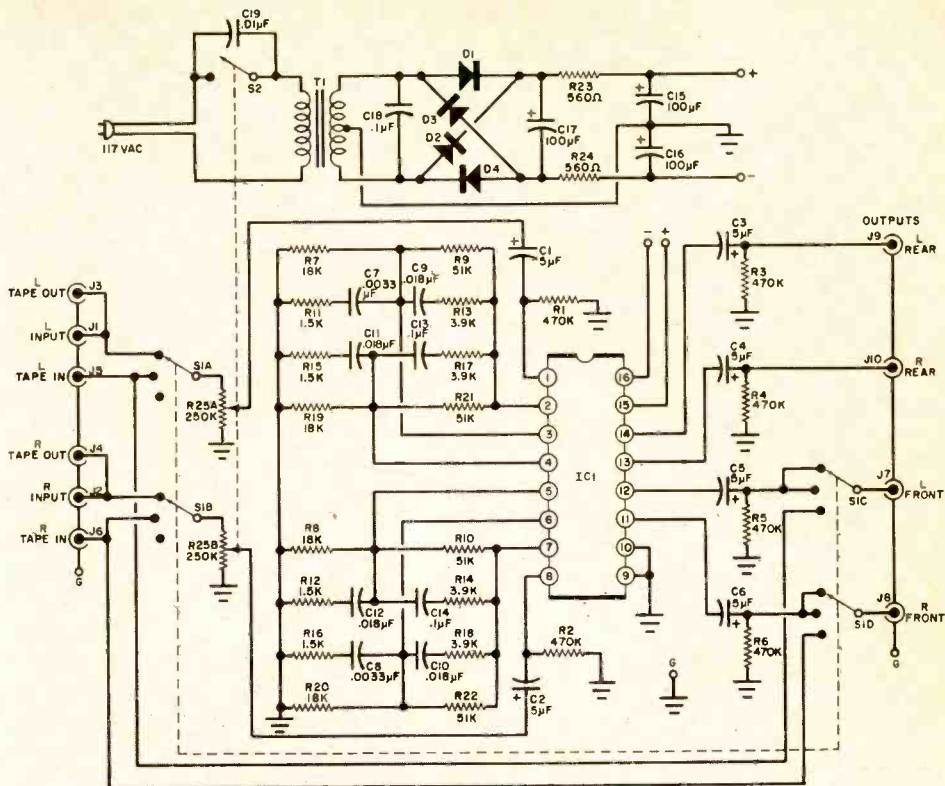
Because the integrated circuit involves simpler and more accurate circuitry than discrete components, a decoder built around this IC makes an ideal home construction project which offers performance equal to that of commercial units. Such a decoder is presented here for use as a separate unit or the decoder circuitry can be built into another piece of equipment, such as a back-channel stereo amplifier. The integrated circuit with close-tolerance phase-shift network components is available from Electro-Voice, as well as a more complete set of specialized parts, including an etched-circuit board. How the decoder board can be mounted in a professional-looking, commer-

cially available enclosure is shown, although the unit can be housed in any manner the builder desires.

Construction. The entire decoder, including power supply, is built on a single printed-circuit board. See Figs. 1 & 2. Use of PC-mount controls greatly simplifies unit wiring. If the controls as shown are not needed, appropriate wire jumpers may be inserted in the board.

Mounting the power transformer, volume control, and selector switch first provides support, making it easy to perform the balance of the assembly. Be sure these parts are fully seated before you start soldering. Use a low-wattage iron and small-diameter rosin-core solder. "Tinning" the copper foil first will speed the component soldering job and reduce the amount of heat required. Special care is required when installing the integrated circuit and phase-shift components—which should be done after all other parts are mounted.

Observe the polarity of the electrolytic capacitors and the identifying notch of *IC1* when installing.



PARTS LIST

R1, R2, R3, R4, R5, R6—470,000 ohm, ½ W res.
 *R7, R8, R19, R20—18,000 ohm, ½ W res., 2%
 *R9, R10, R21, R22—51,000 ohm, ½ W res., 2%
 *R11, R12, R15, R16—1500 ohm, ½ W res., 2%
 *R13, R14, R17, R18—3900 ohm, ½ W res., 2%
 R23, R24—560 ohm, ½ W res.
 R25—250,000 ohm, dual-section audio-taper pot (with a.c. switch, S2)
 C1, C2, C3, C4, C5, C6—5 µF, 25 V electrolytic capacitor
 *C7, C8—0.0033 µF, 25 V polystyrene capacitor, 2½%
 *C9, C10, C11, C12—0.018 µF, 25 V polystyrene capacitor, 2½%
 *C13, C14—0.1 µF, 25 V Mylar capacitor, 5%
 C15, C16—100 µF, 16 V electrolytic capacitor
 C17—100 µF, 50 V electrolytic capacitor
 C18—0.1 µF, 100 V ceramic or Mylar capacitor
 C19—0.01 µF, 150 V a.c.—1400 V d.c. ce-

ramic capacitor
 J1—J10—Phono jack
 D1, D2, D3, D4—1 A, 100 PIV diode
 S1—4 pole, 3-pos. selector switch
 S2—"On-off" switch (on R25)
 T1—Power transformer: 40 V center-tapped, 30 mA.
 IC1—E-V 87743 decoder integrated circuit
 Misc.—Chassis, line cord, grommet, mounting hardware, etc.
 *Indicates close-tolerance phase-shift components. Do not substitute.
 Note: The following parts are available from Electro-Voice, Buchanan, Mich. 49107: Complete set of phase-shift components marked * plus IC1 decoder chip, \$16.00 ppd. Etched and drilled PC board with all parts shown in schematic (except line cord and phono jacks) plus knobs and control hardware, \$32.00 ppd. PC board is NOT available separately.
 Michigan residents add 4% sales tax.
 Enclosure shown on front cover is Ten-Tec Model JW-5; available from electronic parts distributors or Ten-Tec, Inc., Sevierville, Tenn. 37862.

Fig. 1. Schematic diagram and parts list for the "Universal" decoder.

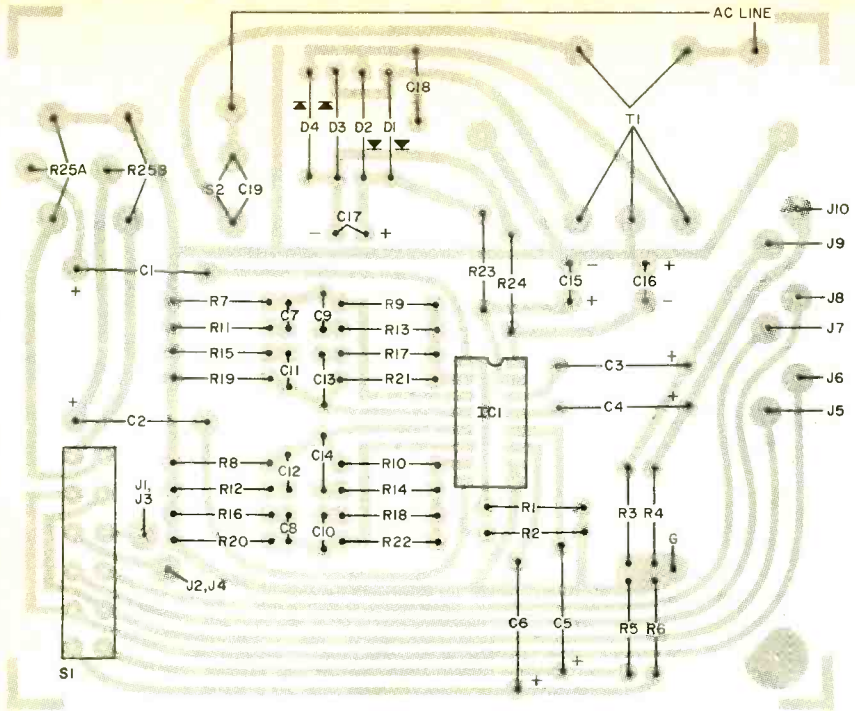
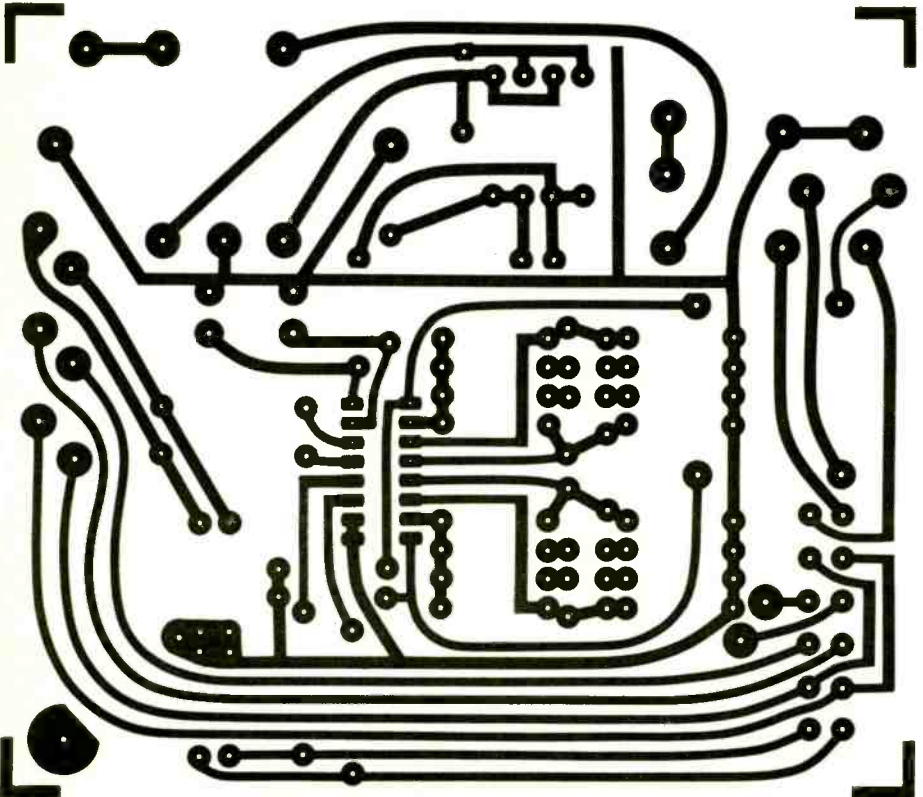
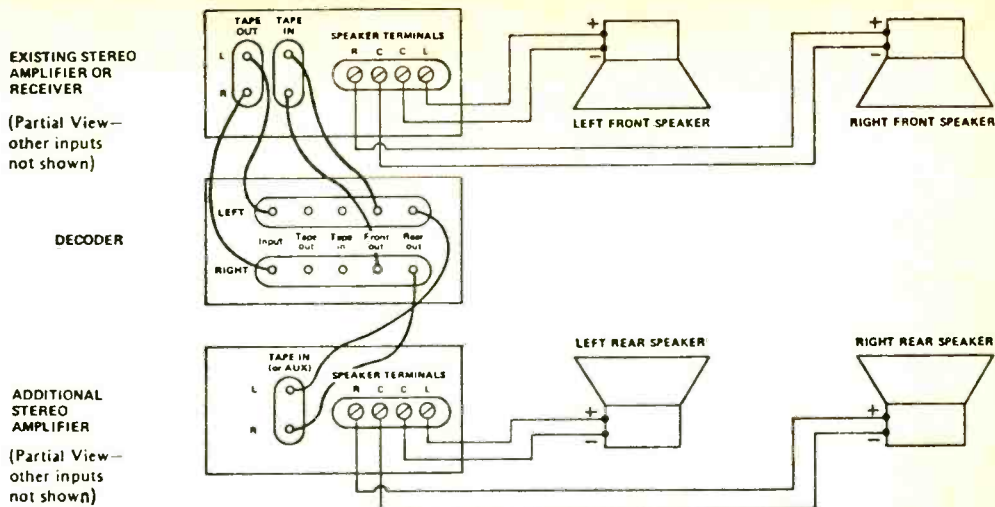


Fig. 2. Actual size PC board foil pattern is shown below; component layout above.





Rear panel connections for both inputs and outputs.

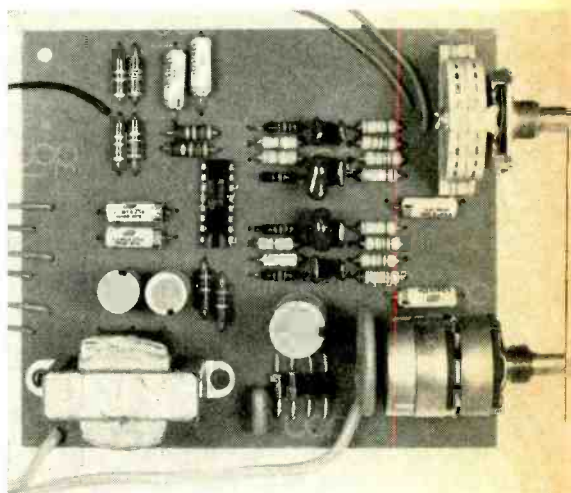
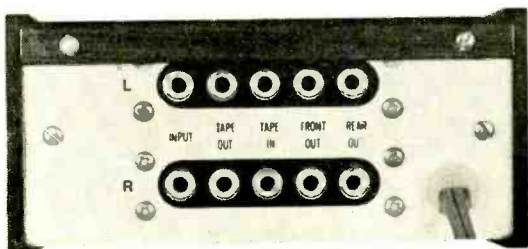
Housing. The assembled PC board may be mounted in any suitable enclosure, using 3/4-inch standoffs. The board should be supported at the two transformer mounting holes, plus another hole provided at the back corner, by 4-40 hardware. The front of the board is secured by the two control shafts.

Ten phono jacks, providing inputs and outputs, should be mounted on the back of the chassis. Insulated jacks, or insulating washers, are recommended. The line cord should be knotted and then exit the back of the chassis through a grommet.

Control functions and the order in which the phono jacks should be installed are shown in the diagram and photos. Appropriate labels may be applied with a tape marker or press-on lettering.

Connections. This decoder is designed to operate with signals in the 0.1 to 1-volt range. Maximum input is 4 volts rms. Normally a set of "tape-monitor" connections

Suggested jack layout on rear panel.



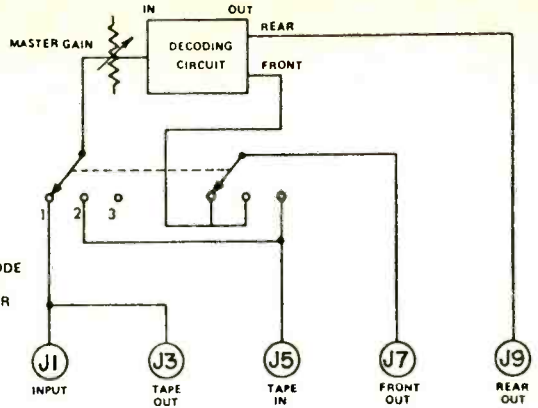
Top view of the decoder PC board.

provides the proper signal source, plus a way to return the decoded front signals to the existing power amplifiers. The rear-channel signals may then be connected to an additional stereo power amplifier and a pair of rear speakers. Of course, the decoder may be connected between separate preamps and power amplifiers as well.

Operation. As shown in the diagram of Fig. 3, the Selector switch allows a choice of decoding from the Source or Tape inputs, or playing the Tape inputs "straight-through." This latter position restores the tape-monitor function to the system.

Fig. 3. The block diagram of the decoder. Only the left channel is shown; but right channel is the same.

SWITCH POSITION	FUNCTION
1	SOURCE DECODE
2	TAPE DECODE
3	TAPE MONITOR



The Master volume control provides control of all four channels when decoding. To start, turn this control fully clockwise. Then advance the volume controls of the front and rear amplifiers to the loudest level you

expect to use. The decoder's Master volume control may then be used to lower the level of all four channels for normal listening. ♦

THE ELECTRO-VOICE EVX-44 DECODER

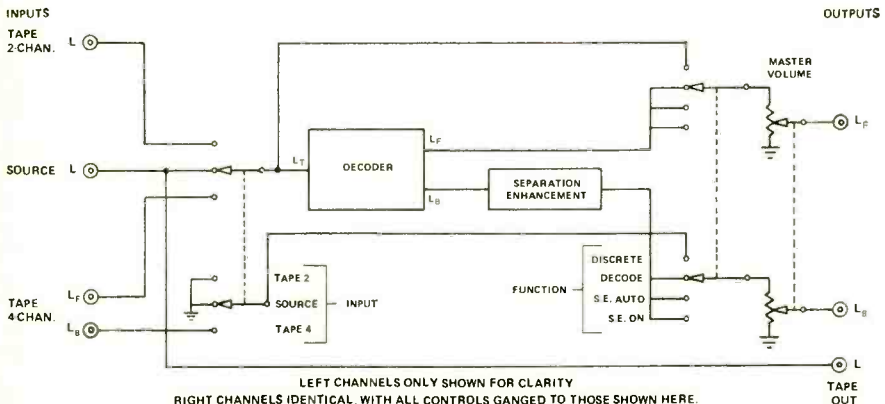
Our Cover Photo shows the original prototype for this particular 4-channel decoder. The circuit used is the simplest and obviously least expensive design for decoding 4-channel program material.

This design differs somewhat from the new Electro-Voice EVX-44 decoder, which is a more sophisticated unit. While it offers the same decoding circuits, the EVX-44 employs a 4-gang master volume control just ahead of the output jacks which can be incorporated by eliminating the input volume control, R25. Outputs J7, J8, J9, and J10 would then go to the inputs of a 4-section, 50,000-ohm audio-taper pot. With this arrangement, the master volume control will affect output in all functions, including the tape monitor (tape 2).

Input and function selection are separate switches in the EVX-44. This permits decoding or playing any input discretely. In addition, a 4-channel discrete tape input is provided.

The EVX-44 incorporates a Separation Enhancement circuit which follows the universal decoder and permits some personal control of playback effect. Incorporating four op amps, the circuitry senses the presence of a front-center soloist. Back separation is decreased and front-to-back isolation is increased to firmly localize the soloist in the front speakers. Separation Enhancement in the EVX-44 operates automatically and can be manually switched "off" or "on" as well. The EVX-44 retails for \$99.95.

Functional diagram of the Electro-Voice EVX-44 decoder.





ALPHA BRAIN WAVES



BIOFEEDBACK TRAINING

NEW WAYS OF EXTENDING
THE INFLUENCE OF
THE MIND OVER THE BODY

BY MITCHELL WAITE

HIGH in the Himalayas, the monks of Tibet have practiced a remarkable initiation ritual for thousands of years. On the coldest days of winter, candidates go to spend the night by frozen lakes clad only in their thin orange robes. Symbolic white robes are dipped into the icy water and draped around their naked bodies. The number of robes a candidate can melt in a single night symbolizes the level of his spiritual achievement.

Eastern mystical teachings have a formula that anyone can follow to achieve such spectacular body control: years devoted to meditation, complex visualizations, and sexual continence.

Characteristically, however, Western technology is encroaching on this formerly Eastern monopoly with electronic devices that demand neither sacrifice nor discomfort.

Elmer Green at the Menninger Foundation in Topeka, Kansas, has taught subjects to lower the temperature of their hands ten degrees by using a simple device which indicates body temperature increases by movement of a meter. Subjects were told to move the indicator up-scale and hold it

there. Most subjects could, in a small amount of time, learn to influence the temperature of different parts of their bodies by using the information transmitted by the electronic measurement circuit.

Similar to the monks, his subjects were using their minds to generate heat energy at a particular area of their body. Ten degrees is a long way from melting frozen robes but scientists are finding that people can influence all kinds of body processes, hitherto believed beyond the range of conscious control.

Closing the Loop. Traditionally, Western medicine considered certain regulatory func-

Editor's Note: In response to many requests from readers for articles on alpha brain waves, we are presenting two stories. This month, we cover the general principles of biofeedback training as well as the various types of waveforms generated by the brain. Next month, we will have an alpha-wave monitor construction project for those who want to do some experimenting.

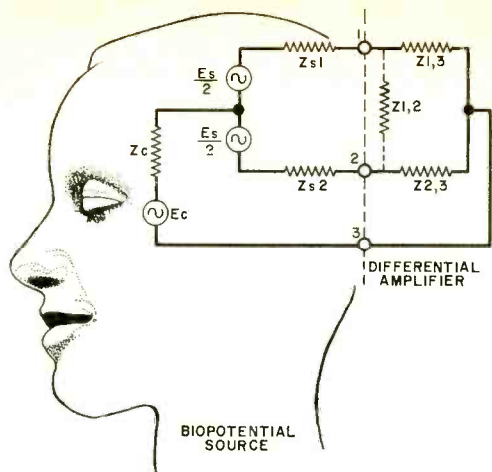
tions of the body such as skin temperature and heart rate as outside the domain of willful control. This assumption seems to have helped shape the self-concept most of us have of being at the mercy of our involuntary nervous system. The self-regulating nervous system is, of course, a necessity, for imagine the effort of controlling all the specialized muscles involved in breathing or digesting. We could, you might say, speed up our heart rate by physical exertion such as fast breathing, but this is not direct control of the autonomic nervous system.

Certain recent experiments have now caused scientists to take a new look at this old assumption. Some visceral organs, it was discovered, could be eventually controlled by the mind if special conditions were first set up. What was needed was a special signal or stimulus, such as sound or light, which would follow the activity of the body function to be controlled. By observing the "feedback" signal, people could actually interact with a particular body function through the monitor. The monitor or bio-feedback mechanism serves in a sense as an interpreter between the mind and the so-called "automatic" mind.

The principle is similar to the way you learn to throw a ball. You feel your arm move, see where the ball went and correct your arm movement the next time. In a similar way, an electronic instrument can detect small internal changes in such processes as blood flow or brain-wave patterns of which you may not be consciously aware. By showing you these changes, the device can help you to recognize the cues and learn control. What is even better is that with practice, control can be developed so that the instrument is no longer needed.

The Body Electronic. To understand fully the range of the feedback principle, it is helpful to examine the source of the feedback signal.

Bio-potentials, tiny voltages present in all living organisms, are caused in man by the activity of nervous system sensors, muscles, or nerves. All bio-potentials originate at the cellular level, but the measurement of any one signal is related to a specific physiological subsystem. Thus, the electrocardiogram (EKG) is a recording of the electrical activity of the heart, the electroencephalogram (EEG) of the voltages in the brain, the electromyogram (EMG) of the activity of the muscles.



Z_{1,2}=COMMON MODE INPUT IMPEDANCE
 E_c=COMMON MODE SIGNAL GENERATOR
 Z_{s1}, Z_{s2}=IMPEDANCE BETWEEN ELECTRODE AND BRAIN
 $\frac{Z_{s1}}{Z_{s2}}$ CAN VARY FROM ONE TO OVER ONE HUNDRED

Fig. 1. Schematic of brain shows how unbalancing of source impedances (Z_{s1} and Z_{s2}) can affect the common mode rejection of differential circuit. Common mode generator includes all unwanted signals such as electrode potentials, power line interference, noise from extraneous body signals, etc. Unfortunately, these signals are not always common mode and show up at differential amplifier output, distorting the real brain-wave signal. Ignoring the loading effect of Z_{1,2}, and if Z_{1,3} equals Z_{2,3}, and both Z_{s1} and Z_{s2} are much less than Z_{1,3} and Z_{2,3}, the CMR limit (greatest reduction to a common mode signal) is 20 times the log to base 10 of Z_{1,3} divided by the difference between Z_{s1} and Z_{s2}. Thus, if Z_{1,3} is 100,000 ohms and electrode impedance ratio is 100, the CMR limit is 60 dB. Source and input impedance of circuit determine actual rejection. A circuit with these values produces 1 mV of common mode output noise for every 1 volt on the input.

Detecting the brain-wave biopotentials is greatly complicated by the minute signal voltages, high level of external interference (noise and hum) and high impedance values of the body. For example, the magnitudes of the signals measured on the scalp typically vary from ten to a hundred millionths of a volt (10-100 microvolts) peak-to-peak. To top it off, in residential areas, stray 60-cycle fields from power lines surround the body. Such fields may reach values of 10 volts, or a million times stronger

than the brain-wave signal! It is this interference problem which has been a stumbling block of experimentalists for so long.

Recent advances in semiconductor technology have allowed the construction of miniature feedback devices which overcome these basic problems. The large fields can be screened out by a differential amplifier, which rejects any extraneous voltage *common to two inputs* while boosting the small difference signal *between the two inputs*. (See Fig. 1.)

Because of the typically high impedance levels of the head (1,000 to 10,000 ohms) the differential amplifier cannot load the signal source and therefore requires a very high input impedance, typically 0.1 to 100 million ohms. The amplifier also must not, while amplifying, contribute any spurious signals to the original biopotential. All these factors add up to a high-gain, low-noise, high-input-impedance differential amplifier commonly referred to in electronics as an instrumentation amplifier. Medical equipment reflects this high quality with typical prices for a multi-channel EEG amplifier and recorder of \$1000 to \$10,000. Less expensive devices sacrifice the unnecessary electronics involved in medical equipment while retaining just enough information for feedback recognition.

The second step in a biofeedback system is utilization of the amplified biopotential signal. Optimally, a second signal source which falls into the range of one of the five senses is varied (modulated) by the amplified biopotential signal. For example, a tone which is easily sensed by the ears is made to vary in volume by the amplified biopotentials of the brain. The user of the feedback device makes a mental effort to alter the intensity of the sound. (See Fig. 2.)

This last step, altering the sound, completes the biofeedback loop. With routine practice a user develops control over the sound pattern and thus is actually altering an organ's functioning. It is still however, a subtle effect, difficult to describe to other people, and some never completely master it.

Although biofeedback training has similarities to conditioning, it does not offer an explicit reward for the correct response. The only reward is what comes from eventual mastering of the process.

Clinical Research. Currently, biofeedback research is being carried on by over 150

different laboratories. A Biofeedback Society has been formed which brings together experimental research and integrates it with current psychological knowledge. The mainstream of activity covers five basic areas of body control: (1) muscle tension (EMG), (2) blood flow and blood pressure, (3) heart rate (EKG), (4) body temperature, and (5) brain waves (EEG).

For example, psychologists at the University of Colorado Medical Center in Denver have employed feedback therapy to cure patients who have suffered from muscle tension headaches for an average of nine years.

Patients lie down in a comfortable position with small surface electrodes taped to their foreheads. They then listen to a tone from a pair of headphones. As the muscle contraction of the forehead increases (increased muscle tension) the pitch of the tone goes higher. The people are told to try to lower the tone. Within twenty minutes the tone drops and they have halved the original muscle tension!

What are these people doing that they hadn't already tried? Most found that any direct effort to relax resulted in a higher pitch tone (increased muscle tension). Only by "letting go" could they relax the forehead muscles. It appears that by not concentrating on the headache, other processes of the brain come into play, processes that are unfamiliar and difficult to explain.

At the Menninger Foundation in Topeka, Kansas, researchers have helped patients to stop their migraine headaches by monitoring the blood flow as it went up the main artery to the face. They trained these people to reduce the arterial swelling by reducing the blood flow through it. Rather than trying directly to stop the headache, they learned, through biofeedback, to steer around it much as a pilot does when he is flying blind.

But even more incredible is the new information coming from heart rate control research. At the University of Wisconsin in Madison, subjects were taught to "drive" their own hearts much like the driving skill booths at penny arcades. Subjects would watch a light which moved left or right as the time between heartbeats changed. Trained subjects could eventually keep the light in the middle and thus keep the time between heartbeats a constant 10%. This didn't mean necessarily that they were directing the autonomic nervous system. As

mentioned earlier, the heart can be influenced by the breathing process. However, this was later ruled out when subjects showed they could learn to control breathing and heart rate independently.

At the Gerontology Research Center in Baltimore, Dr. Bernard T. Engel and his colleagues have trained eight persons to control potentially lethal irregularities in heart rhythm. The subjects were trained to slow their heartbeats by concentrating intensely when a red light appeared and to speed up the heart rate in the presence of a green light. Ultimately, they learned to maintain a safe mid-pace indicated by a steady yellow light. Eventually, three of the patients acquired the ability to stabilize their rhythms at the first sign of an oncoming attack of arrhythmia with their own feedback cues.

Map of Consciousness. Perhaps the most exciting aspect of biofeedback is its contribution to mapping altered states of consciousness.

Dr. Joe Kamiya at the Langley Porter Neuropsychiatric Institute in San Francisco has spent a decade studying the effect of *alpha* brain-wave training. He was particularly interested in whether normal subjects could discriminate alpha from non-alpha. Dr. Kamiya used a feedback program which produced a score every time the person indicated verbally which state he was in; alpha or non-alpha. After two weeks of

training, 70 percent of the subjects could differentiate alpha and non-alpha. What was the alpha experience of Dr. Kamiya's subjects?

The replies were mostly diverse and inarticulate. This is almost to be expected—the English language has few words to describe different conscious states. Alpha has been described as “a range of mildly pleasurable reveries and body feelings often called relaxed awareness.”

As for the other brain-wave states, each frequency band has associated with it certain behavior traits. (See Table.) The theta band (3.5 to 7.5 Hz) occurs during uncertainty, day dreaming, and problem solving. Worry, anger, fear, and tension are characteristic of the beta band, 13 to 28 Hz. Between theta and beta lie the alpha rhythms. These frequencies, 7.5 to 13 Hz, have drawn special attention since they are most often produced during states of meditation and relaxation.

Alpha is difficult to describe. It is a non-thinking and non-emotional condition; a detachment from the usual reality. There is an opening of awareness and an enhanced ability to be still. Researchers call it a mode of de-automatization, a reduction in the cortical activity of the brain.

This partly explains why alpha-wave feedback is being so widely discussed. It is because the alpha wave and its positive mental character can be turned on and sustained by using a biofeedback device.

TYPICAL BRAIN-WAVE DETAILS

Name of Brain Wave	Magnitude (V x 10 ⁻⁶)	Frequency (Hz)	Associated Mental State*	Percent Produced Per Day
Alpha	10 to 100	7.5 to 13	Tranquility, relaxation, heightened awareness.	10
Theta	50 to 200	3.5 to 7.5	Uncertainty, problem solving, future planning, switching thoughts, day dreaming.	25
Delta	10 to 50	0.2 to 3.5	Deep sleep, trance state, non-REM type of sleep.	10
Beta	10 to 50	13 to 28	Worry, anger, fear, attention, tension, hunger, surprise.	35
?	0.01 to 0.1	Vhf to Uhf	**	?

*These descriptors are from a Clyde Mood Adjective checklist following one 60-minute feedback session with the eyes open.

**This last band is a recent Russian discovery. It could be revolutionary in the brain-wave field. In terms of just information content, these signals could contain over a billion times more data than the slower brain waves produce.

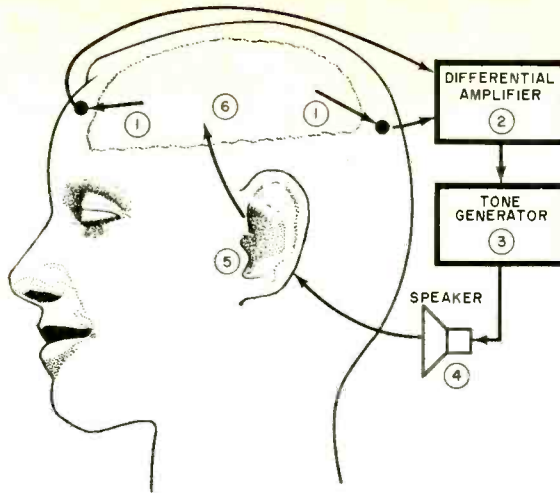


Fig. 2. Brain-wave signals originating in the brain (1) pass through cerebral fluids and reach the surface electrodes. Electrode cream is used on electrodes to help lower resistance to the scalp. From electrodes, the signals flow into the special differential amplifier where interference is reduced and signal level is raised. The amplified signal is used to control (turn on and off) a tone (3) which drives a speaker (4).

Sounds leaving the speaker are following the brain-wave signal (the brain-wave frequency is well below the threshold of human hearing) so a sound is perceived each time brain-wave signal reaches a peak. These peaks occur at a smooth staccato rate which the hearing integrates as the alpha wave if it is a 10-Hz rate or the theta wave if it is 4 Hz. Signals from speaker return to the ear (5) and then back to brain (6).

Kamiya and researchers like him seem to feel that this is one way of reducing tension and increasing awareness by dealing with it in an internal and self-motivated way. It may be possible, says Kamiya, to use the descriptors of biopotential signals (frequency, magnitude, direction, origin) to discover how to reproduce altered states of awareness.

Already various groups are following brain-wave biofeedback research and presenting it to the public in more palatable form. Some of the interest is in providing verbal instruction and exercises in producing the desired brain-wave states. There is some skepticism voiced that these different groups have over-inflated claims and they are using mass suggestion. However, no one has tested the brain waves of these people or how they control them so it is still to be proved. The brain waves of people with ESP powers have been studied and they show a definite abundance of the alpha wave just prior to the ESP experience.

Some companies are producing brain-wave monitors which allow anyone to safely experiment in feedback training. The Xerox

Corporation is exploring the feasibility of brain-wave training in helping employees relax and get their strength back after hard business meetings.

Besides mapping consciousness, brain-wave research is giving science more insight into different philosophies and their objective biophysical correlations.

The classical experiments that started this exploration were set up to record the brain waves of both students and masters of Yoga and Zen. Kasamatsu and Hirai in 1966 found a highly positive correlation between the EEG pattern and the number of years of Zen meditation. They reported as the years of study of Zen increased: (1) the brain-wave rhythm which was predominately alpha lowered in frequency toward theta by up to three hertz; (2) the percentage of alpha in the occipital areas (back of the head) decreased while alpha activity in the frontal (front of the head) increased; (3) there was an increase in average brain-wave amplitude; (4) there was alpha activity with the eyes open (something that is particularly rare in most people's EEG's); and (5) when an external

stimulus (such as a loud click) was delivered, the alpha activity of the Zen student was blocked for constant 2-to-3-second periods. Normal subjects, that is those with non-Eastern type philosophies, block alpha but the blocking interval decreases as the external stimulus occurs more often.

When Anand, et al., studied the brain waves of Yoga masters, they found "increased alpha activity (magnitude and percent occurrence) and absolutely *no* blocking on an external stimulus!"

How can the difference in alpha blocking between the Zen, Yoga, and non-meditator be explained? In the case of the normal subjects (non-meditators) the more the stimulus occurs, the less interference there is in alpha production. The subject adapts to the stimulus and eventually does not hear it. On the other hand, the Yoga student (no alpha blocking) apparently is totally screening out stimuli from the outside world while the Zen meditator (constant alpha blocking interval) is reacting to every stimuli in an equal manner.

For psychology and philosophy, these results help to organize a division between subjective reporting of conscious states according to a particular world view and their measureable physiological correlates. The follower of Buddhism (who uses Yoga as an exercise) believes the sensory world to be illusory and attempts to withdraw from it. The practitioner of Zen, however, believes the world is not illusion and tries to remain awake and fully sensitive to it. From the point of view of the average subjects, the world is simply related to him in a self-centered manner. He explores the stimulus with a "What's in it for me" attitude and, if satisfied it offers nothing, stops paying attention to it.

Biofeedback in the Future. Interpreting brain-wave patterns is helping scientists understand the general activity level of moods, feelings and mental attitudes. To understand the actual mechanisms of thinking and reasoning a closer look at the brain is needed. However the countless chemical reactions of the brain occur at such high speeds and low magnitudes that direct observation reveals little.

Nevertheless, Derek Fender, professor of biology and applied science, and his graduate assistant Robert Kavanagh, have found some beginning answers to how the brain works. They have constructed a machine

which records brain waves from many areas of the scalp and sends them into a specially programmed computer. From there the brain waves are analyzed and displayed on a cathode ray tube. The result is a picture of the brain waves—a contour map of the peaks and troughs of electrical activity as "seen" through the top of the subject's head.

Each picture is photographed and used to make a movie. Two movies have been made, each a minute long, representing the brain-wave activity in a quarter of a second—but slowed down 250 times.

By studying various subjects, Fender and Kavanagh have discovered a simultaneous sound and light-flash stimulus causes activity in three distinct locations of the brain. One area analyzes visual images, the second sound patterns, and the third seems to decide if the sound and light come from the same place. They have discovered these locations by increasing the number of electrode positions to 49 and plotting the locus of the neuron emissions with the powerful computer program. The computer gives an accurate reading of exact positions of the brain-wave sources rather than just the frequency and magnitude. By studying these brain-wave movies, scientists are bridging the gap between single neuron firing and the functioning of groups of neurons working together.

During this project Fender discovered that the best subjects for his brain-wave studies were waitresses. Most people either produced fast surface level beta waves or just went to sleep. Waitresses however were just right. They were quick-minded so they didn't fall asleep and industrious enough to concentrate on the light-flash stimulus. And they weren't too nosy about what was going on or too preoccupied with some other problem.

As computers become more powerful with faster and larger memories, Fender's programs might reveal creative brain-wave patterns and possibly provide a means of utilizing biofeedback to stimulate these types of thinking.

As biofeedback techniques become more effective, we might begin to see their use in therapeutic techniques. Ancient teachings have constantly pointed to using the mind to prevent disease and eliminate infection. We may one day see doctors prescribing biofeedback methods instead of pills. ♦

THE
CONWAY
MASTERANGER
MODEL 639



**This remarkable new
Multitest set
is unique
in its versatility,
in its sensitivity,
and in its price.**

100M Ω input resistance; accurate to 1.5%. 72 Ranges. Floating input for absolute user safety; fully overload protected. Completely portable; battery or AC operation. Attributes such as these make the Conway Masteranger the new STANDARD INSTRUMENT for all electronics. Its price \$150.*

*(Cdn. Dollars, export price—local taxes extra.)

The Conway Masteranger solid state Model 639 is the world's most comprehensively ranged F.E.T. Multimeter. It is the result of five years' intensive research and study to determine the most required measurement parameters and ranges for the rapid testing of AC/DC Voltages, Current, Decibel, Resistance and Voltage Levels.

Its design concept employs 100% silicon solid state technology, making it applicable for the measurement of any anticipated electronic equipment development over the next 10 years. It can also carry out its functions on all contemporary equipment, and that of earlier technologies.

Like many genuine technical advances, its principle is simple enough to make the Conway Masteranger relatively inexpensive. At \$150, it renders many other instruments (some much more expensive) either obsolete or unnecessary.

The Masteranger 639 is amazingly accurate—plus or minus 1.5% through most of its 72 ranges. Its input resistance is high—100M Ω on most voltage ranges. This, coupled with its outstanding sensitivity of 1.5mV AC or DC (full scale) and its current measuring capability from 0.15 μ A (150nA) up to 150A. AC/DC (with shunt box) puts the Masteranger Multitest set in a class of its own.

The instrument is supplied in a smart bridle leather carrying case with detachable shoulder and neck strap. At 2.5Kg (5.5 lbs) it is easily carried.

A wide range of quality matching accessories are available. RF probe extending frequency response to 1000 MHz, current range extension to 150 Amps AC and DC in 4 ranges, HV probe, Powerline cassette, Magic "T", etc.

Complete information, and specification sheets, on this unique professional Multitest set is available on request. Simply fill out the coupon below and mail to:



CONWAY ELECTRONIC ENTERPRISES LIMITED
88-90 ARROW ROAD, WESTON, ONTARIO

Gentlemen:

Please send me complete information on the Masteranger 639 solid state Multitest set.

I would like to test the Masteranger 639 for myself. Please contact me to arrange a demonstration at my office.

Name: _____

Address: _____

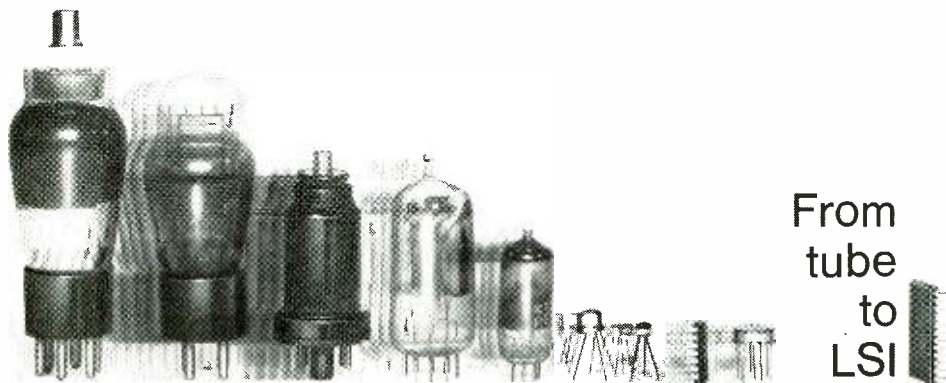
Company: _____

Telephone: _____

Title: _____

CIRCLE NO. 4 ON READER SERVICE CARD

Changes come fast in electronics.



From
tube
to
LSI

Take a look at the race in circuit technology. In the 1960's the tubes at the left made way for the transistors at the right. Today, transistors are surpassed by the large scale integrated circuit (LSI) at the far right. This circuit, less than a quarter inch square, replaces over 6000 transistors!

There's big money to be made by the men who stay ahead of this technology race. Put yourself

ahead with NTS Home Training! You get the latest, most advanced equipment (at no extra cost). More solid-state units, and more advanced technology. Plenty of training with integrated circuits, too! As an NTS graduate, you enter a world of electronics you're familiar with. You have a thorough working knowledge of solid-state circuitry. You're ready to tackle bigger jobs at higher pay!

NTS COLOR AND B & W TV SERVICING



Solid-state
315 sq. in.
Heath color TV

Build and keep the largest, most advanced color TV made! Over-all solid-state design, ultra-rectangular screen, matrix picture tube, built-in self-servicing features, "Instant On," A.F.T., solid-state, 24-channel detent UHF/VHF power tuning, and much more! Also build and keep AM-SW Radio, Solid-State Radio, FET Volt-Ohmmeter, and Electronic Tube Tester. Learn trouble-shooting, hi-fi, stereo, multiplex systems, radio, color and B & W TV servicing.

Learn sophisticated solid-state circuitry as you build this B & W TV receiver. Lo-Silho "Superhet" Radio, FET Volt-Ohmmeter, Solid-State Radio, Electronic Tube Checker, and Signal Generator. TV

and all other equipment are yours to keep.

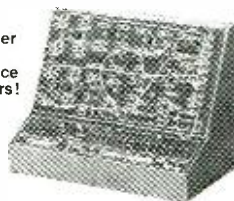
Solid-state
B & W TV,
74 sq. in.
picture
(cabinet
included)



NTS ELECTRONICS & COMPUTER TECHNOLOGY

Build and keep this exclusive NTS Compu-Trainer. It teaches you the

Solid-state
Compu-Trainer
14 integrated
circuits replace
198 transistors!



same principles used in million-dollar systems. Contains 14 inte-

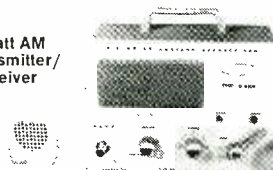
grated circuits! All Solid-State! You perform all wiring and patchcording. No shortcuts. No pre-wired circuit boards. Your training is complete! Also receive an FET Volt-Ohmmeter and a 5" wide-band Solid-State Oscilloscope.

NTS ELECTRONICS COMMUNICATIONS

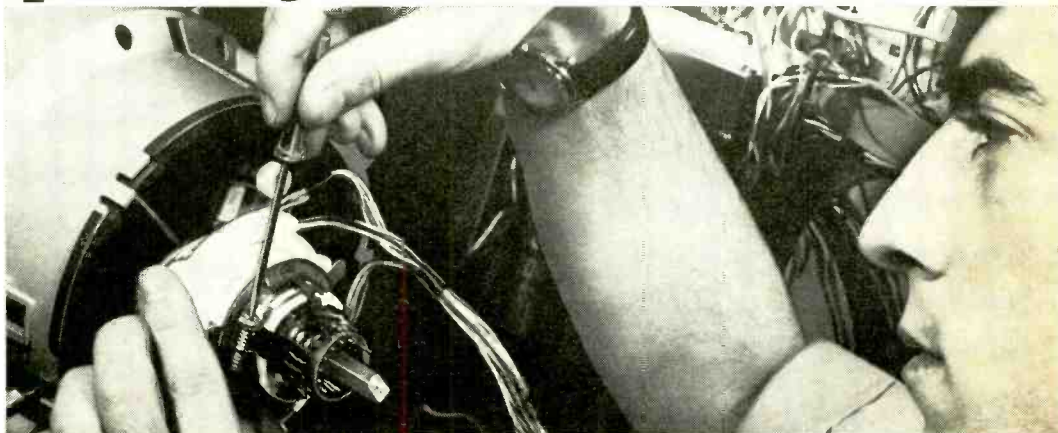
Gain the prestige and earning power of owning an F.C.C. First Class Radio-Telephone License. Two comprehensive NTS courses cover the big opportunity field of transmitting and receiving.

You build and keep 14 kits, including this amateur phone 6-meter VHF Transceiver, NTS's exclusive 6-transistor Solid-State Radio, and a fully transistorized Volt-Ohmmeter. Also, learn 2-way radio, Citizens Band microwaves, and radar.

5-watt AM
transmitter/
receiver

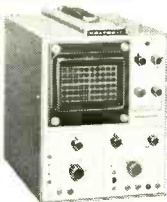


NTS Home Training puts you in the lead.



NTS INDUSTRIAL & AUTOMATION ELECTRONICS

Automation is the future of industry and you can play an important part! Learn industrial controls by training on the NTS Electro-Lab (a complete workshop). You also build and operate this 5" Solid-State oscilloscope. And you perform experiments that involve regulating motor speeds, temperature, pressure, liquid level, and much more. All equipment is yours to keep.



NTS AUDIO ELECTRONICS SERVICING

Learn basic sound theory—how it works in home radio, car tape

decks, stereo multiplex component systems, and more! Set up a spectacular music system. Learn about



Build and keep this famous Heath Stereo Receiver and Speakers.

sound distortion, amplification and control, loud-speaker baffles, problems of system installation, etc. Included is Volt-Ohmmeter, In-Circuit Transistor Tester, and Solid-State

Radio. Prepare yourself for great opportunities in the Home Entertainment Industry!

CLASSROOM TRAINING AT LOS ANGELES

You can take classroom training at Los Angeles in sunny Southern California. NTS occupies a city block with over a million dollars in technical facilities. Check box in coupon below.

NATIONAL TECHNICAL SCHOOLS

WORLD-WIDE TRAINING SINCE 1905
Resident & Home Study Schools
4000 S. Figueroa Street
Los Angeles, California 90037

APPROVED FOR VETERANS

Accredited Member: National Association of Trade and Technical Schools; National Home Study Council.

Big, Colorful NTS Guide to new opportunities in Electronics. Yours FREE!



NATIONAL TECHNICAL SCHOOLS
4000 S. Figueroa Street
Los Angeles, California 90037

Please rush me FREE Color NTS Electronics Guide & FREE lesson, plus information on course checked at right. No obligation. No salesman will call.

- MASTER COURSE IN COLOR TV SERVICING
- COLOR TV SERVICING (FOR ADVANCED TECHNICIANS)
- MASTER COURSE IN B&W TV & RADIO SERVICING
- MASTER COURSE IN ELECTRONIC COMMUNICATIONS
- PRACTICAL RADIO SERVICING
- FCC LICENSE COURSE
- MASTER COURSE IN ELECTRONICS TECHNOLOGY
- AUTOMATION & INDUSTRIAL ELECTRONICS
- COMPUTER ELECTRONICS
- BASIC ELECTRONICS
- AUDIO ELECTRONICS SERVICING

Dept. 205-122

NAME _____ AGE _____

ADDRESS _____

CITY _____

STATE _____ ZIP _____

- Check if interested in Veterans Training under new G.I. Bill.
- Check if interested ONLY in Classroom Training at Los Angeles

What's in a Color-TV Signal ?

More than you might think—
information for the viewer,
the broadcaster, the phone
company, and the
program originator.

BY FOREST H. BELT

IF ELECTRONICS is your specialty, you probably think that you know all about the makeup of a television signal. But do you really? If you grew up with black-and-white TV, you might not know that stations change their horizontal and vertical scan frequencies when they switch to color programs. Engineers and technicians outside the broadcast field often can't identify the white lines that are sometimes seen at the top of the picture (slightly over the edge of the top black bar). Hardly anyone ever sees the little network cue-flag that tells a station operator that he can drop away from the network for a local commercial or station identification.

You may be surprised to learn just how much information rides on an ordinary color-TV signal. There's more than just video, sync, and chroma—and every month, someone seems to find something new to add.

Assuming that you know how a monochrome signal is put together, let's take a look at what happens when color enters the picture.

Switching to Color. The conventional monochrome transmitter sync generator un-

dergoes some changes in the switch to color. The main timekeeper, or "clock", now comes from a 3.579545-MHz oscillator (chroma phase reference), which, besides acting as the color reference for chroma coding (later decoding at the receiver), also changes the horizontal sync frequency from 15,750 Hz to 15,734.264 Hz, and the vertical frequency from the conventional 60 Hz to 59.94 Hz. This slight frequency change is a result of complex harmonic relationships that enable the interleaving of the chroma signal with the black-and-white (brightness) signal to make color-TV compatible with monochrome.

The color camera separates the red, blue, and green components of the scene being viewed and feeds these, along with the brightness signal (now called "Y"), into a matrix that develops two signals called "I" and "Q." (These stand for in-phase and quadrature-90°-phase, respectively.) In the actual operation, the chroma phase reference signal is passed through a 57° phase shifter and applied to the I modulator along with the I chroma information. The same signal is also passed through a 90° phase shifter and applied with the Q chroma to the Q modulator. The construction of the I and Q chroma signals is a matter of vector addition, too complex to go into in this brief article.

The outputs of the two modulators are added, along with the Y signal, so that the chroma is interleaved with the Y to make it invisible on a monochrome receiver. To enable a color set to decode and display the chroma information, a small piece of the original chroma phase reference signal is required at the receiver to establish a local phase reference so that the colors come out right. At the transmitter, a special gating circuit, called logically a burst gate, extracts eight cycles of this oscillator frequency and inserts them on the "back porch" of each horizontal sync pulse. Special circuits within the receiver extract this reference burst and use it to phase lock a crystal-controlled 3.579545-MHz oscillator within the receiver with the original phase of the transmitter. The local reference is used in a decoding matrix, in conjunction with the video signal, to regenerate the red, blue, and green color components for further processing for display on the color CRT.

Test Signals. Because transmission facilities—both microwave and coaxial cable—

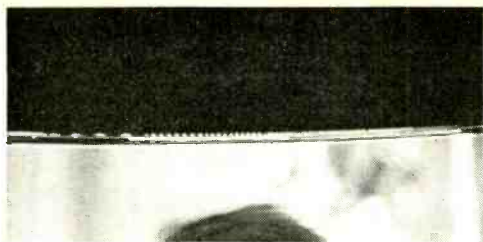


Fig. 1. Adjust vertical hold to see VITS at top of picture on receiver.

are not perfect and because color-TV chroma information is both phase and amplitude sensitive, some means must be found to check the transmission medium continuously without interfering with the viewers' pleasure. (A few degrees of phase shift causes color to change, while a change in amplitude causes a gentle pastel to go to a saturated color.) This takes the form of a test signal of known amplitude and phase that is transmitted from the point of video origin, with tests at various points down the line to show what, if anything, has changed.

The most useful test signal accompanies the color signal all the time. The FCC long ago approved the insertion of a test signal in the last 12- μ s of line 17, and anywhere on lines 18, 19, and 20; and this can be done in both fields. If you don't know what these lines are, remember that when the scanning beam reaches the bottom of the picture, a vertical pulse resets the beam to the top of the picture, so that the vertical sweep can begin again. Each of these scans is called a "field" and when both are interlaced, this is called a "frame". All during the vertical interval (retrace), a continuous series of horizontal pulses is transmitted to keep the set's horizontal oscillator in step

during the vertical blanking interval. There is a "dark" spread of 18 horizontal lines in each field during the vertical retrace; and, in a normally operating set, these are above the visible picture masked by the CRT enclosure, so that they are not normally visible.

A network transmission committee (NTC) formed of network and phone-company engineers, agreed on a more-or-less standard test signal that would fit on lines 18 and 19 of both fields. Appropriately, they named it Vertical Interval Test Signal or "VITS".

At home or on a picture monitor, the VITS is visible only if the raster doesn't fill the top of the screen. Or, you can roll down the blanking bar (with the vertical hold control) and see the video patterns caused by VITS (see Fig. 1).

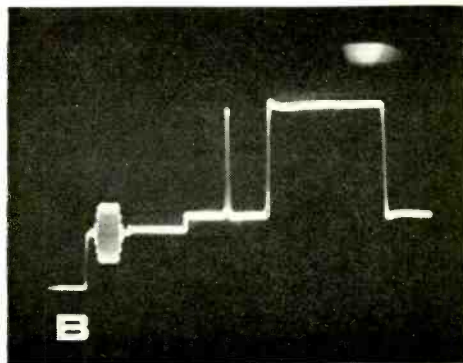
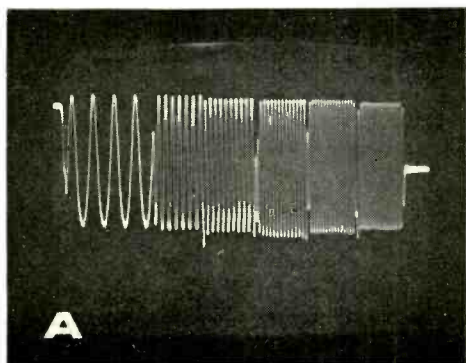
The VITS appears only when network color is on, unless your local station uses a VITS generator of its own to check its studio transmitter link. TV stations are beginning to operate by remote control and you may soon see more locally generated VITS.

In a station, you watch the VITS on a line-selective A-scope, a triggered oscilloscope made especially for monitoring television waveforms a line at a time. Delay circuits let you pick which line you want to inspect and in which field.

The first item in the test signal, on line 18 of field 1 (top line of Fig. 1), is a flag—a single bar of brightness. Its leading edge rises abruptly from zero to maximum white. That's followed by a signal called *multiburst*. It comprises six bursts of r-f energy, one each at 0.5, 1.5, 2.0, 3.0, 3.6, and 4.2 MHz.

The position of the multiburst flag denotes where the VITS originates. If the bar of brightness precedes the 0.5-MHz burst, as

Fig. 2. Two lines of VITS as seen on a special A-scope. Multiburst is at left and sine-squared and window bar are at right.



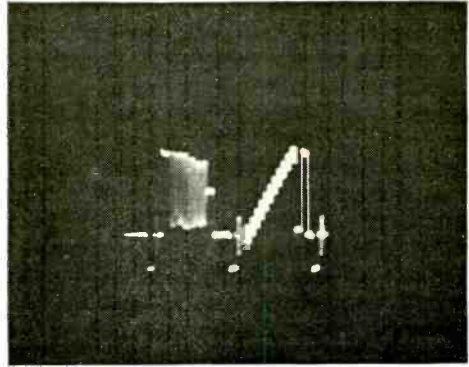
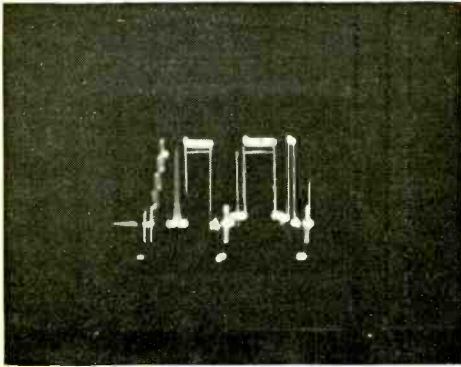
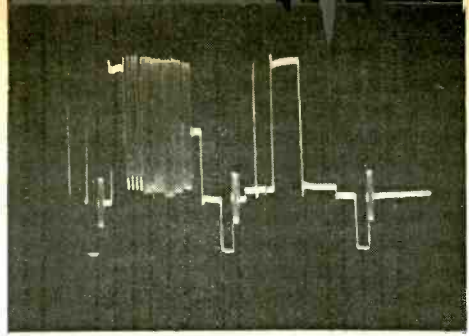
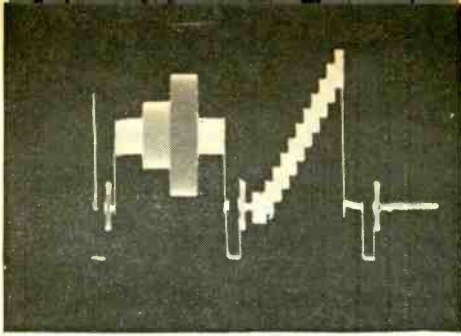


Fig. 3. At top is NBC VITS used during some tests; field 1 at left, field 2 at right. ABC used the version of VITS shown in bottom row; field 1 at left, field 2 at right.

in the photo, the VITS comes from New York; between the 0.5 and 1.5 bursts, Hollywood; and between 1.5 and 2.0, Chicago. For all three networks, most VITS originates in New York.

Take another look at Fig. 1. The flag is the long white bar at the left end of the top line. The first group of four "bumps" is the 0.5-MHz burst. Next is the 1.5-MHz burst; if you can distinguish its bumps, the bandwidth of the receiver or monitor exceeds 1.5 MHz.

The next grouping is the 2.0-MHz burst, and so on. You can distinguish bumps all the way out to the fifth group (printing permitting). That means response goes up to 3.6 MHz. The little bumps in the sixth burst run together so the response doesn't extend quite to 4.2 MHz.

You can get a look at one multiburst spread out on an A-scope in Fig. 2A. The flag is off-screen to the left. The important thing is the amplitude of each multiburst. If higher-frequency bursts are shorter, response is poor in the transmission chain. If taller, highs may be overpeaked. Either condition degrades color reproduction.

Following the multiburst is a program-black reference bar at 7.5 IRE units amplitude. The A-scope lets you check compar-

ative levels. Then comes a program-white reference bar at 100 IRE units.

First along line 19 is a *sine-squared* pulse. It is extremely sharp, of 0.125- μ s duration (at half-amplitude). You evaluate it with the A-scope (Fig. 2B). If you spread the pulse out to $\times 25$, over-shoot indicates the signal has picked up phase delay somewhere along the way.

The wide bar is a *window* signal. It checks sync compression or expansion, video streaking, and ringing. The window is followed by a return to 10 IRE units, then to zero, and finally program-black and program-white reference levels.

Line 19 of field 2 has what is known as a *modulated staircase* signal. It is a series of eleven bursts of 3.579545-MHz energy, each 20 IRE units in peak-to-peak amplitude. The first burst rides at zero level, extending 10 above and 10 below. Each successive burst rides 10 IRE units higher.

Without the 3.58-MHz modulation, the signal would be a simple 10-step black-and-white gray scale and would show video linearity. The modulation lets you test differential gain and differential phase.

Everything Has Changed. In recent months networks have been altering their

VITS to suit themselves. Some are redesigned in cooperation with the telephone company (the Long Lines Dept. of AT&T, which handles network transmission). Often however, even affiliate-station engineers don't know what a new version is for. Such confusion irks station personnel since they can't depend on the VITS—which cancels out its usefulness.

Fig. 3 (top) shows what the VITS looked like at one NBC affiliate for a few days a while back. Line 18 of field 1 carries the unfamiliar pattern at the top left. It consists of four 13- μ s bursts of 3.579545-MHz signal. Checked with a vectorscope, all four were found to be 90° away from burst reference. The purpose of this signal was not explained to either AT&T or the network's station engineers. Line 19 of the same field carries a modulated stairstep.

Field 2 is at top right in Fig. 3. The standard multiburst is all that is on line 18. Line 19 has only the sine-squared and window pulses. On other days, NBC had been sending a more standard VITS.

At an ABC affiliate, recently, the VITS was as shown at bottom left in Fig. 3. Field 1 has a five-step modulated stair on line 18, a special modulated pulse called a 10T (more about it shortly), and a window; on line 19 are sine-squared pulse, window, and white reference. Field 2 (Fig. 3, bottom right), has multiburst on line 18 and modulated stairstep and white reference on line 19.

About that time CBS was also sending a VITS variation. Field 1, Fig. 4 (top left), was standard, but not field 2 (top right). On line 18 was a five-step modulated stair, a sine-squared pulse, that special modulated pulse, and a long-duration window. On line 19 were a standard modulated stairstep and white reference bar.

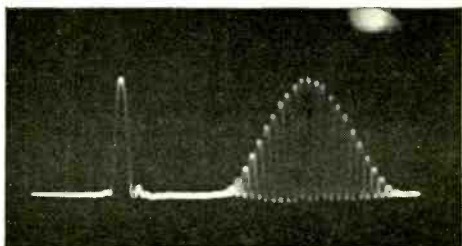
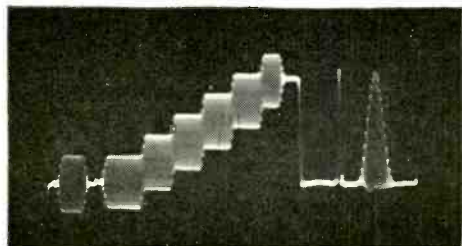
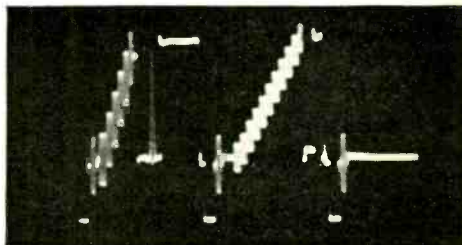
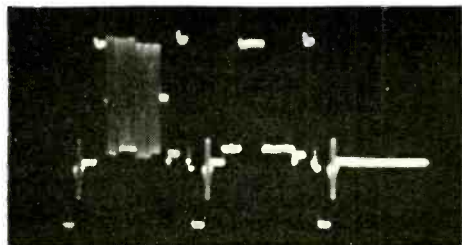
That field-2 line 18 in the CBS test signal is worth spreading out for a closer look. Switch on the 5 \times multiplier of the A-scope (Fig. 4, bottom left). The first burst is color sync on the back porch of the horizontal pulse. Then comes a burst of 3.58 MHz at zero, and five more at 20, 40, 60, 90, and 100 IRE units.

The next patterns on line 18 are gaining popularity. The narrow one is called a 2T bar. The wider one is a 20T display, modulated by 3.579545-MHz signal. Their purpose is quick measurement of envelope delay at both low and high video and chroma frequencies. (ABC alters the 20T phase to show VITS origin; New York is 347° or blue. Chicago is 103° or red, Washington is 241° or green.)

The CBS version is actually a 2T and 14T display. It is shown spread out 25 \times in Fig. 4 (bottom right). The things to watch are overshoot and symmetry of the 2T pulse and the baseline of the 14T. The latter is wavy in the photo, instead of straight. The distortion reveals delay in some portion of the chroma signal.

A more informative VITS is a continuing

Fig. 4. CBS version of VITS with field 1 at top left, field 2 at right. The first line of field 2 is expanded at lower left, and lower right is expanded 2T and 14T.



goal of network, station, and telephone-company engineers. But it may be time for a new Network Transmission Committee to recap who's doing what. The "standard" VITS no longer is.

Making Sure of Color. An experiment last year added still another signal to the vertical interval. It was a chroma reference signal and was called Vertical Interval Reference (VIR). Since lines 18 and 19 were already full, the VIR went on line 20.

The VIR was worked out by a Broadcast Television Systems (BTS) committee of the EIA. The purpose is to give network, telephone company, and station engineers a way to check and adjust chroma phase and amplitude. Eventually, transmitter and repeater equipment could have circuitry to sample the VIR and automatically compensate for any chroma discrepancy. Receivers, too, might be so equipped.

The VIR signal is diagrammed in Fig. 5. Program-black reference is at 7.5 IRE units. Luminance (brightness, Y, or video) reference is at 50 IRE units, a reference against which the chroma amplitude must compare.

and amplitude and the test signal were processed differently in repeaters. The 2T/20T display may be one step in that direction. Meanwhile, if you occasionally spot something on line 20, someone is still trying the VIR signal or some revision of it.

There's More. But that's still not all that a color transmitter sends you. The FCC last year approved transmitting coded signals on the first and last 10 μ s of lines 21, 22, 23, 260, 261, and 262. But no such transmission can exceed 1 second.

So, some commercials are now coded with bars or dots in all four corners. Monitoring services can determine from this digital information when particular commercials are aired. You won't see the dots or bars very long—less than a second. You might catch them on an under-scanned monitor. Not many A-scopes display lines beyond 20.

Networks often use a small cue-flag to show when a station can drop away to its own commercials or station identification. The cue-flag is a small white square superimposed in the upper right corner of the ac-

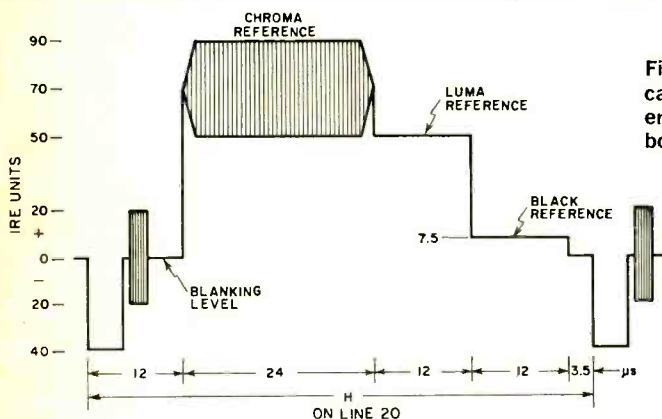


Fig. 5. Latest EIA test signal is called VIR (vertical interval reference) and is usually on line 20, both fields. It is being tested.

Chroma is in a bar 40 IRE units high, 20 units above and below an amplitude center of 70 IRE units.

The VIR experiment went on several months. The signal was on line 20 of field 1 part of the time and on line 20 of both fields the rest of the time. All three networks tried out the VIR.

There is still controversy over whether VIR is needed or not. Aims of VIR could be as well served by VITS, say some station people, if equal care were taken with phase

tive raster. It flashes for about a second. You won't see it unless the raster is under-scanned or the picture tube is one of the new square types. (The ends of film reels usually have a round spot or circle in a similar position.)

If you thought the color signal was just monochrome with a little paint added, a rethink is in order. It is sound, video, sync, chroma, tests, references, digital ID's, and, by the time you're reading this, who knows what else. ♦

LAST month in Part 1 of this article, we discussed the features and test results of a number of communication-type SWL receivers. In Part 2, our discussion is limited to portable receivers and one table-type receiver for shortwave listening.

TABLE & PORTABLE RECEIVERS

Midland 13-910.

Externally, this receiver is similar to many of the small radios used in bedrooms and children's rooms for ordinary AM and FM listening. However, unlike the latter which, at most, cover the AM and FM broadcast bands, the Midland receiver has no fewer than seven tuning ranges. The usual AM and FM broadcast bands are supplemented by a 30-45-MHz (police), 108-135-MHz (air-to-ground), and 145-175-MHz (mobile radio, police, and weather) bands.

The SWL's needs are met only partially, by two bands covering 1.6-4.0 MHz and 4-12 MHz. Concentric with the main tuning control is a smaller fine tuning knob for use on the two high-frequency bands. Its measured range was about 20 kHz at 4 MHz and 90 kHz at 12 MHz. There is also a switchable afc for FM reception. A small tuning meter is operative on all ranges.

The measured sensitivity of the receiver was 9-11 μ V on the AM broadcast band and 2.2-3.8 μ V on the two SW bands. The vhf sensitivity was not measured, but rough checks showed it to be 30-100 μ V on the various ranges.

The i-f bandwidth (selectivity) was 8 kHz at -6 dB, 23 kHz at -20 dB, 54 kHz at -40 dB, and 125 kHz at -60 dB. Image rejection was negligible at 12 MHz and approximately 30 dB in the lower half of the tuning range.

The dial calibration points were widely spaced (4-MHz intervals on FM and 1-2-MHz intervals on the SW bands), making tuning in a station on a known frequency a

RECEIVERS FOR THE SHORTWAVE LISTENER

BY JULIAN D. HIRSCH
Hirsch-Houck Laboratories

PART 2

TABLE MODEL AND PORTABLE RECEIVERS

matter of luck and skill. However, the accuracy of the dial calibration points was generally good, within 1-2 percent of the indicated frequency. On the FM band, the error was typically 300 to 500 kHz, giving little chance of selecting a desired station in a well-populated area except by trial-and-error methods.

This receiver can serve the beginner and young SWL as an introduction to this fascinating hobby. The stronger SW transmissions can be received well, although the absence of the bands above 12 MHz tends to limit the receiver's usefulness to late afternoon and evening hours, and its selectivity is put to a severe test at those times. We also noticed a tendency to overload and produce spurious responses from any moderately strong signal.

The retail price of the Midland 13-910 receiver is \$104.95.

Heath GR-78.

This one could be described either as a communication-type or a portable receiver. We have elected to classify it with the portables because it is battery powered. The receiver is a very compact, lightweight unit, much smaller and pounds lighter than any other receiver in this survey.

This is a general-coverage receiver, tuning 550 kHz to 30 MHz in five bands and the LF band from 200 to 400 kHz. Externally, it resembles other general-coverage receivers. A slide-rule dial is flanked by a



Midland 13-910

small drum dial with bandspread calibrations for the 10-80-meter ham bands and a signal strength meter with arbitrary calibrations from 1 to 5. Adjacent to the main tuning and band-spread tuning control knobs are the band switch and concentric r-f and a-f controls. Between these are anl, avc/mvc, AM/CW-SSB, 500-kHz crystal-controlled marker signal, receive/standby, and light switches. The light switch is spring loaded; pressing it illuminates the dials and meter.

A single-conversion superhet, the GR-78 has a 455-kHz i-f on the lower five bands. On the highest band, it is a double-conversion receiver with a 4034-kHz first i-f. Selectivity is accomplished with ceramic filters in the 455-kHz i-f. There are also separate AM and product detectors.

The power supply design of the GR-78 is unique—and baffling unless one reads the manual carefully. Its internal batteries are rechargeable nickel-cadmium cells which power the receiver whether or not it is connected to an external power source. The internal batteries are trickle charged by the external source, but only when the receiver is turned off. In other words, if the GR-78 is plugged into the ac line when used and unplugged when not in use, the batteries will run down after about 8 hours of operation. The charging rate is based on the receiver being left plugged in at all times and used no more than 8 hours out of a 24-hour period.

No preselector tuning control is provided. Hence, sensitivity varies widely from one end to the other of each tuning range. We measured values of 1.4-6.0 μV at most frequencies, reducing to 14 μV at 200 kHz. The i-f bandwidth was 8 kHz at -6 dB, 14 kHz at -20 dB, 22 kHz at -40 dB, and 38 kHz at -60 dB. Image rejection was fair (35.5 dB) at 7 MHz, but the use of double conversion on the high band resulted in a much better than average figure of 37.5 dB at 30 MHz. The S meter had a roughly logarithmic characteristic with 11 μV producing a reading of S-1 and 700 μV being required for a full-scale reading of 5 (at 11 MHz).

The major weakness of the GR-78 was its tuning and dial calibration. The small dials are crowded and the tuning was critical. The calibration of the main dial was very good, within 1 percent, but the bandspread dial calibration errors were large. The stability and tuning "feel," in general, were



Heath GR-78

not adequate for SSB reception. (Switching on the dial illumination often completely detuned high-frequency SSB signals.)

On the other hand, the receiver did a perfectly satisfactory job of pulling in SW stations, and its size and weight could be significant advantages for portable or vacation use. We question the advisability of the ham band calibrations on the bandspread dial which imply that the receiver could be used for this service. But the SW band calibrations can be of value to many users.

The Heath GR-78 receiver retails for \$129.95 in kit form.

Sony CRF-160.

This is a 13-band portable receiver. On its lower frequency ranges (150-400 kHz, 530-1605 kHz, and 1.6-4.5 MHz), the CRF-160 is a conventional superhet receiver. Band selection is via pushbutton. Three slide-rule scales are clearly marked, although their calibration intervals are widely spaced at 500 kHz on the highest of the three bands.

Pushing a button marked SW3-SW10 converts the unit to a double-conversion receiver with nine band-spread ranges covering the SW bands at 60, 49, 41, 31, 25, 19, 16, 13, and 11 meters. A large knob set into the right side of the case is used to change bands and display only the selected frequency scale in a window above the main tuning dial.

Although no schematic or technical information was supplied, the performance of the receiver strongly suggested the use of a crystal-controlled oscillator for the first conversion and a stable, fairly linear tunable oscillator covering 600 kHz for the second conversion. Since each SW band covers only 600 kHz, the CRF-160 tunes even less critically on the SW bands than on the broad-

cast band. A small knob shifts the 100-kHz dial calibration intervals to align with the numbers on the dial scale. Since the receiver has no built-in calibrating signal, one must depend on CHU (7335 kHz) or WWV (10 or 15 MHz) for this purpose. However, we found that setting the calibration lines to center on the dial numerals was sufficiently accurate.

An r-f gain control turns on the bfo when rotated clockwise. Concentric with this control is a ring that tunes the bfo frequency for proper reception of USB or LSB signals. A tone control and a selectivity button that narrows the i-f bandwidth on the AM bands are provided.

A pushbutton selects the FM band which is tuned by a separate knob, dial pointer, and scale. Switchable afc is provided, but it is not necessary since the receiver is quite stable and easy to tune. A spring-loaded switch illuminates the dial and tuning meter when it is depressed. A miniature headphone jack is on the front panel, and a 6" X 3" oval speaker is at the top of the panel.

Our measurements of the CRF-160 showed sensitivity varying from 1.6 to 6.0 μV on the SW bands, 6-7 μV on the broadcast band, and 6-9 μV on the longwave bands. The normal selectivity was 7 kHz at -6 dB, 10 kHz at -20 dB, 27 kHz at -40 dB, and 37 kHz at -60 dB. In the sharp selectivity position, these figures were reduced by about one-third. The i-f's were not specified, but a search with a signal generator for image responses indicated a first i-f of about 2.2 MHz. At 7 MHz, image rejection was 35 dB; 26 MHz, it was 0 dB. A number of spurious responses were

found at other frequencies, but they were too low in level to present any problems.

The frequency calibration of the bandspread dial scales was excellent, with typical errors between 1 kHz and 20 kHz, even without previous calibration against a known frequency. While this unit is not the equal of those communication receivers having a 1-kHz or better readout capability, it is far more accurate than any of the general-coverage models. Tuning the CRF-160 was easy and non-critical in spite of some backlash in the tuning mechanism. Hard blows on the receiver produced no more than a faint microphonic quaver on CW and SSB signals. In this respect, the CRF-160 resembled the better communication receivers.

The FM dial calibrations were at 2-MHz intervals, with errors of 250-500 kHz at the marked points, making it impractical to identify a station from the dial reading alone. Performance was good with respect to sensitivity, selectivity, tuning ease, and sound quality.

The Sony CRF-160 receiver is retail priced at \$249.50.

Zenith D7000Y

This receiver is an 11-band portable which has a number of conveniences for the camper and boating enthusiast as well as the SWL and general public. The D7000Y covers the standard AM broadcast band, a low-frequency band from 150 kHz to 400 kHz, the FM broadcast band, and the vhf services band from 161 MHz to 164 MHz. For the SWL, there are two general-coverage bands from 1.6 MHz to 3.5 MHz and 3.5 MHz to 9 MHz, and five bandspread ranges covering the 31-, 25-, 19-, 16-, and 13-meter bands. The bandspread tuning ranges average about 1 MHz wide, giving a tuning rate comparable to that on the AM broadcast band.

This is a single-conversion receiver with a 455-kHz i-f for AM reception. Three separate "front ends" are used for the LW/AM/SW, FM broadcast, and vhf bands. A single tuning knob and a large band switch knob are features, the latter rotating the dial scale drum so that only the scale in use is visible.

There are separate r-f and a-f gain (the former turns on age), tone, and combined bfo switch/pitch controls for CW and SSB reception. Although a conventional diode detector is employed, the bfo signal is in-

Sony CRF-160



jected into the i-f amplifier at a sufficient level for satisfactory SSB reception.

The tuning meter can be used to monitor battery condition by moving a 3-position switch to the right. Moving the switch to the left turns on the dial and meter illumination as well as a retractable chart light on the front panel. Two other switches control FM afe and AM bandwidth.

A world time map is displayed on the inside top cover of the cabinet. A movable index allows the time in any part of the world to be determined at a glance. Also in the cover is a removable book which contains operating instructions, lists of standard time and frequency transmissions, and information on specialized transmissions and the frequencies and locations of SW and FM broadcast stations. Inside the front cover is a rotatable compass scale which can provide directional bearings on a station by observing the null on the tuning meter. A comprehensive instruction manual gives suggestions on using the receiver for direction finding while boating.

The receiver's sensitivity varied by 2.5-4.0 μV on the SW and AM broadcast bands. At the low-frequency end of each general-coverage band, sensitivity was a poor 16-25 μV , and was 5.5-10 μV on the low-frequency band.

With normal bandwidth, selectivity was 7 kHz at -6 dB, 15 kHz at -20 dB, 24 kHz at -40 dB, and 32 kHz at -60 dB. The sharp setting reduced these figures by about one-third. Image rejection was 28.5 dB at 7 MHz and 6 dB at 22 MHz. The frequency calibration was quite good on all bands; the maximum error was about 50 kHz, and typically 10-30 kHz. The FM calibration was also very good, within 100 kHz, although the dial was calibrated at only 2-MHz intervals.

The general-coverage dial scales were quite crowded, but tuning was fairly easy. On the band-spread ranges, the receiver tuned very easily. Although CW and SSB signals could be received, there was considerable hand capacitance which detuned signals when the panel or cabinet was touched. Mechanical stability was fairly good.

The receiver overloaded quite easily on very strong signals, and many spurious responses could be detected with inputs as low as 1000 μV (although most SW signals are well below this level). In-band images were also evident in the 13-, 16-, and 19-meter bands with the same station appear-

Zenith D7000Y



ing twice. Although the receiver gives the impression of being "hot," due to its busy-sounding bands, much of this is the result of spurious and image responses.

The performance and listening quality on AM and FM broadcasts were good. The overall behavior of the receiver on SW reception was also good.

The Zenith D7000Y receiver sells for \$279.95.

Panasonic RF-5000A

An 11-band portable, the Panasonic RF-5000A was the largest, heaviest, and most expensive of those we tested. A general-coverage, single-conversion unit, it tunes a 160-400-kHz low-frequency band, continuously from 530-kHz to 30 MHz in nine bands, and the FM broadcast band. This receiver appears to have been designed to meet the needs of both our and the Japanese markets since the FM range is 76-108 MHz.

A large rectangular dial has all ranges clearly marked. Pushing a button below the dial illuminates the scales and lights an arrow on the dial next to the band in use. A row of pushbuttons are on top of the receiver. These select the bands (simultaneously turning on power) and separately turn off power. Four smaller buttons are for wide/narrow AM bandwidth, FM afe, anl, and bfo. Turning on the bfo disables the agc. A small thumbwheel is used to control

r-f gain. The large tuning knob is mechanically clutched to move the FM dial pointer only when the FM button is depressed. At all other times, only the large AM/SW dial pointer moves. The tuning meter is used to keep tabs on battery condition. Two small knobs control volume and fine tuning (an electrical vernier which is active on only the AM and SW bands), and a pair of small concentric knobs control separate bass and treble tone characteristics.

On top of the receiver are two telescoping antennas for FM reception. A rectangular metal loop swings up from the rear to form an SW antenna for frequencies above 4.5 MHz. Two built-in ferrite rod antennas are used for the lower frequencies. Two speakers—a circular and a larger oval—are operated in parallel.

When the front cover is swung down to operate the receiver, a world time conversion dial is visible next to a pocket containing a collection of hints in several languages on SW'ing. The open cover extends well in front of the receiver to form a desk surface, but it can be removed if desired.

Sensitivity varied by 2.2-5.0 μV at all frequencies above 4.5 MHz. It dropped from 5.2 to 35 μV between 4.5 and 1.6 MHz and varied 11-45 μV across the two lower frequency bands. The wide i-f bandwidth was 10 kHz at -6 dB, 16 kHz at -20 dB, 30 kHz at -40 dB, and 52 kHz at -60 dB. With the narrow setting, the corresponding figures were 3, 12, 19, and 35 kHz. Image rejection was 26.5 dB at 7 MHz and 14.5 dB at 30 MHz.

The dial calibration was good, with the error typically less than 25 kHz and never more than 50 kHz, except at 30 MHz where it was off by 130 kHz. The FM calibration was in error typically by 500 kHz or more; combined with the calibration intervals 4

Panasonic RF-5000A



MHz apart, this made tuning a particular station largely a matter of guesswork.

In tuning the RF-5000A, we were immediately aware of its excellent audio quality and high undistorted output, both far superior to any of the other receivers in the group. The mechanical stability was very good even with hard tapping on the case. We were also surprised to find that the antenna worked very well—much better, in fact, than on most of the other receivers having this feature. The FM quality was on a par with the audio performance of the receiver, and the AM quality was at least as good as that of most hi-fi receivers.

The Panasonic RF-5000A receiver retails for \$299.95.

Conclusion. A careful study of the features in this group of receivers and our test data will reveal that there is no "ideal" receiver for the SWL. Of course, your listening habits should be given the highest priority when shopping for a receiver. The portables, in general, offer the greatest overall utility. Their performance is more than adequate for a great many SWL's. From a practical standpoint, we found little difference between the portables with respect to their effectiveness.

As our tests reveal, a low-cost communication-type receiver is not necessarily better than—or even as good as—a good general-purpose portable. However, low cost is an undeniable plus, especially when the user is a youthful newcomer to SW'ing.

The best SW performance is definitely offered by the more expensive double-conversion communication-type receivers such as the Allied SX-190, Drake SW-4A, and Heath SB-313. Although their list prices are comparable to those of good portables, the elimination of such features as FM and AM broadcast band reception and battery operation has permitted the enhancement of their basic receiving performances. They are unequivocally fine receivers, their high prices easily justified if tuning accuracy by the serious listener is a must for SW DX.

Bear in mind that the specific figures we obtained for receiver performance may not agree with the manufacturers' published data. This does not mean that either of us is incorrect but simply that test conditions differed somewhat. Since our data were obtained on all receivers under identical conditions, we consider them to be valid as a basis for making comparisons. ♦

RADIO EMERGENCY CALL BOXES

OPERATE WITHOUT BATTERIES OR CONNECTING WIRES

A UNIQUE call-box system for use in summoning emergency assistance on highways and city streets is shown below. Designed to operate without batteries or interconnecting cables, the emergency call box can be easily installed and requires little maintenance over long periods.

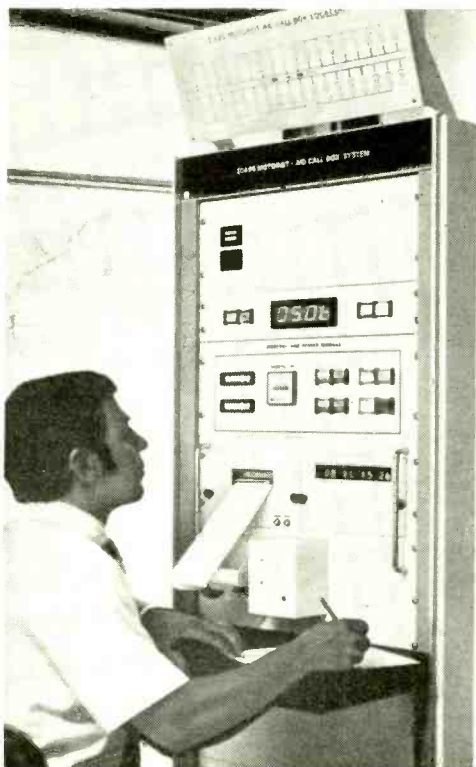
In a typical highway use, the boxes are placed about every half mile on both sides of the road. When faced with an emergency or distress situation, the motorist merely walks or drives to the nearest box, opens a door lever, and presses one or more of four buttons marked "Fire," "Police," "Ambulance," and "Service." A coded distress call is received at either a master console located at a central dispatch station or a small console at a substation. Aid can then be dispatched immediately.

When motorist in need of help pulls down front door handle on the roadside call box, power is automatically turned on. Then when he presses one of the buttons, a signal is transmitted to the central station, right, and the proper aid is sent to him.

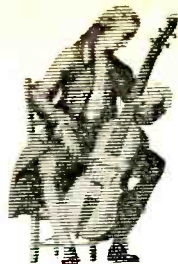


Using solid-state circuitry, the boxes derive their power from a patented electro-mechanical power module, which is activated when the door lever is opened. The electrical charge thus produced is retained temporarily to power the compact, integral FM transmitter. This means no batteries to run down and no dependence on regular electric power, which can fail just when motorists may particularly need help.

Because the solid-state transmitter circuits are supplied with power only when the door is opened and the emergency buttons are depressed, there is no chance that they can be electronically operated by a false signal. Thus, a box will never pick up a spurious signal such as might be produced by a passing vehicle with a mobile radio transmitter. The call boxes are manufactured by ADT. ♦



Build a Crystal-Controlled Musical Instrument Tuner



AN ACCURATE SOURCE OF 440 HZ, A ABOVE MIDDLE C

BY HANK OLSON

MANY orchestras use the oboe as the instrument to which all of the others are tuned just before a performance. The oboe has been previously tuned to an accurate source of 440 Hz (A above middle C). Although there are many ways of generating the 440 Hz, the most accurate is an electronic system using a crystal-controlled oscillator. In this way, the pitch can be established within $\frac{1}{10}$ th of a hertz, which is far better than most other tune-up systems. In addition, the 440-Hz tone can be

Capacitor C5 is mounted on L1. Power supply components are under T1 and C2.

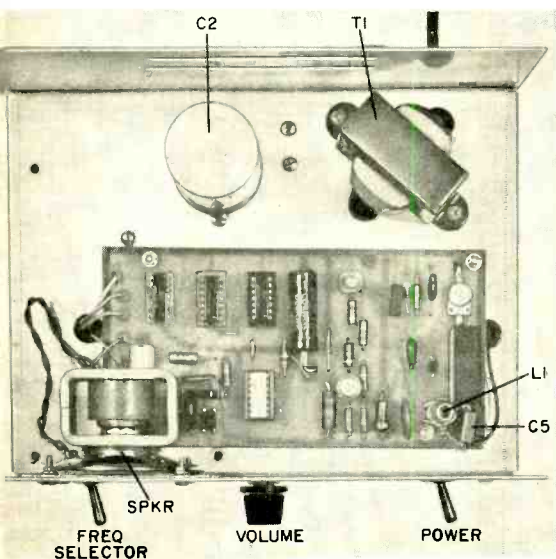
easily divided by two to obtain 220 Hz, which can be used to tune a bassoon.

Since 440-Hz crystals are hard to find, a crystal with a higher frequency and a suitable countdown circuit can be used. Such a circuit is shown in Fig. 1. The oscillator (Q1) operates at approximately 901 kHz. This frequency is used because there is usually available a surplus-type crystal (FT241) that will fill the bill. However, before starting this project, it is advisable to check on the availability of the crystal.

The oscillator operates in the 32-pF parallel-resonance mode and is quite stable. Between the crystal oscillator and the first digital divider (IC2), are two isolation stages (Q2 and Q3) that drive a Schmitt trigger (IC1) to produce a clean toggle waveform.

The digital countdown circuit (IC2 through IC4) needs no adjustment and is inherently stable. Total division is 2^{11} or 2048 which brings the crystal frequency down to within $\frac{1}{10}$ th of a hertz of 440 Hz. The oscillator frequency can be adjusted slightly by C1 to make the final frequency even closer to 440 Hz. If a sharper or flatter A note is required, FT241 crystals are available every 1.042 kHz, making each step represent a change of about $\frac{1}{2}$ Hz in output frequency.

Construction. Although almost any type of construction can be used, an etched circuit board makes the work easier (see Fig.



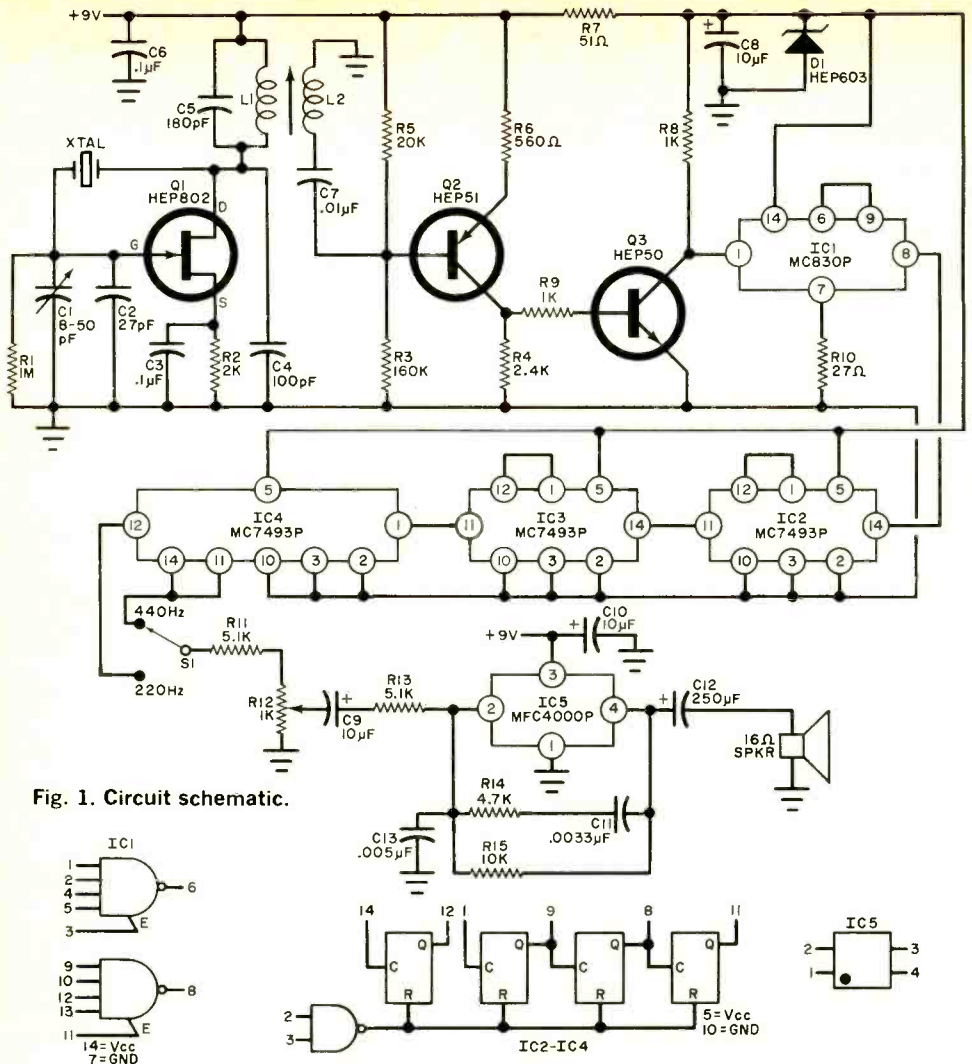
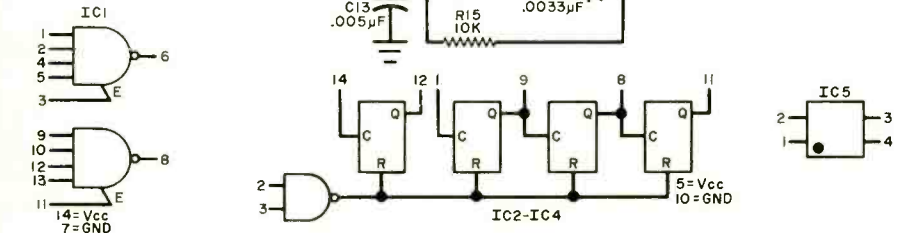


Fig. 1. Circuit schematic.



PARTS LIST

- C1—8-50-pF ceramic trimmer capacitor
 C2—27-pF silver-mica capacitor
 C3,C6—0.1- μ F, 50-volt Mylar capacitor
 C4—100-pF silver-mica capacitor
 C5—180-pF silver-mica capacitor
 C7—0.01- μ F, 50-volt Mylar capacitor
 C8-C10—10- μ F, 12-volt electrolytic capacitor
 C11—0.0033- μ F, 50-volt Mylar capacitor
 C12—250- μ F, 15-volt electrolytic capacitor
 C13—0.005- μ F, 100-volt Mylar capacitor
 D1—5.6-volt, 1-watt zener diode (1N4734A, HEP603)
 IC1—Dual 4-input gate (μ L930, MC830P, SN15830N, CD2300E/830, HEPIC1030P)
 IC2-IC4—4-bit binary counter (SN7493N, MC7493P, or similar)
 IC5—Audio amplifier (MFC4000P HEPIC6003)
 L1—120-243- μ H (CTC X2060-8)
 L2—10 turns #24 wire wound over L1
 Q1—FET (HEP802, MPF102, or similar)
 Q2—Transistor (HEP51, 2N3638, 2N5142)
 Q3—Transistor (HEP50, 2N3646, 2N708)

- R1—1-megohm, $\frac{1}{2}$ -watt resistor
 R2—2000-ohm, $\frac{1}{2}$ -watt resistor
 R3—160,000-ohm, $\frac{1}{2}$ -watt resistor
 R4—2400-ohm, $\frac{1}{2}$ -watt resistor
 R5—20,000-ohm, $\frac{1}{2}$ -watt resistor
 R6—560-ohm, $\frac{1}{2}$ -watt resistor
 R7—51-ohm, $\frac{1}{2}$ -watt resistor
 R8,R9—1000-ohm, $\frac{1}{2}$ -watt resistor
 R10—27-ohm, $\frac{1}{2}$ -watt resistor
 R11,R13—5100-ohm, $\frac{1}{2}$ -watt resistor
 R12—1000-ohm potentiometer with switch
 R14—4700-ohm, $\frac{1}{2}$ -watt resistor
 R15—10,000-ohm, $\frac{1}{2}$ -watt resistor
 S1—Spdt switch
 SPKR—16-ohm speaker
 XTAL—901.042-kHz FT241 crystal (available from JAN Crystals, 2400 Crystal Dr., Ft. Myers, FL 33901)
 Misc.—Suitable chassis, knob, line cord, rubber feet, mounting hardware, etc.
 Note—An etched and drilled PC board is available from Eico, 283 Malta St., Brooklyn, NY 11207 for \$3.00.

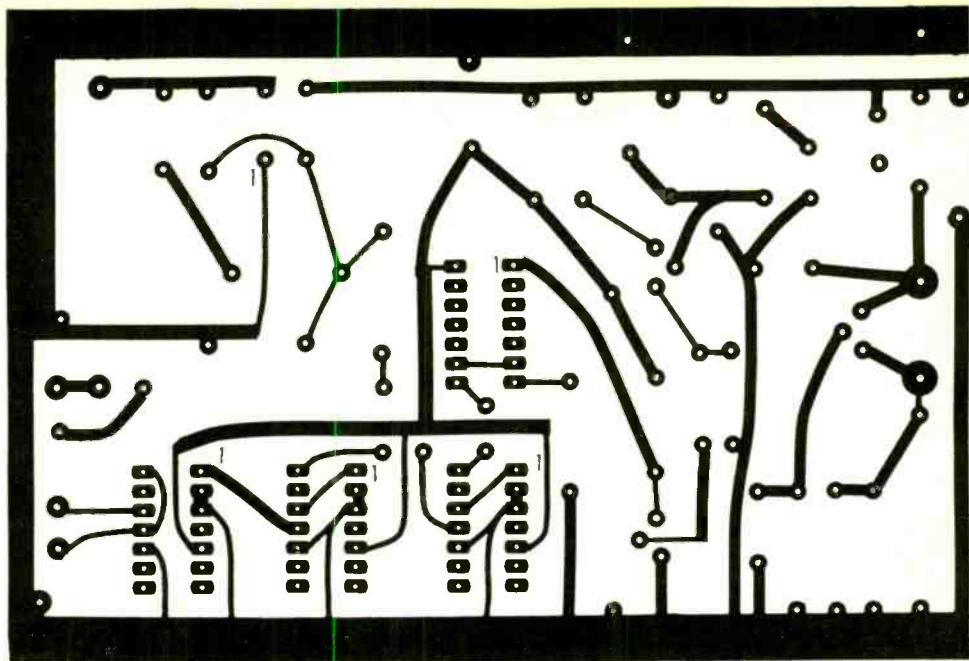
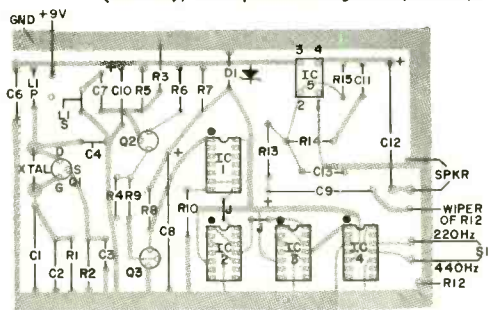


Fig. 2. Actual size foil pattern (above), component layout (below).



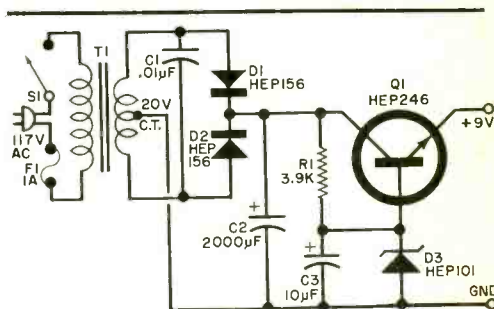
2). A power supply circuit is shown in Fig. 3. Although the photograph of the prototype shows the semiconductors and IC's mounted in sockets, they are optional and the devices may be mounted directly on the PC board.

The power supply transformer and filter capacitor are mounted in any available space on the chassis, with the other components mounted on a multi-lug terminal strip. The PC board is mounted in the chassis on insulated stand-offs. The power on-off switch, the 440/220-Hz selector switch, the volume control, and the speaker are mounted on the front panel.

Once the unit is assembled the frequency can be checked with a frequency counter or by generating Lissajous patterns with a suitable audio generator on a scope. At this

point, trimmer capacitor *C1* can be set to adjust the frequency as close as possible.

Operation consists simply of turning on the power, setting the frequency selector switch, and adjusting the volume. ♦



PARTS LIST

- C1*—0.01- μ F, 1-kV ceramic disc capacitor
- C2*—2000- μ F, 15-volt electrolytic capacitor
- C3*—10- μ F, 15-volt electrolytic capacitor
- D1, D2*—Diode (HEP156, 1N4002, or similar)
- D3*—10-volt, $\frac{1}{4}$ -watt zener diode (HEP101, 1N4104, or similar)
- F1*—1-ampere, 3-AG fuse and holder
- Q1*—Transistor (HEP246, 2N5191, or similar)
- R1*—3900-ohm, $\frac{1}{2}$ -watt resistor
- S1*—Spst switch (on volume control)
- T1*—20-volt CT transformer (Triad F90X or similar)

Fig. 3. Power supply schematic and parts.



480000			
100	100	0.35'	
100	100	1.21'	
100	100	1.21'	
100	100	1.21'	
100	100	1.21'	
100	100	1.21'	
100	100	1.21'	
100	100	1.21'	
100	100	1.21'	
100	100	1.21'	

ADVANCED ELECTRONICS CAREER TRAINING AT HOME

Modern aircraft are loaded with vital electronic equipment. There is equipment for communications, direction finding, instrument landing and for many other functions to insure safe operation of the aircraft.

The man who checks out this equipment has to be an expert. Many lives depend on his specialized knowledge as an engineering technician. His work is interesting and exciting and he enjoys top pay in his field.

Consider a career In advanced electronics

Aeronautical and Navigational Electronics is just *one* of the advanced electronics programs CREI offers. There are *seventeen* others. All of the programs, except a brief introductory course, are college-level. The programs cover every major field of electronics today.

If you want to qualify for the highest paying level of technical employment in electronics, we invite you to consider the unique home study programs of CREI. Here is a list of just some of the CREI programs: *Communications Engineering • Computer Engineering • Missile & Spacecraft Guidance • Radar & Sonar • Television Engineering • Nuclear Instrumentation & Control • Digital Communications • Industrial Electronics • Electronic Systems Engineering • Microwave Communications • Satellite Communications • Cable Television Engineering*

For over 45 years, CREI programs have been recognized by industry and government as effective home study training in advanced electronics.

Qualifications to enroll. To qualify for enrollment in a CREI program, you must be a high school graduate (or equivalent). You should also be working in electronics or have previous training in this field.

Send for FREE book. If you are qualified, send for CREI's newly published book describing your career opportunities in advanced electronics. This full color book is filled with facts about career opportunities for you.

Capitol Radio Engineering Institute
A Division of McGraw-Hill Continuing Education Co.
3939 Wisconsin Avenue, Washington, D. C. 20016



Accredited Member, National Home Study Council

CREI, Dept. E1212C
3939 Wisconsin Avenue
Washington, D. C. 20016

Rush me your FREE book describing my opportunities in advanced electronics. I am a high school graduate.

Name _____ Age _____

Address _____

City _____ State _____ ZIP _____

If you have previous training in electronics, check here

Employed by _____

Type of Present Work _____

Veterans and servicemen, check here for G. I. Bill information

CREI
CAPITOL
RADIO
ENGINEERING
INSTITUTE

WASHINGTON, D.C.

Nuclear Radiation & Detection

Part 3: Radiological Survey Meters

BY J. G. ELLO Radiation Measurements and Instrumentation
Electronics Division, Argonne National Laboratory

HOW THE IONIZATION CHAMBER, PROPORTIONAL COUNTER, AND GEIGER-MULLER TUBE OPERATE

SO FAR, we have discussed the phenomenon of radioactivity and found that the three types of radiation are alpha and beta particles and gamma rays. Radiation can ionize atoms. Since the ions have an electrical charge, they can be directed in an electrical field to a positively charged anode (collector) where they are neutralized by supplying the positive ions with electrons from a battery, thus providing a measurable current.

To make use of this detector current, a unit of measurement must be established. Radiological survey meters measure radiation intensity in roentgens per hour (R/hr). A roentgen is the intensity of gamma radiation that will produce one electrostatic unit of ions/cu cm of dry air, or the intensity of radiation that will produce a little over 2 billion ion pairs/cu cm of dry air. The unit of measurement for detectable radioactivity is called the roentgen; the order of magnitude most commonly used is the milliroentgen, or mR.

As an example, a radioactive source is emitting an intensity of 2 mR/hr at a point a certain distance from the source. If you were to stand at this distance for one hour, you would receive a 2 mR/hr exposure. If the intensity were only 1 mR/hr and exposure time were extended to two hours, the

radiation dose would be the same since $(1 \text{ mR/hr}) (2 \text{ hr}) = 2 \text{ mR}$.

Ionization Detector. The construction of an ionization chamber is quite simple. As shown in Fig. 1, it consists of an insulated central anode enclosed by a shell of conducting material with an alpha window. The ionization chambers used in many commercial survey meters are designed for only beta/gamma radiation. If alpha particles are to be detected, a very thin window is incorporated into one end of the detector to allow the particles to pass into the detector. Most alpha windows are made from 1-mil (0.001") thick Mylar with a coating of conducting material on both sides. In some ionization survey meters, slide-type alpha and beta absorbers are used to permit measuring beta particles in the presence of alpha particles and gamma rays in the presence of beta particles.

An ionization survey meter is shown in Fig. 2. Through use of its built-in absorbers, it can detect and measure alpha, beta, and gamma radiation. This is a self-contained unit, powered by internal batteries. It consists of an ionization chamber, range selector, amplifier, and dc microammeter. The alpha absorber is a 0.01"-thick cellulose sheet, while the beta absorber is a 0.102"-thick plate of aluminum. Its range may vary from about 5 mR/hr to 50 R/hr.

A simplified block diagram of the ionization survey meter is shown in Fig. 3. The ionization detector is maintained at the proper voltage for operation in the ionization-chamber region of the pulse-size/detector-voltage curve. As ions are neutralized at the collector, a small ion-chamber current flows through the selected range

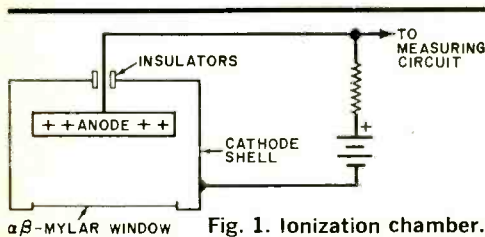


Fig. 1. Ionization chamber.



Fig. 2. Two views of ionization survey meter.

resistor. The pulse developed across this resistor is applied to the grid of the amplifier tube or gate of a field-effect transistor. This minute current is amplified and passed through the meter movement which is calibrated in mR/hr.

In use, the ionization chamber is located in the bottom forward position of the instrument with the window on the bottom surface. To detect beta and gamma radi-

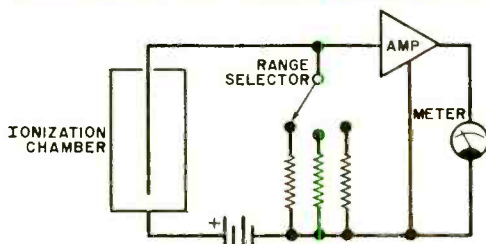


Fig. 3. Schematic of ionization survey meter.

tion simultaneously, the aluminum absorber is pulled up; to detect alpha, beta, and gamma radiation simultaneously, both absorber tabs are pulled up.

To check the unit's operation, an alpha or beta source is held close to the Mylar window. With the survey meter adjusted to a suitable range, a reading should be indicated on the meter. When making surveys, the unit would be moved across the suspected material at about a 2 in./second scan and close to the material's surface to obtain a true reading. Whenever a rapid jump of the meter pointer is observed, radioactivity is most likely present in the material. To determine if it is gamma radiation, both the

alpha and beta absorbers should be in place. To read beta radiation, the alpha absorber is left in place and the beta absorber is removed. To determine beta intensity, the gamma reading is subtracted from the new reading. To check for alpha radiation, both alpha and beta absorbers must be removed. Alpha intensity is determined by subtracting the reading obtained for beta only from the new reading. If no change is observed, there is no detectable alpha radiation present.

Proportional Detector. Although the ionization detector is ideal for detecting the three types of radiation, it needs a very sensitive electrometer tube or field-effect transistor amplifier stage. To eliminate the need for sensitive amplifiers, detectors in which internal amplification takes place have been devised. This amplification is referred to as the proportional region on the pulse-size/detector-voltage curve. In this region, it is possible to differentiate between alpha-, beta-, and gamma-generated pulses.

The internal amplification within the detector is caused by increasing the detector voltage and, hence, the electrical field between the anode and cathode which causes the electrons produced in the primary ionization of the atom to travel at higher velocities. The primary electrons also have sufficient energy to dislodge other electrons in their path and thereby generate larger pulses.

Shown in Fig. 4 is a basic sketch of an air proportional detector. It consists of a 1-mil diameter center wire mounted on Teflon insulators. The alpha particle window, fastened to the shell by an adhesive, is made from 0.25-mil thick Mylar. The detector may consist of one center wire or as many as ten wires.

A battery-operated count-rate survey meter and its air proportional detector are shown in Fig. 5. The detector has a metal screen to protect the alpha window against

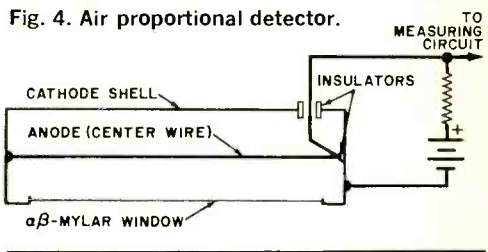


Fig. 4. Air proportional detector.

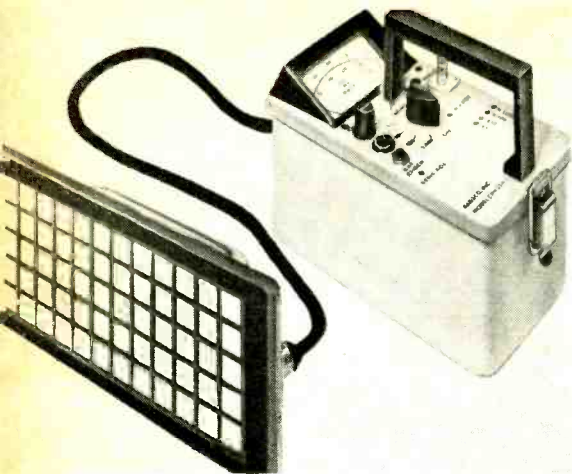


Fig. 5. An air proportional survey meter.

punctures. It is called air proportional because it contains air instead of a counting gas like that used in Geiger-Muller detectors. The detector is capable of responding to all three types of radiation and, through the use of a discriminating control, identify pulses produced by alpha particles and those produced by beta particles.

The survey meter consists of an adjustable detector, high-voltage power supply, range selector, amplifiers, discriminator, and count-rate circuit which supplies current to the dc microammeter. The meter is calibrated in counts/minute instead of mR/hr as in the ionization and Geiger-Muller survey meters.

The simplified block diagram of the survey meter is shown in Fig. 6. The detector is set to operate in the proportional region by means of the detector voltage supply. Pulses

produced at the center wire (anode) are coupled to the grid of the first amplifier stage and are then coupled to the second amplifier through the range selector circuit. At the discriminator control, pulses of proper size are selected and fed to the count rate circuit which supplies the dc current for the meter.

The average efficiency of an air proportional detector is about 10-15 percent; the detector, therefore, is affected by only 10-15 percent of the total disintegration taking place. For example, if a radioactive source disintegrates at a rate of 1000 disintegrations/minute (d/min), the detector "sees" about 100-150 d/min.

The surveying technique is the same as for ionization survey meters. The proportional survey meter is used mainly in the field for alpha detection and measuring. If beta and/or gamma radiation are to be measured, the discriminator control must be adjusted to pass the smaller pulses they produce. In addition to gamma pulses, beta and alpha pulses, if present, will also be indicated under these conditions. Hence, the unwanted reading (in this case, the alpha reading) must be subtracted from the total reading. Absorbers can also be used as in the ionization survey meters.

Geiger-Muller Detector. Often referred to as the "G-M tube," the Geiger-Muller detector is the most often used radiation detection instrument. It operates in the Geiger-Muller region of the pulse-size/detector-voltage curve. The main difference between the proportional detector and the G-M tube is that in the former, the incident radiation produces an avalanche of electrons at only

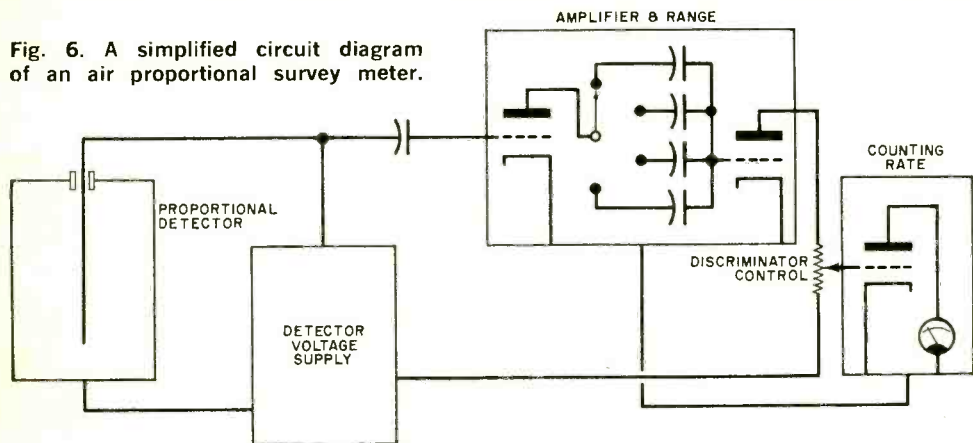


Fig. 6. A simplified circuit diagram of an air proportional survey meter.

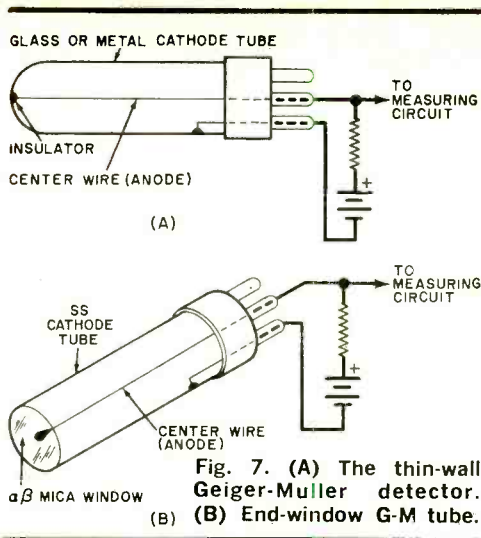


Fig. 7. (A) The thin-wall Geiger-Muller detector. (B) End-window G-M tube.

one point in the detector, while in the latter, the electron avalanche spreads along the entire length of the wire anode. The pulse size in the proportional detector varies with the number of secondary electrons produced. In the G-M tube, electron amplification is much larger so that the pulse size is practically independent of the number of electrons produced per nuclear radiation incident. The G-M tube, therefore, cannot discriminate between types of radiation.

The larger pulse size is due to the high electrical field and the fact that the G-M tube is filled with a counting gas, such as neon plus halogen, instead of air. This provides an additional electron amplification factor, referred to as "gas amplification." The main advantage of gas amplification is that the detector itself requires less external amplification.

Shown in Fig. 7A is a basic thin-wall G-M tube, while Fig. 7B depicts a basic end-window G-M tube. The cathode is stainless steel or glass tubing with a conductive coating on the inside.

To detect alpha radiation, the wall of the tube must be very thin. For this application, the G-M detector is fabricated with a very thin window as shown in Fig. 7B. The cathode material, usually made from stainless steel, is about 0.003" thick, mainly for strength. The end window is made from very thin mica. The center wire is supported only at the base end, while the free end is tipped with a glass bead to prevent spurious internal discharges.

In Fig. 8 are shown two battery-powered G-M survey meters. The end-window G-M survey meter is at the left; a thin-wall G-M meter is on the right. Both instruments contain a high-voltage detector supply, amplifier and trigger stages, and a drive circuit for the dc microammeter. Like the proportional survey meter, an audio jack is provided for aural monitoring.

A simplified block diagram of a G-M survey meter is shown in Fig. 9. The detector is maintained at a fixed voltage to operate in the Geiger-Muller region of the pulse-size/detector-voltage curve. Due to the detector gas electron amplification, a pulse amplifier is not required; detector pulses are coupled directly to a two-tube trigger circuit which modifies the pulse sizes and feeds them to the metering circuit which is calibrated in mR/hr. The coupling between the trigger tubes serves as the range selector.

The walls and mica windows of the G-M tube are very thin; so, care must be exercised to avoid any physical shock to the detector. Unlike an ionization survey meter which can work if the detector's window

Fig. 8. (Left) End-window and (right) thin-wall Geiger-Muller survey meters.



is ruptured, G-M detectors become inoperative if the wall or window is damaged.

Another limitation of G-M detectors is their inability to respond indefinitely to radiation, which can be done by ionization and air proportional detectors. The normal life of a G-M tube is about a billion counts, after which efficiency drops off. Many G-M tubes cease to give any indication and may read zero mR/hr when exposed to a very high radiation intensity.

Scintillation Detector. Another type of detector used in surveying radioactivity is known as the "scintillation detector." It is made from a phosphorescent material which gives off flashes of light called scintillations, when exposed to nuclear radiation. Modern scintillation materials are in the form of crystals, liquids, or gases. The most widely used at the present time is a sodium iodide crystal, optically coupled to a #6292 photomultiplier tube.

When exposed to nuclear radiation, the scintillator gives off a glow which is converted into electrical pulses by the photomultiplier tube. The scintillation detector consists of an optical coupling system contained inside a light-tight package. To detect alpha and beta particles, the housing

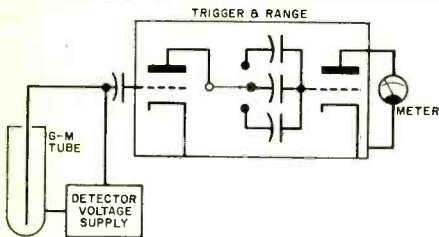


Fig. 8. Basic diagram of G-M survey meter.

must have a very thin opaque window to exclude all outside light while passing only the radiation particles.

The magnitude of the electrical pulses generated by the scintillations is proportional to the energy of the radiation. In most cases, the pulse information is analyzed in a multichannel pulse-light analyzer to identify nuclear radiation by type. In addition, the scintillation detector can operate in counting ranges many times higher than the G-M detector.

Solid-State Detector. One of the newer developments in radiation detection is the solid-state detector. It operates on basically

the same principle as the G-M tube and ionization detector except that it employs a semiconductor material such as silicon instead of a gas for the counting material. When employed as a detector, the silicon is in a highly purified state and, like other detectors, is sensitive to and can measure energy levels of alpha, beta, and gamma radiation.

Silicon diode detectors can be made very small, so small in fact that they can be mounted in hypodermic needles. Most detectors, however, measure about 1" in diameter by 1/16" thick. They are used mainly in the health physics field for counting airborne radioactive particles.

Non-electronic Detectors. Radiological survey meters discussed above are electronic instruments used for measuring radiation intensity at a given moment in time. There are, however, devices which measure the total accumulated radiation dosage to which an object is exposed over a period of time (as short as a few minutes or as much as a week or more).

The self-indicating dosimeter is basically a miniature ionization chamber made in the form of a fountain pen. It contains a capacitor which is originally charged up to a fixed voltage. When exposed to radiation the ions formed in the chamber remove some of the capacitor's charge and reduce the voltage. The voltage charge remaining is measured by a movable quartz fiber built into the unit. An internal scale, when held to the light and viewed through a lens magnifier, indicates this voltage drop in mR/hr.

Another type of dosimeter employs the radioluminescence phenomenon. Called a thermoluminescent dosimeter, it works in a manner similar to the scintillation detector. However, external equipment is needed to "develop" the indicating medium and to count the accumulated radiation intensity received.

One of the oldest known types of detectors is the film badge. The radiation received on exposure causes the film to darken in proportion to the amount received. Special film badges have been developed for low-energy beta, gamma, X-ray, and neutron types of radiation. Detection of alpha particles is virtually impossible due to the fact that the film must be packaged in an opaque container. External equipment is needed for developing and interpreting the film's information. ♦

REPORT ON PROPOSED CLASS "E" CB BAND

WILL THE HAMS
LOSE PART OF THEIR
220-TO-225-MHZ BAND?
IT'S POSSIBLE UNDER AN
EIA PROPOSAL BEFORE THE FCC.

BY RICHARD HUMPHREY

THERE was much weeping and wailing and gnashing of teeth back in 1958 when radio amateurs were elbowed from the 11-meter band to the 10-meter band and the 27-MHz frequencies were given to a fresh upstart called the "Citizen Bander." And it's beginning to sound as if another CB invasion of ham frequencies is about to take place.

While the FCC has yet to issue a Notice of Proposed Rule Making on the Electronic Industries Association's petition to create an 80-channel vhf/CB "Class E" band in the first two MHz of the 220-225-MHz amateur frequencies, a spokesman says "it's due soon."

No More Frequencies

According to a study prepared for the Department of Commerce, all available radio frequencies had been allocated by 1965. Further, the FCC was beginning to advocate a "use it or lose it" policy. If a communications service or band of frequencies wasn't being used, it was taken away and given to someone who *would* use it. As Irving Brownstein of the FCC staff put it "frequency cannibalism may be a major means of survival."

Surprisingly, even the powerful broadcasting interests got hacked. They had broken their backs to get the ulf TV channels—420 MHz of radio-frequency spectrum that stretched from 470 MHz to 890 MHz—and then had given them little use. Twenty years ago this "grab-it-and-sit-

on-it" power play would have made a few people mad but the majority would have shrugged their shoulders and muttered "Why fight City Hall?"

In 1970, though, things were different and the bottom seven channels (14 through 20; 470 MHz to 512 MHz) and the top 14 channels (70 through 83; 806 MHz to 890 MHz) were opened to public safety, industrial, land transportation, land mobile (other than common carriers) and domestic public use with the television interests retaining certain limited rights. The question: if the broadcast industry can lose 126 MHz of radio-frequency spectrum through non-use, what about those 2 MHz in the little-used 220-225 MHz amateur band?

Then, too, the 27-MHz Class-D band frequencies are "skip" frequencies. And it's too much to expect from a CB'er—not interested in "self policing" in any event—that he ignore a juicy (and illegal) DX call. And DX'ing doesn't fit in with the avowed purpose of Citizens Band radio, namely a "short-distance radiocommunications service." The point: the EIA petition might have come at the right moment and the FCC might be inclined not only to take 2 MHz away from radio amateurs but also eliminate Class D entirely and put all Citizens Band activity on 220 MHz.

Like Marine Band

The FCC—under the press of a tremendous pleasure-boat population—did exactly that with marine communications and

CB CLASS "E" (VHF BAND)

CHANNEL	FREQUENCY ¹	USE	NOTES
1	220.000	Mobile	2
2	220.025	"	2
3	220.050	"	2
4	220.075	"	2
5	220.100	"	2
6	220.125	"	2
7	220.150	"	2
8	220.175	"	2
9	220.200	Emergency Only	3
10	220.225	Mobile	2
11	220.250	Mobile Calling	4, 5
12	220.275	Travel Assistance Only	4
13	220.300	"	4
14	220.325	Weather Advisory	4
15	220.350	Traffic Advisory	4
16	220.375	Mobile	6
17	220.400	"	6
18	220.425	"	6
19	220.450	"	6
20	220.475	"	6
21	220.500	Mobile Calling	4, 5
22	220.525	Mobile	6
23	220.550	"	6
24	220.575	"	6
25	220.600	"	6
26	220.625	"	6
27	220.650	"	6
28	220.675	"	6
29	220.700	"	6
30	220.725	"	6
31	220.750	"	6
32	220.775	"	6
33	220.800	"	6
34	220.825	"	6
35	220.850	"	6
36	220.875	General Use	7
37	220.900	"	7
38	220.925	"	7
39	220.950	"	7
40	220.975	"	7
41	221.000	"	7
42	221.025	"	7
43	221.050	"	7
44	221.075	"	7

CHANNEL ALLOCATION

(As Proposed by EIA)

CHANNEL	FREQUENCY ¹	USE	NOTES
45	221.100	General Calling	5, 7
46	221.125	Business	2, 8
47	221.150	"	2, 8
48	221.175	"	2, 8
49	221.200	"	2, 8
50	221.225	"	2, 8
51	221.250	"	2, 8
52	221.275	"	2, 8
53	221.300	"	2, 8
54	221.325	"	2, 8
55	221.350	Calling	2, 5
56	221.375	Marine	
57	221.400	"	
58	221.425	"	9
59	221.450	"	9
60	221.475	"	9
61	221.500	Local Area	9, 10
62	221.525	"	9, 10
63	221.550	"	9, 10
64	221.575	"	9, 10
65	221.600	"	9, 10
66	221.625	In-Plant	9, 11
67	221.650	"	9, 11
68	221.675	"	9, 11
69	221.700	"	9, 11
70	221.725	"	9, 11
71	221.750	Local Traffic Control	9
72	221.775	"	9
73	221.800	"	9
74	221.825	"	9
75	221.850	"	9
76	221.875	Road Condition Information	9, 12
77	221.900	"	9, 12
78	221.925	"	9, 12
79	221.950	"	9, 12
80	221.975	"	9, 12

NOTES: Use is restrictive, i.e., channels may be used *only* for stated use. 1. Frequency in MHz. 2. Between units under same license. 3. Same use as in channel 9 Class D. 4. General calling permitted. 5. General calling for contact only; units must switch to a working channel for traffic. 6. Between units of same or different licenses. 7. Between units of same or different licenses, base or mobile. 8. Business communications only between units under the same license. 9. Channels 61 through 80 are limited to one-watt output to the antenna. 10. Local use of units with same call sign. 11. For use within plants, factories, etc. 12. TX audio call signs.

eliminated most of the congestion and interference in the maritime service. As of January 1, 1972 there can be no new installation of 2-3-MHz marine radiotelephones unless the vessel is already equipped with a validly licensed vhf/FM two-way radio operating between 156 and 162 MHz, which are line-of-sight frequencies. The Commission also requires that vhf communications be used when the maritime mobile stations "are within vhf range." By simply taking advantage of a frequency characteristic, the FCC—by January 1, 1977—will have effectively separated "local" and "distance" communications and will slowly be reducing interference in the service during the 1972-1977 period. And don't forget that aeronautical communications in and around airports have been on vhf for years to prevent interference hundreds of miles away.

The EIA petition makes pointed reference to the Commission's action in the vhf/FM marine band and suggests that "the vhf marine regulation be referred to as an excellent example of providing the greatest use to the general public of the limited frequency spectrum available to satisfy the growing need for more short-range 'personal communications.'" We have a hunch the FCC might find this idea attractive.

The political practicalities are rather interesting, too. The Electronic Industries Association represents a financially robust and powerful group. The EIA certainly did not keep its action secret so it must be assumed that the manufacturers are for it as would be the makers of antennas, microphones, and components. Their attitude may change if the 27-MHz band bites the dust for they obviously want *both* "D" and "E." With the large inventory the industry has tied up in 27-MHz equipment, stock, etc., they'd be sure to oppose any move to cut the Class D band.

Against these powerful forces will be the ARRL. The question: Can David once more successfully defend his title?

Position of the FCC

The function of the FCC in all this is that while it has the right and responsibility to rule "yes" or "no" in the matter, it will—and must—listen to the pro's and con's from all comers. A Notice of Proposed Rule Making is a notice to the public-at-large that the FCC is *considering* a change in its Rules and Regulations.

This move can be made on its own initiative or as a result of a petition from the outside.

The Commission allows a reasonable length of time after a Notice of Proposed Rule Making has been issued for comments and yet another length of time for replies to those comments. If you're "fer" or "agin", *write*. While there are definite forms and rules to be followed in filing official comments, the FCC has waived these requirements many times in the past and considered "letters and informal comments."

Another thing about the 27-MHz operation that has irked the FCC and might lead it to favor Class E "only" is the operator who refuses to identify his station. Much work has been going on behind FCC-scenes to require a tamper-proof, computer-coded, automatic-identification module in practically all two-way radio transmitters and a brand-new vhf/CB band would be a great place to start.

We can't believe the FCC will go along with the simplified licensing procedure suggested in the EIA petition: using the initials of the applicant's state and the last six numbers of his Social Security number. If anything, the Commission will probably stiffen CB licensing. One FCC representative mentioned a simple examination on which "the applicant must get all the answers right. We'll let them use a book, anything they want to, but they've got to get 100%."

The antenna height change asked for by the EIA—20' limit above the nearest man-made or natural object within 500 yards or 60' above existing terrain whichever is higher—is not too much different from what is presently required in Class D.

In an editorial, *QST* magazine has criticized the specific uses (see table) presented in the EIA petition. But examination of Parts 81 and 83 covering the maritime mobile service shows that not only does limiting a definite channel(s) to a definite use(s) solve many problems but also that it isn't as complex as it might seem.

One last item which might see the end of 27-MHz operation is that it has been a bobble from beginning-to-end on almost everyone's part and it has left a distinctly bad taste in the FCC's mouth. It may be that the Class-D Citizens Band will end "not with a bang" but a resounding "ptooey!" ♦



Ask your franchised dealer* to A-B the BOSE 501 with any speaker he carries that uses woofers, tweeters and crossovers.

There is an important reason why we ask you to make this test. There are inherent limitations of performance in the use of a woofer, a tweeter and a crossover—limitations covered in detail in earlier issues. The bypassing of these limitations played a large part in the advances which have made the BOSE 901 the most highly reviewed speaker, regardless of size or price.

We set out to design a lower priced speaker which would preserve as much as possible of the performance of the 901. Most important, we were able to design into the 501 much of the 901's great advance in spatial properties. The BOSE 501 is the second DIRECT/REFLECTING® speaker system.

But it became evident that there was no way to keep the advantages of multiple small full-range drivers and equalization. The cost problem was too great. We were forced to accept the woofer-tweeter-crossover combination as the only feasible compromise and set out to achieve the fullest possible realization of this design approach.

Our engineers designed a unique woofer with an unusually long voice coil which provides tight control of bass transients. They developed a new and different approach to crossing over the outputs of the woofer and the two tweeters. In the process they became convinced that in terms of quality of performance there is no acoustical reason to spend more than \$125 on any speaker containing woofers, tweeters and crossovers.

The design goal of the 501 was to outperform any other woofer-tweeter-crossover speaker. You be the judge. If we have succeeded, the results will be obvious to you when you make the comparison.

*Literature sent in answer to your request will include a list of franchised BOSE dealers in your area who are capable of demonstrating BOSE speakers to their full performance.

Patents applied for.

NATICK, MA. 01760

BOSE®

You can hear the difference now.

CIRCLE NO. 8 ON READER SERVICE CARD

10 New Heathkit Projects



499⁹⁵*
less cabinet

NEW Heathkit 21V Color TV — Solid-State Plus Detent UHF Tuning

The new Heathkit GR-271 is the 21-in. (measured diagonally) version of our famous GR-900, the most advanced color TV we've ever offered. The GR-271 has the same state-of-the-art tuning convenience with power detent selection of all VHF and any 12 pre-selected UHF channels; exclusive angular tint control for consistently better flesh tones; voltage controlled varactor UHF tuner & MOSFET VHF tuner for unmatched sensitivity, exclusive MTX-5 matrix tube with etched face plate for increased contrast, less glare. Plus, the GR-271 has built-in dot generator, convergence panel and volt-ohm meter — full remote control options, too. It's Heathkit TV at its finest in a space-saving size.

Kit GR-271, less cabinet, 121 lbs. 499.95*
Assembled GRA-501-21, table model cabinet shown, tough walnut Marlite® finish, 33 lbs. 54.95*

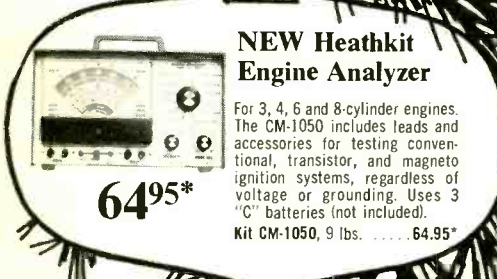


689⁹⁵*

NEW Heathkit/Thomas Spinet Organ with two 44-note keyboards

A kit for the whole family to build and enjoy. The all-solid-state TO-1160 Heathkit/Thomas Spinet has full 44-note keyboards for Solo and Accompaniment, exclusive Color-Glo keys that light up to indicate notes and chords. With the Color-Glo course included you'll be playing songs almost instantly. There are six solo stops — flute 16', 8' and 4', trumpet 8', oboe 8', and violin 8'. Five accompaniment stops — horn 8', diapason 8', melodia 8', cello 8', and pedal voice with 16' & 8' combined. Plus both regular and a new "light" vibrato effects. Other features include keyboard jacks for private earphone listening or use of a tape cassette deck. The beautiful pecan-veneer cabinet is shipped fully assembled, includes bench. The TO-1160 Spinet organ is one of the most exciting gifts you can give or get for Christmas.

Kit TO-1160, 211 lbs. 689.95*



NEW Heathkit Engine Analyzer

For 3, 4, 6 and 8-cylinder engines. The CM-1050 includes leads and accessories for testing conventional, transistor, and magneto ignition systems, regardless of voltage or grounding. Uses 3 "C" batteries (not included).

64⁹⁵*

Kit CM-1050, 9 lbs. 64.95*

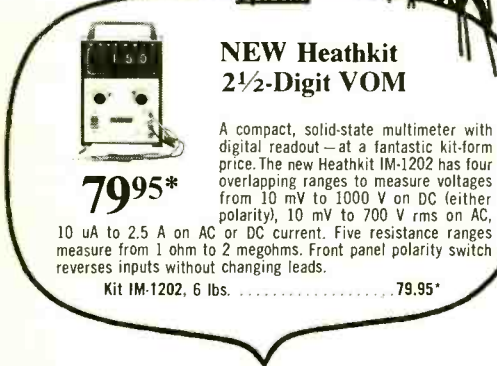


NEW Heathkit C-D Ignition System

39⁹⁵*

This simple, one-evening kit will increase spark-plug and point life up to 50,000 miles on any car or truck using a 12-volt, negative ground system. The Heathkit CP-1060 automatically varies spark duration — longer for low-battery, cold-morning starts, shorter for high-rpm cruising. Screw-on terminals make installation easy; external pushbutton lets you override system without removing leads.

Kit CP-1060, 4 lbs. 39.95*



NEW Heathkit 2 1/2-Digit VOM

79⁹⁵*

A compact, solid-state multimeter with digital readout — at a fantastic kit-form price. The new Heathkit IM-1202 has four overlapping ranges to measure voltages from 10 mV to 1000 V on DC (either polarity), 10 mV to 700 V rms on AC, 10 uA to 2.5 A on AC or DC current. Five resistance ranges measure from 1 ohm to 2 megohms. Front panel polarity switch reverses inputs without changing leads.

Kit IM-1202, 6 lbs. 79.95*



NEW Heathkit 30 MHz Counter

169⁹⁵*

The Heathkit IB-1100 gives 1 Hz to over 30 MHz counting on a full 5-digit readout with 8-digit capability. The lighted overrange indicator makes misreading virtually impossible. Stable time-base circuitry assures accuracy better than ±3 ppm from 22° to 37° C. Diode protected J-FET gives improved triggering over 100 mV to 150 V input range. Solid-state circuitry mounts on one large board.

Kit IB-1100, 6 lbs. \$169.95*

to Brighten Anybody's Christmas!



See them all
in this NEW
FREE CATALOG

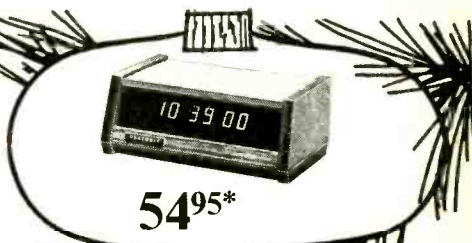
Your new Heathkit is ready and waiting. If you're not already into a Heathkit hobby, what's holding you back? Ask around and you'll find a Heathkit builder who can show you the rewards. You'll pay yourself back for your kitbuilding time with better products. Better in terms of price, value, performance specifications,

and self-service features. And the Heathkit line-up is bigger and better than ever. Including color TV, stereo/hi-fi, electronic organs, home appliances, engine tune-up tools, radio control, shortwave, marine gear, instruments, hundreds more. They are all in the free '73 Heathkit Catalog. Send for yours now.

NEW Heathkit 6-Digit Electronic Alarm Clock

The exciting Heathkit GC-1005 Digital Clock displays hours, minutes and seconds on highly visible cold-cathode readout tubes. A gentle "beeper" alarm can be set for 24-hour cycle and features a snooze switch that gives you seven more minutes of sleep before the alarm sounds off again. The all-solid-state circuitry is designed to display either conventional 12-hour or 24-hour international time (Manual shows you how to wire it for the readout you prefer). Includes am/pm indicator light to facilitate setting time and alarm. Special fail-safe circuit flashes all "eights" on display if 60-cycle line voltage is interrupted.

Kit GC-1005, 4 lbs. 54.95*



NEW Heathkit 8-Channel VHF Band-Scanning Monitor with digital readout

Crystal-controlled monitor tunes any selected 9 MHz segment of the 146 through 174 MHz band — gives you police, fire, marine, ham 2-meter, etc. Features either manual or automatic scanning with numerical readout, channel lock-out buttons. Priority channel "0" takes precedence over all other channels when in the automatic mode. Also has built-in speaker and rear-panel jack for remote speaker; Gimbal bracket and mounting plate for either base-station or mobile use. Operates on either 120/240 VAC or 12 VDC. Includes crystal OSC/Mixer signal source for easy alignment. Order up to eight Crystal Certificates with kit, fill out and return for speedy delivery of the frequencies you need.

Kit GR-110, 9 lbs. 119.95*

GRA-110-1, Crystal Certificate, postpaid each 4.95*



NEW Heathkit Dolby® Cassette Deck

A kit-form cassette deck utilizing the famous Dolby® noise reduction system. Accommodates the greater fidelity and dynamic range of chromium dioxide cassettes. Independent switches provide Dolby on/off and regular or CrO₂ bias control. Domestic-make tape transport comes preassembled for easy kit building.

249.95* dioxide cassettes. Independent switches provide Dolby on/off and regular or CrO₂ bias control. Domestic-make tape transport comes preassembled for easy kit building.

Kit AD-1530, 21 lbs. 249.95*

NEW Heathkit Dual-Range Visual/Audible Fish Spotter®

Flasher-type sounder with two ranges reading 0-60' and 0-240'. Audible alarm can be set to sound at any level in between. Super Bright neon light. Runs on 12 VDC ship's power.

Kit MI-2901,
9 lbs. \$99.95*

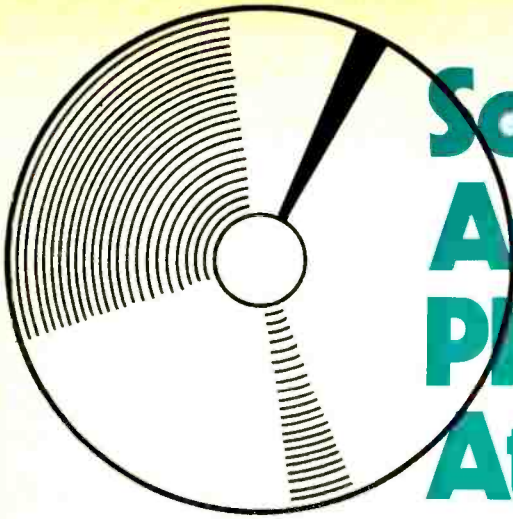


99.95*

Send For Free '73 Heathkit Catalog,

HEATHKIT ELECTRONIC CENTERS — ARIZ.: Phoenix, 2727 W. Indian School Rd.; CALIF.: Anaheim, 330 E. Ball Rd.; El Cerrito, 6000 Potrero Ave.; Los Angeles, 2309 S. Flower St.; Pomona, 1555 Orange Grove Ave. N.; Redwood City, 2001 Middlefield Rd.; San Diego (La Mesa), 8363 Center Dr.; Woodland Hills, 22504 Ventura Blvd.; COLO.: Denver, 5940 W. 38th Ave.; CONN.: Hartford (Avon), 395 W. Main St. (Rte. 44); FLA.: Miami (Hialeah), 4705 W. 16th Ave.; GA.: Atlanta, 5285 Roswell Rd.; ILL.: Chicago, 3462-66 W. Devon Ave.; Downers Grove, 224 Ogden Ave.; IND.: Indianapolis, 2112 E. 62nd Ave.; KANSAS: Kansas City (Mission), 5960 Lamar Ave.; MD.: Baltimore, 1713 E. Joppa Rd.; Rockville, 5542 Nicholson Lane; MASS.: Boston (Wellesley), 165 Worcester St.; MICH.: Detroit, 18645 W. Eight Mile Rd. & 18149 E. Eight Mile Rd.; MINN.: Minneapolis (Hopkins), 101 Shady Oak Rd.; MO.: St. Louis, 8296 Gravois Ave.; N.J.: Fair Lawn, 35-07 Broadway (Rte. 4); N.Y.: Buffalo (Amherst), 3476 Sheridan Dr.; New York City, 35 W. 45th St.; TENN.: Lenoir, 15 Jericho Turnpike; Rochester, Long Ridge Plaza, OHIO: Cincinnati (Woodlawn), 10133 Springfield Pike; Cleveland, 5444 Pearl Rd.; PA.: Philadelphia, 6318 Roosevelt Blvd.; Pittsburgh, 3482 Wm. Penn Hwy.; TEXAS: Dallas, 2715 Ross Ave.; Houston, 3705 Westheimer; WASH.: Seattle, 221 Third Ave.; WIS.: Milwaukee, 5215 Fond du Lac.

HEATHKIT Schlumberger	
HEATH COMPANY, Dept. 10-12 Benton Harbor, Michigan 49022	
<input type="checkbox"/> Please send FREE Heathkit Catalog.	
<input type="checkbox"/> Enclosed is \$ _____, plus shipping.	
Please send model(s) _____	
Name _____	
Address _____	
City _____	State _____ Zip _____
Prices & specifications subject to change without notice. *Mail order prices; F.O.B. factory.	
CL-443R	



Sound-Activated Photoflash Attachment

FREEZE HIGH-SPEED MOTION USING THIS SIMPLE CIRCUIT

BY VIC LESHKOWITZ

HAVE you ever wondered how "frozen motion" photographs are made? Like the one that shows a balloon in the process of bursting as a needle penetrates the skin? They are easily made and you can do it yourself if you have a camera with a "bulb" or "time" position, an electronic photoflash (strobe), and the circuit shown below.

Theory of Operation. An electronic strobe uses the closing of a switch within the camera to energize the flashtube circuit. This occurs automatically when the camera shutter release is operated to take a picture. As shown below, an SCR can be used to simulate the camera switch. When the SCR is turned off, it has a very high resistance; when fired, its resistance is very low.

The microphone senses the sound pro-

duced by the action to be photographed; and this signal is amplified by the high-gain audio module. Transformer *T1* steps up the output signal and generates the trigger pulse for the SCR. Sensitivity potentiometer *R1* determines the sound level required to trip the SCR and thus determines the moment of firing of the electronic strobe.

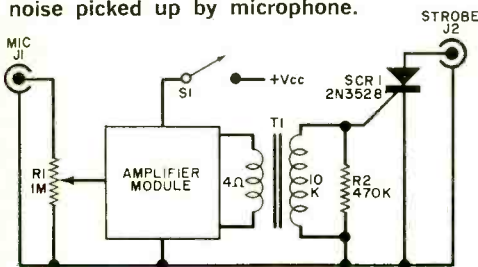
Since sound travels at approximately 1000 ft/s, each foot between the microphone and the sound source represents about 1/1000 of a second in time delay. Thus the positioning of the microphone is very important if high-speed action is desired.

Construction. The physical size and power requirements of the circuit are determined by the audio amplifier module

PARTS LIST

B1—Battery suitable for audio module used
J1—Miniature phone jack

The SCR simulates camera flash switch and is triggered by the noise picked up by microphone.



J2—Phono connector
R1—1-megohm potentiometer with *S1* attached
R2—470,000-ohm, 1/2-watt resistor
S1—Spst switch on *R1*
SCR1—Silicon controlled rectifier (2N3528, HEP621, or similar)
T1—Audio output transformer 4/10,000 ohms (Stancor A3822 or similar)
Mic—Crystal microphone
Module—Any solid-state module capable of driving a speaker (Lafayette 19-55103 or similar)
Misc.—Electronic flash extension cable (Kaiser 1421 or similar), battery holder, phono plug, suitable chassis, multi-lug terminal strip, mounting hardware, wire, etc.

used. Although a low-cost Lafayette module (19-55103) was used in the prototype, almost any transistor or IC audio module capable of driving a 4- or 8-ohm speaker will suffice. These are usually battery powered.

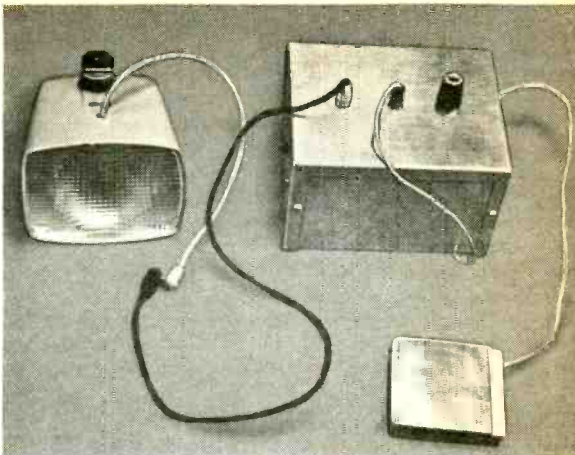
Mount the audio module and battery in a chassis with the input (*J1*) and output (*J2*) connectors, the sensitivity control, and the on-off switch on the front panel. Transformer *T1* is mounted directly on the chassis bottom with a multi-lug terminal strip to hold the remainder of the components.

Secure an electronic flash extension cable from a camera supply house and remove the jack that goes to the camera. Strip the ends of the two leads and temporarily solder-tack the two leads to the connections on a conventional phono plug, which will be inserted in *J2*.

With the microphone connected to *J1* and the strobe attached to *J2*, make sure that the strobe is charged and ready to fire. (The little red light should be on.) Turn on the power to the module and adjust the sensitivity control until a sound activates the flash. If the flash does not occur, the connections to *J2* may be wrong. Unsolder the leads on the *J2* phono connector and reverse them. If the strobe still does not fire, check that there is an audio signal across *R2* with the sensitivity control up and some sounds in the room. If there is an audio signal, then the SCR may be at fault.

Operation. The sound-triggered flash pictures should be taken in a reasonably dark room. Total darkness is not essential as you will probably have to stop the camera down to the point where a little light will not register on the film. Place the shutter speed dial in the bulb position; and, using the guide index of the film in conjunction with the indicator on the strobe, set the lens opening for the flash-camera to subject distance. If you are using an SLR, a closeup lens may be used for a more dramatic effect. Try to keep the camera and flash about the same distance from the subject because the dial on the flash is calibrated for this type of use.

With power applied to the sound module and the strobe ready to fire, slowly turn up the sensitivity control and make a sound of about the same volume as the event to be photographed. Adjust the sensitivity control to fire the flash with this sound. Make a note of the sensitivity dial setting and turn the sensitivity down.



Strobe (upper left), circuit chassis, and mike are attached as shown here.

Allow time for the strobe to recharge, position the microphone near the target (but not within the photographed area), and focus the camera on the subject. Open the camera shutter by placing the shutter mechanism in the time or bulb position. Return the sensitivity control to its predetermined position, execute the event, and close the camera shutter. That's all there is to it.

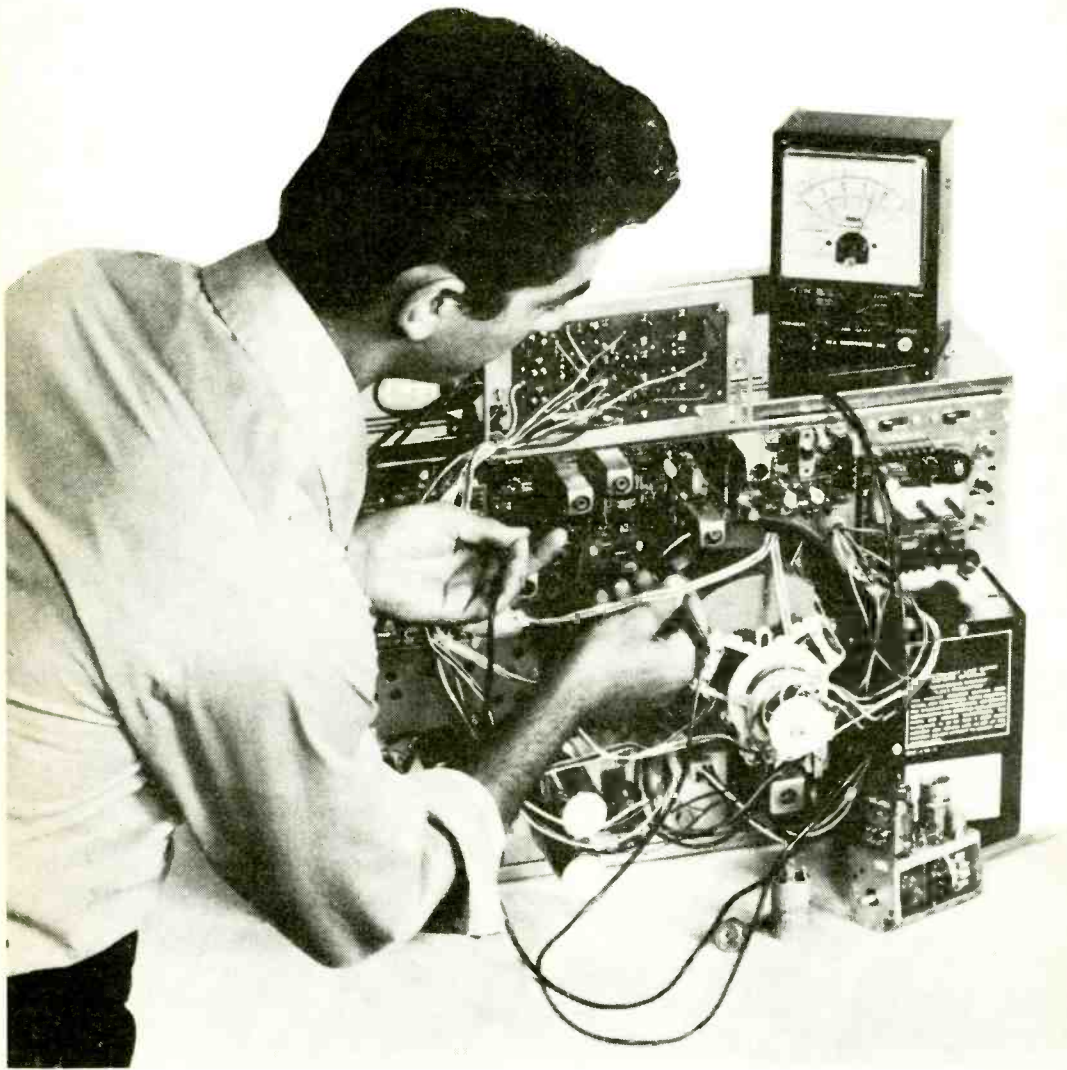
Remember that the microphone-to-noise source distance represents the time delay between the action and the firing of the strobe. This can be adjusted to stop the action at almost any point. ♦

This photo was taken by dropping the sticks onto drum, triggering flash.



RCA Institutes Home Training may be

your best investment for a rewarding career in electronics



1 LEADER IN ELECTRONICS TRAINING

For over half a century, RCA Institutes, Inc., a subsidiary of RCA, has been a leader in resident school technical training in electronics. For many years, it has offered home study training in electronics.

2 RCA AUTOTEXT TEACHES ELECTRONICS RAPIDLY, EASILY

Beginner or refresher, AUTOTEXT, RCA Institutes' own method of programmed Home Training will help you learn electronics rapidly, easily.

3 WIDE CHOICE OF CAREER PROGRAMS

Start today preparing for an electronics career. On the attached card is a list of "Career Programs," each of which starts with the amazing AUTOTEXT method of programmed instruction. Look the list over, pick the one best suited to you and check it off on the card.

4 SPECIALIZED ADVANCED TRAINING

For those already working in electronics or with previous training, RCA Institutes offers advanced courses. You can start on a higher level without wasting time on work you already know.

5 PERSONAL SUPERVISION THROUGHOUT

All during your program of home study, your exams are reviewed and your questions are answered by RCA Institutes instructors who become per-

sonally involved in your efforts and help you over any "rough spots" that may develop.

6 HANDS-ON TRAINING

To give practical application to your studies, a variety of valuable kits are included in many programs. In RCA's Master TV/Radio Servicing Program, you will actually build and keep an all solid-state black and white TV set, and a color TV set. You also construct an oscilloscope which is yours to keep and use on the job.

7 FCC LICENSE TRAINING — MONEY BACK AGREEMENT

Take RCA's Communications Career Program — or enter with advanced standing and prepare immediately for your 1st, 2nd, or 3rd class FCC Radio Telephone License examinations. RCA Institutes money-back agreement assures you of your money back if you take, and fail to pass, the FCC examination taken within 6 months after completing the course.

8 CONVENIENT PAYMENT PLANS

You get a selection of tuition plans. And, we are an eligible institution under the Federally Insured Student Loan Program.

9 RCA INSTITUTES IS FULLY ACCREDITED

RCA Institutes is licensed by N.Y. State and is accredited by the Accrediting Commission of the National Home Study Council. Its courses of study, faculty and instructional facili-

ties are approved by the State Education Department. In addition, all RCA Institutes courses and programs require the approval of the RCA Institutes Board of Technical Advisers who represent various technical, research and educational activities of RCA Corporation.

Approved by N.Y. State Education Dept. for the training of veterans.

SEND ATTACHED POSTAGE PAID CARD TODAY! FREE DESCRIPTIVE BOOK YOURS WITHOUT OBLIGATION!

If reply card is detached, send this coupon

RCA INSTITUTES, INC.	
DEPT. 694-212-0	
320 W. 31 ST.	
NEW YORK, N.Y. 10001	
Please send me FREE illustrated career catalog. I understand that I am under no obligation.	
Name _____	_____
Address _____	_____
City _____	_____
State _____	Zip _____
Age _____	_____
Veterans: Check here <input type="checkbox"/>	

RCA



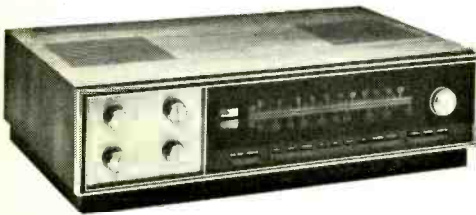
In the Master TV/Radio Servicing Program, you build and keep the all solid-state black and white TV set, the color TV set, the oscilloscope and the multi-meter shown above.

CIRCLE NO. 32 ON READER SERVICE CARD



Product Test Reports

HEATHKIT AR-1500 AM/STEREO FM RECEIVER (A Hirsch-Houck Lab Report)



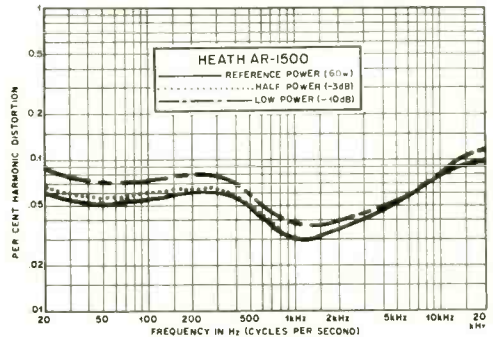
THE NEW Heath AR-1500 stereo receiver is a logical development of their popular AR-15—basically quite similar, yet with a major electrical and mechanical re-design. Although it is at least as complex as the AR-15, the AR-1500 is easier to build. The parts for each of its ten major subassemblies (AM r-f circuit board, phono preamplifier, etc.) are packaged separately, which is an important consideration in a kit comprising many hundreds of components. The final assembly and any subsequent service are further simplified by the extensive use of plug-in circuit boards with hinged sockets, and wiring harnesses connecting the various sections.

However, construction of the AR-1500 is still a lengthy process. Some 116 pages of the 247-page assembly manual are devoted to the actual wiring and assembly of the kit. It is to Heath's credit that the AR-1500 can be completely tested and adjusted for correct operation by a layman, without using external test instruments. To do this, the receiver's signal-strength meter can be switched to make resistance and voltage measurements, using built-in test leads. Each circuit board is tested separately, and the possible causes of any incorrect meter indications are suggested at each stage of the process.

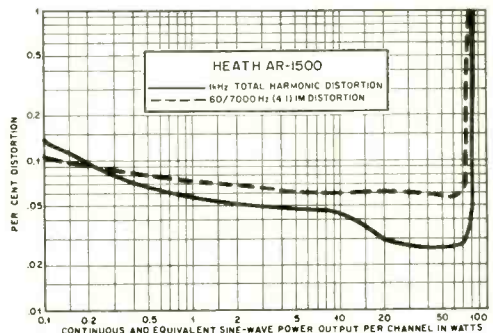
The FM front end is pre-aligned, and the i-f section uses sealed, fixed-tuned LC filters that never require alignment. So FM

alignment is concerned only with the metering and noise squelch circuits. The multiplex adjustments are made with a received stereo FM broadcast signal. The AM tuner also has a fixed-tuned i-f filter, so its alignment consists only of tracking the front end to match the tuning dial calibrations.

Specifications for the AR-1500 are extensive, but a few of the key items show its essential qualities. The FM tuner has a rated IHF usable sensitivity of 1.8 μ V,

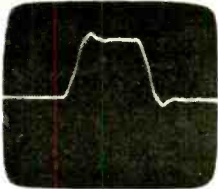


Curves on graph show percent harmonic distortion present at various power levels between 20 and 20,000 Hz.

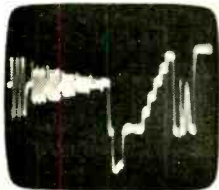


Total harmonic and intermodulation distortion are shown for continuous sine-wave output power per channel.

TRIGGERED SWEEP

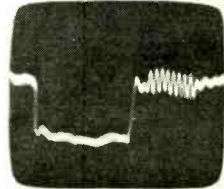


250-nanosecond ($\frac{1}{4}$ -microsecond) pulse demonstrates trace expansion and rise time capability of the new RCA WO-535A in Triggered Sweep Mode.

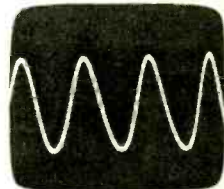


Typical TV VITS pattern on the new RCA WO-535A in Triggered Sweep Mode.

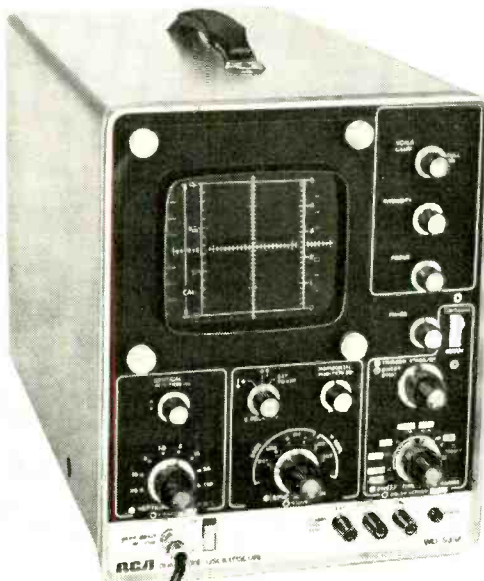
RECURRENT SWEEP



Expanded video signal on the new RCA WO-535A in Recurrent Sweep Mode shows the horizontal sync pulse and 3.58 MHz color-burst signal.



3.58 MHz sine-wave as shown on new RCA WO-535A in Recurrent Sweep Mode.



Now... a 5-inch triggered/recurrent sweep oscilloscope for only \$329*

It's the all solid-state RCA WO-535A featuring one-step calibration for simplified voltage measurements and usable frequency response to 10 MHz.

In the Triggered Sweep Mode, you can lock in waveforms and patterns that cannot be viewed easily using recurrent sweep. Triggered sweep with wide, variable trace expansion permits you to view small segments of complex waveforms, such as vertical-interval test signals (VITS). In the Recurrent Sweep Mode, you get all the ad-

vantages of a conventional continuous-sweep oscilloscope.

There are many other features of the WO-535A you'll like — and your RCA Distributor will be glad to supply complete information about this general-purpose oscilloscope that provides high performance in such applications as radio and TV servicing, industrial maintenance, troubleshooting, and general waveform analysis.

Also ask your RCA Distributor for the full story on the RCA WO-505A,

priced at \$299*, and the RCA WO-33A, priced at \$180*. Or write RCA Test Equipment Headquarters, Harrison, N.J. 07029.

*Optional Distributor Resale Price, complete with direct/low capacitance shielded probe and cable.

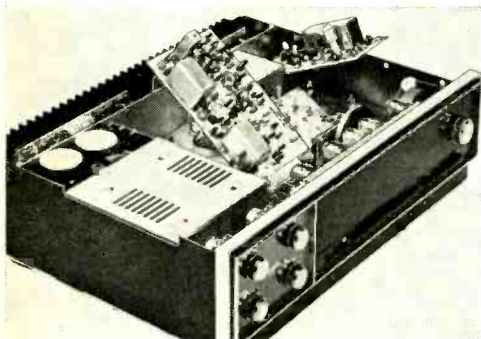
RCA [Electronic Components] Harrison, N.J. 07029.

RCA

INTERNATIONAL SALES OFFICES: ARGENTINA—Casilla de Correo 4400 Buenos Aires/BRAZIL—Caixa Postal 8160 São Paulo/CANADA—21001 No. Service Rd. Ste. Anne de Bellevue, 810 Quebec/ENGLAND—Sunbury-on-Thames Middlesex/HONG KONG—P.O. Box 112, MEXICO—Apizaco 17, 570 Mexico 17 D.F./SWITZERLAND—2, rue du Livret 1227 Geneva

CIRCLE NO. 31 ON READER SERVICE CARD

with a 1.5-dB capture ratio. The image and spurious signal rejection are each rated at 100 dB, with 90 dB of alternate channel selectivity. These are outstanding figures—20 to 40 dB better than most manufactured receivers that are priced comparably to the AR-1500 kit.

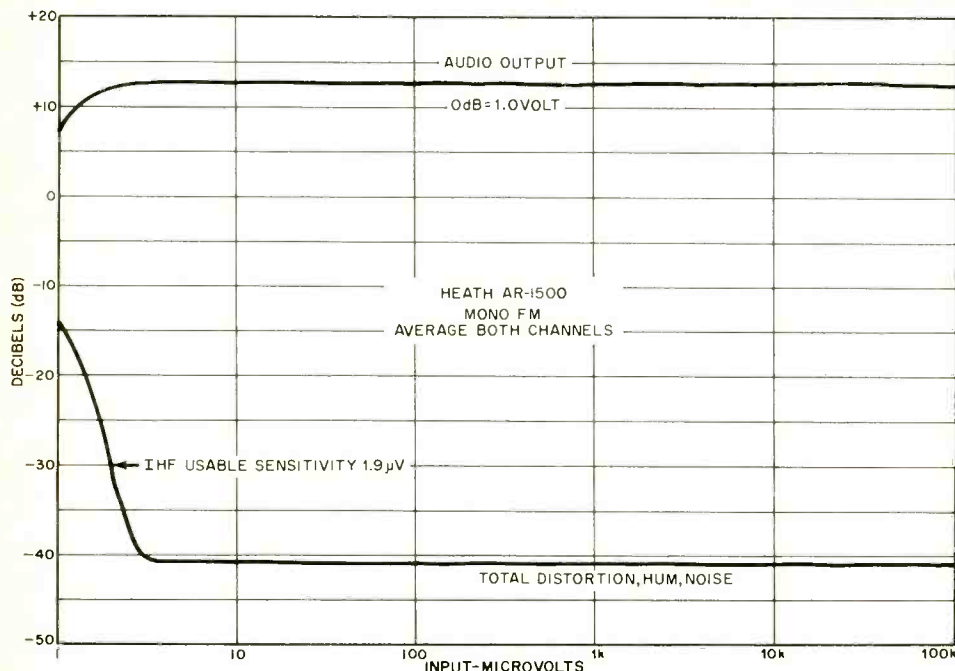


The audio amplifiers are probably the most impressive feature of the AR-1500. They are rated, with extreme conservatism, at 60 watts per channel into 8 ohms, 100 watts per channel into 4 ohms, and 40 watts per channel into 16 ohms, with both channels driven simultaneously. Harmonic distortion is rated at less than 0.25% from 20 to 20,000 Hz at 60 watts; and IM distortion is less than 0.1% at 60 watts.

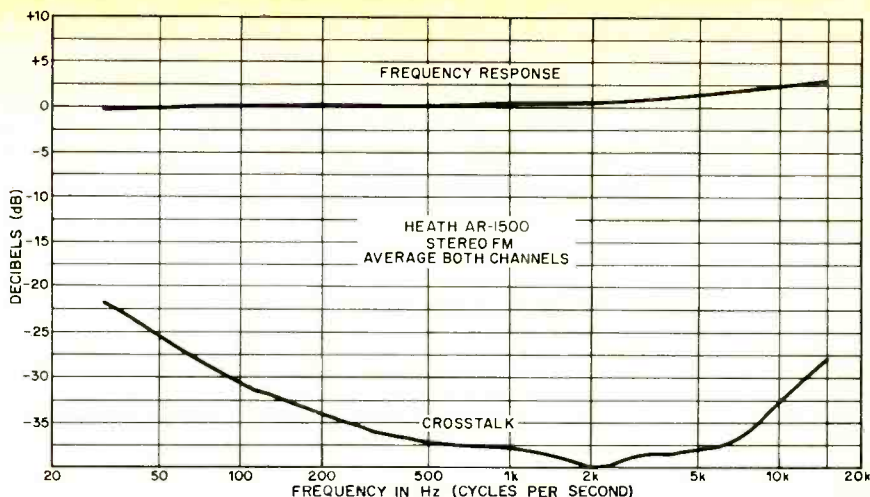
The receiver presents a simple appearance from the front. Four knob controls (bass, treble, volume, and balance) are on the left, with the tuning knob at the right. Between them is the large slide-rule dial, which is blacked out when the receiver is off and softly lit in green when it is on, and two tuning meters (zero center and relative signal strength).

Below the dial are 14 pushbuttons. Six of them select the input source: tape, auxiliary, phono, AM, FM stereo, and FM auto. In the FM stereo mode, the receiver responds only to stereo transmissions. One switch turns the receiver on and off, and two others connect either, both, or neither of two pairs of speaker outputs. Tape monitoring, high-frequency blending for stereo FM noise reduction, and mono/stereo mode selection are controlled by three other switches, while the remaining two switch on the loudness compensation and bypass the tone control circuits. Beneath the pushbutton switches are two stereo headphone jacks and a small, unmarked knob that varies the FM muting threshold.

Most of the rear of the receiver is occupied by the heavy finned heat sink for the output power transistors. Below them is a hinged AM ferrite antenna, the vari-



Mono output from tuner was relatively flat for inputs between 1.9 μ V and 100,000 μ V.



The frequency response (top) and crosstalk (bottom) are shown for the stereo FM tuner section of the Heath AR-1500 AM/stereo FM receiver.

ous input and output jacks, and antenna terminals. There are vertical and horizontal outputs for connecting an oscilloscope to monitor FM multipath distortion. The pre-amp outputs and main amplifier inputs are brought out to separate jacks, but they are normally wired together internally. There are two ac outlets, one of them switched. The AR-1500 is 18 $\frac{1}{2}$ " \times 5 $\frac{1}{2}$ " \times 13 $\frac{1}{2}$ " and weighs 32 lb.

Laboratory Tests. In our tests, the audio amplifiers clipped at 76 watts per channel into 8-ohm loads, 117 watts per channel into 4 ohms, and 45.5 watts per channel into 16 ohms. Both the IM and 1000-Hz harmonic distortion were under 0.1% (typically about 0.05%) from 0.1 watt to between 75 and 80 watts. At the rated 60 watts per channel (or any smaller output) the distortion was between 0.03% and 0.1% at all frequencies from 20 to 20,000 Hz. The complete freedom from crossover distortion at low levels was shown by our IM measurements, with less than 0.18% distortion from 2 milliwatts to 75 watts output.

The tone controls and loudness compensation had conventional characteristics. The RIAA phono equalization was very accurate, within ± 1 dB from 30 to 15,000 Hz. Hum and noise were 76 dB below 10 watts on the auxiliary inputs and from 62 to 71 dB below 10 watts on the phono inputs.

The AR-1500 is unique among receivers in that it has separate input level adjust-

ments for each channel of each input (accessible through the bottom plate). Not only can all program levels be matched and balanced, but overloading by an excessive input voltage is virtually impossible. The phono sensitivity, for 10 watts output, can be adjusted from 0.63 mV to about 4.5 mV, with corresponding overload levels of 20 mV to 140 mV. The noise level varies slightly with the control settings; hence the range of our measurements. Even at maximum auxiliary sensitivity, where only 48 mV is needed for 10 watts output, the overload point is a safe 1.5 volts, which increases linearly as the sensitivity setting is reduced.

The FM tuner had an IHF usable sensitivity of 1.9 microvolts, with 50 dB of noise quieting at only 3 microvolts input. The ultimate S/N ratio was 72 dB, at inputs of 70 microvolts or more. The frequency response was within ± 0.5 dB from 30 Hz to 4000 Hz, rising very slightly to +2.5 dB at 15,000 Hz (where most FM tuners show a falling response). The stereo separation was very good—between 35 and 40 dB from 250 to 8500 Hz, and better than 22 dB from 30 to 15,000 Hz. The capture ratio was 2 dB. Image rejection was 92 dB, and AM rejection was 53 dB. The muting system of the AR-1500 cannot be disabled, although its threshold can be varied from 1 to 10 microvolts. The presence of the muting action prevented measurement of selectivity, but this was obviously exceptionally good, judging by the on-the-air performance.

The AM tuner of the AR-1500 was unequivocally the best we have ever seen. With a frequency response within ± 3 dB from 20 to 9000 Hz, its sound quality truly approached that of the FM tuner, and the sensitivity and freedom from whistles and birdies were excellent.

Performance Comments. Overall, the Heath AR-1500 impressed us by its sheer performance as a tuner and as an amplifier. In these areas, which are the really important ones, it is clearly one of the most refined receivers on the market. It does have a few minor idiosyncrasies, such as the non-defeatable muting, which had a very positive action but also tended to produce a "clunk" in the speakers when tuning on or off a station. We also found the push-button control settings a little hard to determine, due to the lack of contrast be-

tween the buttons and the black panel and the small size of the identifying markings.

In terms of operating flexibility, the AR-1500 is average; however, it is certainly adequate for the vast majority of audio enthusiasts. Not everyone feels the need to interconnect two or three tape recorders, a half a dozen assorted program sources, and more than two pairs of speakers to his receiver!

In use tests, the receiver was as outstanding as it was on the test bench. It is an ideal receiver for use with low-efficiency speakers (particularly 4-ohm types) since it is by far the most powerful receiver we know of for driving 4-ohm loads.

The Heath AR-1500 kit sells for \$379.95. An optional walnut cabinet is \$24.95. The AR-1500 is also available in wired and tested form, complete with the cabinet, for \$649.95.

Circle No. 65 on Reader Service Card

LAFAYETTE SQ-M 4-CHANNEL DECODER (A Hirsch-Houck Lab Report)



ALL four-channel matrix techniques (CBS SQ, E-V Stereo 4, and Sansui QS are the principal ones) are somewhat similar, combining four channels with specific amplitude and phase relationships to form a two-channel stereo program that can be recorded on discs and played back with conventional stereo cartridges. When played through a two-channel stereo system, the left and right back channels are combined with the corresponding front channels, so that the complete program is heard through the two front speakers. For quadrasonic playback, the two stereo channels are processed by a decoder which divides them and recombines them with the proper phase and amplitude relationships to recreate the original four channels.

Ideally, the decoder phase and amplitude coefficients should be inversely related to those in the encoding matrix. Fortunately, even if they are not, four somewhat dif-

ferent channels will be derived. The practical effect is a change in spacial relationships, so that instruments are not necessarily heard in the intended locations, but may appear elsewhere in the listening area. In most cases, this does not seriously diminish the major benefit of quadrasonic sound, which is principally to provide a greatly enhanced sense of presence and involvement with the performers.

Product Description. The Lafayette SQ-M four-channel decoder is a simple, inexpensive (\$44.95) device for decoding matrixed programs with the CBS SQ parameters. It is a small ac-powered unit, about 6" \times 3" \times 7½", in a metal case with a simulated wood-grain finish. The auxiliary inputs of the SQ-M are driven from the tape recorder outputs of a stereo amplifier or receiver. A pair of jacks marked REC in the rear of the SQ-M replaces the normal tape output jacks of the system. There are four output jacks. The front outputs go to the tape recorder inputs of the front-channel amplifier (the regular stereo system amplifier). The rear outputs go to the high-level inputs of a second stereo amplifier, which drive the two speakers in the back of the room. Finally, there is a pair of phono inputs (MAG). If the regular amplifier has magnetic phono inputs, these

increase its flexibility by permitting the use of a second record player.

On the front panel are two pushbuttons for power switching and AUX/MAG input selection. A FUNCTION switch selects the operating mode: F + R, COMPOSER, and SQ; and a MASTER VOLUME knob controls the volume for all four speakers. In the F + R mode, the stereo inputs are heard normally, except that the front and back speakers on each side of the room carry the same program. The COMPOSER mode derives a simulated four-channel signal from ordinary two-channel stereo programs, driving the rear speakers with a difference (L-R) signal. Many records have a considerable amount of out-of-phase, or L-R, information containing the ambience, or reverberant sounds from the recording environment. The SQ mode provides the correct coefficients for decoding CBS SQ records, a number of which are presently on the market.

Laboratory Tests. The decoder required an input of 0.38 volt (AUX) or 2.2 mV (MAG) for 1 volt output. The maximum undistorted output was about 8 volts—far more than would be required by any re-

ceiver or amplifier. Phono overload occurred at 50 mV, a safe margin with practically any modern cartridge. The phono equalization was within +2.5 dB of the RIAA curve from 50 to 15,000 Hz. Output hum and noise was about 63 dB below 1 volt output, using either input. Harmonic distortion in the output was typically about 0.1% up to 5 volts output, although it was masked by power supply hum at low levels. (The hum was not audible in normal use.)

With only a left channel input (using the SQ mode), the left front output was flat within +2 dB from 30 to 20,000 Hz. The right front output was down 15 to 20 dB across the full frequency range. The level of the back output was typically about 6 dB under the front level. The phase angles among the four outputs were reasonably constant over most of the audio range, though the phase shift between the input signal and each of the outputs changes with frequency. Our measurements showed about 50 degrees of phase shift between the two front outputs, about 60 degrees between the two back outputs, and 65 to 70 degrees between front and back outputs on the same side.

SAVE MONEY!

A Delta Mark Ten Capacitive Discharge Ignition (CDI) System On Your Car Slashes Maintenance Costs And Increases Performance.

Put a Mark Ten on your car and save by eliminating 3 out of 4 tune-ups. Save as gasoline mileage increases (up to 20%). The Mark Ten CDI system also extends spark plug life, promotes more complete combustion and assures instant starts in all weather. It operates on any 6 or 12 volt negative or positive ground system.

The Mark Ten B affords additional money saving advantages by drastically reducing combustion contaminants and restoring power lost by the use of smog control devices. Equipped with handy switch for instant return to standard ignition, the Mark Ten B works with ANY 12 volt negative ground engine. Both systems install in ten minutes without rewiring.

Order your Mark Ten or Mark Ten B today. Save money while you enjoy low maintenance and increased performance.

Mark Ten (Assembled) \$44.95 ppd.

Mark Ten (Deltakit) \$29.95 ppd.

(Kits available in 12 volt only, positive or negative ground)

Mark Ten B \$59.95 ppd.

(12 volt negative ground only)

Superior Products at Sensible Prices

Mfg. in U.S.A.



Dept. PE



DELTA PRODUCTS, INC.

P.O. BOX 1147 • GRAND JUNCTION, COLORADO 81501
PHONE (303) 242-9000

Please send me literature immediately:
Enclosed is \$ _____

Ship ppd. Ship C.O.D.

Please send: _____ Mark Ten B @ \$59.95 ppd.
 ___ Standard Mark Ten (Assembled) @ \$44.95 ppd.
 ___ 6 Volt: Neg. Ground Only ___ Positive Ground
 ___ 12 Volt: Specify _____ Negative Ground
 ___ Standard Mark Ten (Deltakit®) @ \$29.95 ppd.
 (12 Volt Positive Or Negative Ground Only)

Car Year _____ Make _____
 Name _____
 Address _____
 City/State _____ Zip _____

In the **COMPOSER** mode, the front outputs are completely isolated, with the front and back outputs at approximately the same levels. However, the two back channels are 180 degrees out of phase with each other and with the diagonally opposite front channels. Applying a mono (L + R) input, the back outputs are some 17 dB below the front outputs in the **COMPOSER** mode and 6 to 10 dB down in the **SQ** mode.

We used the Lafayette **SQ-M** with a variety of front and rear amplifiers and

speakers. A number of CBS **SQ** records were played, with a satisfactory and pleasing quadrasonic effect. We also played other records, made with the **E-V** and Sansui matrices, with very similar results. Using two-channel input material, either the **SQ** or the **COMPOSER** mode produced a simulation of quadrasonic sound, sometimes as effective as specially encoded records. There were differences in sound between the two modes; and one or the other was often more effective.

Circle No. 66 on Reader Service Card

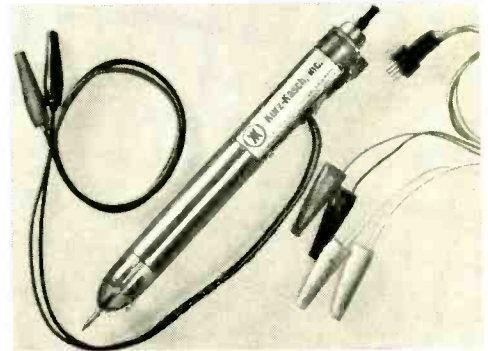
KURZ-KASCH LP-520-GM LOGIC PROBE

WHEN an experimenter or service technician who deals with digital equipment has a lot of flip-flops in a multi-IC arrangement and they suddenly stop flipping and flopping, that's when you'll hear loud cries of anguish. The problem is in knowing where to start troubleshooting.

There are several in-circuit digital logic testers available, and they come in a wide range of prices; but the latest one that we have examined (from Kurz-Kasch, Inc.) seems to provide the greatest flexibility. The particular model we tested is somewhat more expensive (\$69.95) than most others, but it has a number of advantages. The probe-like instrument is 6" long and 3/8" in diameter and derives its power and signal ground through a pair of long flexible leads terminated with alligator clips.

Readout is through three subminiature lamps enclosed in the transparent plastic tip and located just above the needle-sharp metal probe. One lamp (red) comes on for a logic 1, indicating that there are 2.4 volts or more on the probe tip. The second lamp (clear) comes on when there is less than 0.8 volt at the tip. A third lamp (blue) comes on to indicate a positive- or negative-going pulse of at least 40 nanoseconds duration. The blue lamp remains on for 200 milliseconds despite the short duration of the pulse. Designed for DTL, TTL, and similar 4.75-to-5.5-volt dc logic families, the input impedance is greater than 35,000 ohms for the logic 1 signal, while overload protection is to ± 100 volts dc intermittent.

The basic probe comes with three options: the "M" feature uses a push-pull switch at the upper end of the probe to permit selection of either "stretch" or "memory" modes. In the stretch mode, the



probe detects a high-speed pulse of 50 ns or greater and turns on the blue lamp for 200 ms. In the memory mode, the probe detects a high-speed pulse and keeps the blue lamp lit until the probe switch is reset. The "G" feature simulates a three-input scope with a special four-clip connector that couples to the probe. This mode is used to detect pulse coincidence in those circuits where it should appear. The "S" feature is designed to detect the presence of a 5-ns pulse which will illuminate the blue lamp. Each option adds \$10 to the basic price of the probe.

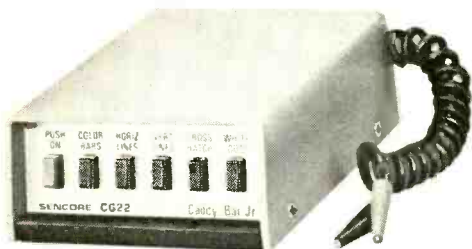
Besides the LP-520, Kurz-Kasch also has an LP-510 (\$44.95) for use with 4.75-to-5.5-volt dc logic families, with only 1 and 0 indicators; the Model LP-530 (\$44.95) for 12-to-15 volt logic families, with only 1 and 0 indicators; and the Model 540 (\$69.95) also for 12-to-15-volt logic, but with the blue pulse indicator.

Use Tests. We used the LP-520-GM to troubleshoot the complex PC board of our favorite frequency counter (which was out of order). We found that using the probe is very simple; and having the bright, easily

read display right down at the probe tip was a real help. It was very easy to trace the path of the logic flow around the IC's and the foil patterns. In our case, when we didn't get a red indication (logic 1) on a particular B+ line, we knew where the trouble was located. Using the counter manufacturer's schematic, it was a snap to follow the logic around the circuit. This clearly demonstrated the value of the probe in finding malfunctions.

Circle No. 67 on Reader Service Card

**SENCORE CG-22
COLOR-BAR GENERATOR**



THERE are many times during the service technician's work when he wishes he had a color generator in his pocket for those convergence touchups that are needed in the customer's home. The idea of dragging along the shop generator is too much to consider, what with its size, the need for ac power, and the fact that the generator always seems to be needed back at the shop at the same time. The idea of a small, battery-powered generator has always intrigued us; and we have tried a few in the past—with unspectacular results.

Not long ago, we were introduced to the Sencore Caddy Bar Jr. (Model CG-22) Color Generator. This dandy, small, battery-powered unit may be the answer to the technician's dream. Packed into the 2" x 4" x 6" generator (weighing less than 2 lb) is a pushbutton array which permits selection of ten standard color bars, horizontal lines, vertical lines, crosshatch, and white dots. Obviously, the unit is all solid-state and uses crystal-controlled timing and color-bar generation. The internal power source is a pair of conventional 5.6-volt mercury batteries, with power consumption a low 14 mA on color and 12 mA for the other displays.

Design Features. There are several interesting features in the CG-22. One is an

**CONTROLLED
QUALITY
CRYSTALS by**



CRYSTEK



The "On-Channel" Crystals

**FOR
CITIZEN BAND
23 Channels and "Mars"
HAM OPERATORS
Commercial 2-Way**

Marine-Monitor

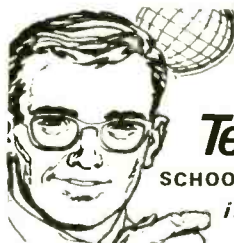
See your Distributor for Speedy
"Zip Certificates"



CRYSTEK

formerly Texas Crystals
Div. of Whitehall Electronics Corp.
1000 Crystal Drive 4117 W. Jefferson Blvd.
Fort Myers, Florida 33901 Los Angeles, California 90016

CIRCLE NO. 12 ON READER SERVICE CARD



**Attention
Electronic
Technicians!**

**SCHOOLING OF EXCELLENCE
in ELECTRONICS
ENGINEERING**

If you have adequate schooling and experience at the technician level you may be able to qualify to enter our college-level Home Study Program in Electronics Engineering. The CIEE Program is OUTSTANDING, and up-to-date in every respect. CIEE is a forward-looking school, and Engineering is taught on the basis of application and understanding rather than on the basis of memorization. All lesson material and texts are thorough and easy-to-understand. Through this Highly Effective Home Study Program in Electronics Engineering you can raise your status and pay to the Engineering level. No residence classes required for those who qualify. If you are an electronics technician with above-average ambition, and not willing to settle for anything less than the best home study Engineering Schooling available anywhere, then you should write TODAY for our free revealing descriptive literature. There is no obligation, and no salesman will call on you.

**COOK'S
INSTITUTE of Electronics Engineering**



Raymond Road
P. O. Box 10634
Jackson, Miss. 39209

Established 1945
Formerly Cook's School of Electronics

CIRCLE NO. 10 ON READER SERVICE CARD

automatic built-in timer that shuts the generator off after about 15 minutes, in case you forget to do so. This can be quite a battery saver for the forgetful service technician. Then, if you have used solid-state generators and the idea of the unit's not working properly after being left in the truck over a cold winter night worries you, the Sencore engineers have taken care of that problem, too. They have included a simple built-in heater and all you have to do is plug the TV set's cheater cord into a rear-panel receptacle and allow the CG-22 to warm up for a few minutes. Also on the rear panel is a set of battery test points so that you can keep tabs on the built-in power source.

The r-f cable (which often gets in the way) is no problem here since it is a coiled cable (similar to a telephone cable) terminated with alligator clips and easily retracted and stored in a special chamber in the generator.

In use, both in the field and on the bench, the CG-22 has proved to be very handy (small enough to sit on top of a small color portable) and easy to carry from job to job. Incidentally, have you ever tried using the crosshatch signal to set the linearity controls on monochrome receivers? Try it and you'll be surprised at how easy it is.

All the patterns produced by the CG-22 were clear and stable, making it well worth its price of \$89.

Circle No. 68 on Reader Service Card

A. A. E. MODEL T-101 TRANSISTOR TESTER

IN-CIRCUIT transistor testers, particularly those producing characteristic curves on a scope, are becoming very popular. This is because removing suspect transistors from a small cramped board is difficult and may also do additional harm to the transistor. The latest instrument of this type to come

to our attention is the Advanced Applied Electronics Model T-101.

The metal-cased unit measures 4½" × 3" × 1" and is designed to be mounted to the underside of the workbench shelf where it is out of the way. It has leads long enough to reach the ac socket, the scope,



Short Wave Listening

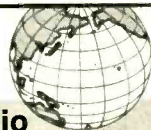


Drake
MODEL
SW4-A

International Shortwave Broadcast Receiver

- Precision tuning dial eliminates guesswork, permits Direct Frequency Dialing on SW and standard AM Broadcast
- Crystal lattice filter for adjacent station rejection and good AF response
- Dual conversion
- Solid state AF output
- S-meter
- Preselector gives superior sensitivity by peaking antenna and RF stages
- Crystal-controlled H. F. Oscillator stability
- Amplified AVC constant AF output.

\$335.00



Communications Radio



Drake
MODEL
SPR-4

Programmable Communications Receiver

- Programmable to suit any interest: SWL, Amateur, Laboratory, Broadcast, Marine Radio, etc.
- All solid state
- Direct Frequency Dialing: 150-500 kHz plus any (23) 500 kHz ranges, 500 to 30 MHz
- FET Circuitry
- Linear dial, 1 kHz readout
- 3 bandwidths: 0.4 kHz, 2.4 kHz, and 4.8 kHz for: CW, SSB, AM
- Power: 120 VAC, 220 VAC, and 12 VDC
- Crystals supplied for LW, BC and seven SW bands.

\$499.95

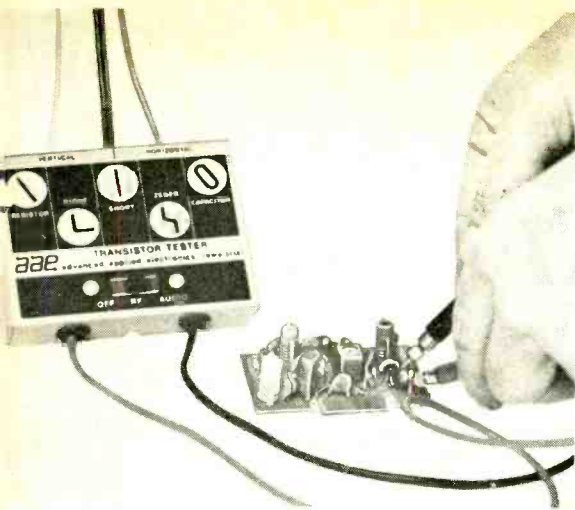
R. L. DRAKE COMPANY



540 Richard Street
Miamisburg, Ohio 45342

CIRCLE NO. 16 ON READER SERVICE CARD

POPULAR ELECTRONICS Including Electronics World



and the circuit under test. The two test leads are terminated in probes with needle tips to break through any PC board coating compound and make good electrical contact with the transistor leads.

Use Results. The T-101 is very simple to use. It is merely necessary to get the probes on either the base and emitter or base and collector terminals. It is not necessary to determine which is which. The waveform displayed on the scope tells you the condition of the junction being tested. Diodes can also be tested in the same way. Both good junctions and leaking junctions have their own peculiar waveforms. Shorted or open junctions cause straight lines on the scope—vertical for a short and horizontal for an open.

A diode having a resistor or capacitor in parallel with it can also be checked. Capacitors, including electrolytics, can be checked for quality; and low resistances from 1 to 200 ohms can be checked by observing the waveform across them.

Provisions are also made for checking either small-signal r-f transistors or audio power transistors. The case of the T-101 has the various displays produced on the scope printed on the front panel. There is also an instruction manual.

We have been using the tester for several weeks and find that it does what the manufacturer claims and that it has saved quite a bit of time ordinarily spent in unsoldering and resoldering transistors. Price of the tester is \$29.95.

Circle No. 69 on Reader Service Card

DECEMBER 1972

FREE

send today
for the all-new
money-saving

Olson CATALOG

1973

CATALOG

Olson

FOR THE ELECTRONICS IN YOUR LIFE



NOW
the only
catalog
offering
a wide
selection of

**THE BEST
OF THE
FAMOUS
BRANDS**

SAVE ON EVERYTHING IN ELECTRONICS

YOUR BEST BUYING GUIDE... COMPLETE SELECTION!

Here's everything for the hobbyist, kit builder, audiophile, Ham, CB'er, ... everyone in electronics!

- Everything in audio & hi-fi
- Tape recorders & accessories
- Radios & phonos of all kinds
- New build-your-own kits
- Auto electronics & accessories
- Citizens Band 2-way radios
- Police/fire monitors
- PA & intercom systems
- Shortwave & Ham radios
- Test Gear • Parts Bargains
- Electronic security systems
- TV-FM antennas & equipment
- Books, batteries, tools, transistors, tubes, more!

Send for it now!

MANY FULL-COLOR PAGES!

OLSON ELECTRONICS

**OLSON
EXCLUSIVES!**

See special products and values sold only by Olson, including our all-new TELE DYNE stereo line for '73.

FREE!

Olson



Olson Electronics Dept. IA Rush 1973
260 S. Forge St., Akron, Ohio 44327 catalog to:

Name _____ Apt. _____

Address _____

City _____ State _____ Zip _____

Name _____ Apt. _____

Address _____

City _____ State _____ Zip _____

CIRCLE NO. 28 ON READER SERVICE CARD



A New TV Antenna

By John T. Frye, W9EGV, KHD4167

BARNEY stood in the doorway of the service department staring at Mac, his employer, who was down on his knees on the floor unpacking a carton containing an object that seemed to be mostly gold-colored tubing.

"It never fails," Barney sighed resignedly. "We're having a regular blizzard outside, and you're thinking about putting up a new TV antenna. Just once I wish you'd get this urge on a nice balmy summer day. What's wrong with the old antenna?"

"Nothing," Mac replied, "but these Quantum antennas by Channel Master represent a new concept in TV antenna design, and I want to see if they're as good at noise reduction as claimed."

"How can a TV antenna reduce noise?" Barney scoffed. "That's like saying the windmills make the wind blow."

"Not true," Mac denied. "The IEEE defines noise as, 'unwanted disturbances superposed upon a useful signal that tend to obscure its information content.' That's a very broad definition and, as far as TV reception is concerned, includes interference from such diverse sources as electrical ignition systems, all kinds of switches, diathermy, X-ray, electronic ovens, universal motors, CB-amateur-police-taxicab transmitters, FM broadcasts, static, power transmission lines, reflection ghosts, and adjacent and co-channel interference. So an antenna that discriminates strongly between a desired signal off the front and undesired noise off the sides or back can have a marked effect on noise reduction. Such discrimination is achieved by: (1) providing maximum antenna directivity, and (2) minimizing feedline pickup—which, of course, degrades directivity."

"You're right about the noise level coming up all the time," Barney said. "We hams will testify to that. And it's getting tougher and tougher to find a relatively quiet

location for a radio telescope, like the immense parabolic array at Green Bank, West Virginia. Scientists are already turning to space to escape this 'ether pollution.' Noise is especially bad on channels 2 through 6. That's where you see the most—but not all—of the streaking, the herringbone and moire patterns, the venetian blind and wind-shield wiper effects, the shadowy sync bars, etc. This condition is worst in the metropolitan areas, but it is getting worse in the suburban areas, too, as the use of electrical appliances proliferates and factories move out into the suburban and rural areas."

"Glad to see you appreciate the problem," Mac commented. "Little can be done if the source of interference is directly in line with the desired signal, but there's at least a 50-50 chance the interference will come in off the sides or back of the antenna. In the case of co-channel or adjacent channel, probably 90% of the undesired signals come in from the rear because of the FCC's channel allocations. The set owner should, therefore, without sacrificing gain, select an antenna designed for high interference rejection."

"The Interference Rejection Factor of an antenna is defined as the ratio of the antenna's maximum sensitivity (normally at the front) to its peak sensitivity in the rear 180° sector. Note this is not, necessarily, the same thing as front-to-back ratio. Quite often high gain antennas will have secondary lobes not directly opposite the primary front lobe. Such an antenna may have a very high front-to-back ratio, but the ratio of the front response to the response of say 30° either side of the rear will be much lower."

"Up to now, according to Channel Master, the peak IRF of high gain antennas has been 15 to 18 dB. This Quantum Model 1160 I am unpacking is claimed to have an IRF of 35 dB. It is further claimed that,



8 Sams Books to update and broaden your Electronics Skills

Three are newly revised editions . . . 5 are brand new this fall . . . all will be valuable additions to your library.

ABC'S OF LASERS AND MASERS (3rd Edition)

By Allan Lytel and Lawrence Buckmaster
The completely updated explanation and review of the development and applications of lasers and masers in measurements, communications, medical surgery, and industrial usages; 128 pages; 5½" x 8½"; softbound.
No. 20863 \$3.50

99 WAYS TO IMPROVE YOUR SHORTWAVE LISTENING (NEW)

By Len Buckwalter
A valuable source of information for both hobbyist and experienced technician. Includes: antennas and installation, receiver improvements, accessories, interference sources, troubleshooting tips, listening techniques. 144 pages; 5½" x 8½"; softbound.
No. 20911 \$3.95

101 QUESTIONS AND ANSWERS ABOUT AM, FM, & SSB (NEW)

By Leo G. Sands
Easy-to-understand information about the three basic modulation techniques and the various types of transmission. Describes best uses, technical aspects and limitations of each in a Q&A format. 96 pages; 5½" x 8½"; softbound.
No. 20919 \$3.95

1-2-3-4 SERVICING STEREO AMPS (NEW)

By Forest H. Belt
Details the "divide and conquer" method of troubleshooting and servicing stereo equipment and shows how to apply the method for best results. Many illustrations and schematics in this clear, easy-to-read manual. 240 pages; 5½" x 8½"; softbound.
No. 20912 \$4.95

NORTH AMERICAN RADIO-TV STATION GUIDE (8th Edition)

By Vane A. Jones
Lists nearly 10,000 a-m, fm and television stations in the U.S., Canada, Mexico, and the West Indies. Includes: power (day and night), antenna height, and time sharing. Arranged by geographical location, frequency (or channel), and call letters. 160 pages; 5½" x 8½"; softbound.
No. 20915 \$3.95

ABC'S OF INDUSTRIAL ELECTRONICS (NEW)


By J. A. Wilson
Covers the circuits and applications of electronics used in manufacturing, together with all types of electronics systems that are not designed for home entertainment. Tells and shows how electronics have improved on old-time methods of machine and process controls. 96 pages; 5½" x 8½"; softbound.
No. 20913 \$3.95

FM MULTIPLEXING FOR STEREO (3rd Edition)

By Leonard Feldman
Analyzes the fm stereo signal; gives requirements for fm stereo receiver; covers multiplex decoder circuit variety and servicing, stereo indicator lights and automatic stereo switching; test equipment and alignment procedures. 176 pages; 5½" x 8½"; softbound.
No. 20910 \$4.95

MARINE SINGLE SIDEBAND (NEW, NOT SHOWN)

By Donald M. Stoner and Pierre B. Goral
Fills a void in published literature on the subject of Marine Single Sideband, the method by which all marine electronic voice communications must soon be carried out. Covers all facets of Single Sideband in marine communications. 192 pages; 5½" x 8½"; softbound.
No. 24929 \$5.95

 **HOWARD W. SAMS & CO., INC.**
4300 West 62nd Street, Indianapolis, Indiana 46268

Order from your Electronics Parts Distributor, or mail to Howard W. Sams & Co., Inc.

Send books checked at right. \$_____ enclosed.
Please include sales tax where applicable.
Canadian prices slightly higher.

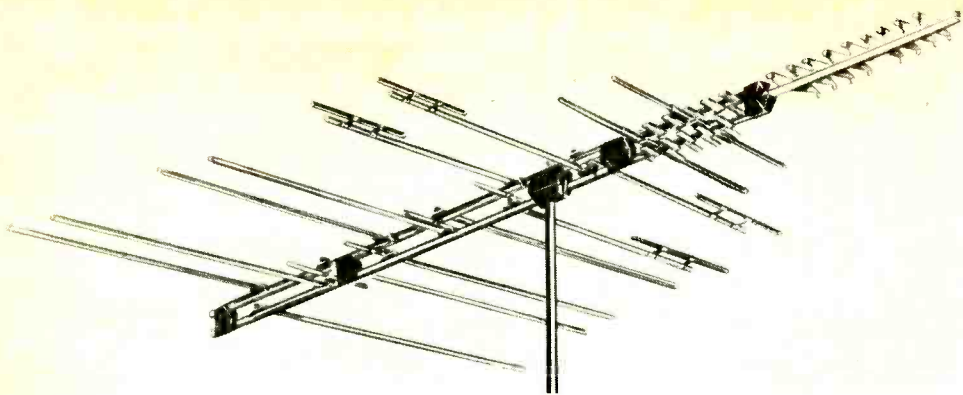
Send Free 1972 Sams Book Catalog.

Name _____
Address _____
City _____ State _____ Zip _____

20863 20915
 20911 20913
 20919 20910
 20912 24029

PE-122

CIRCLE NO. 34 ON READER SERVICE CARD



when the predominant interference originates at the rear or sides of the antenna, an improvement of 10 dB in signal-to-noise ratio will occur. This is equivalent to a 10 dB increase in antenna gain. In a deep fringe area the elimination of interference by this high IRF can bring about the same dramatic improvement you'd expect from a higher gain antenna. And in near-fringe suburban areas, where you have enough TV signal but there are lots of interference sources, the high IRF should usually eliminate all signs of interference."

"Sounds great, but how do they do it?" Barney said skeptically.

Mac had been busy unpacking the antenna and assembling it as he talked. This did not take long because the elements snapped out and the boom sections were fastened together with bolts and wing nuts.

"According to Channel Master, the extremely high IRF is achieved by the application of the Fourier Transform Theory to TV antenna design. The way current distributes over the elements of an antenna determines its gain, bandwidth, and pickup patterns. In the past, uniform current distribution has been the key to high broadband gain, but the Transform Theory, widely applied to radio telescopes and space communication, states a *tapered*, symmetrical distribution of current over an antenna's elements will yield patterns with the smallest side and rear lobes. As one CM engineer puts it: 'Just as the amplitude function of a waveform is transformed into the frequency spectrum, so the distribution of current over an antenna array is transformed into the radiation pattern by the Fourier Transform.'

"Until recently almost all work in this connection has been done on broadside ar-

rays of the parabolic and 'bed-spring' types. Very little application has been attempted on end-fire yagi-style arrays. One reason has been the lack of instrumentation to measure accurately the amplitude and phase differences in the antenna elements. But with the development about five years ago of the Hewlett-Packard Model 8405 Vector Voltmeter, which allows measurement of amplitude and phase differences of two signals up to 1000 MHz, the roadblock was removed.

Experimental Development. "Even so, CM spent three years of experimental effort to develop the Quantum line of antennas—work consisting of painstaking adjustment of element configurations, lengths, and spacings, and testing, testing, testing. When you consider that this top-of-the-line Model 1160 has 16 fed elements and 26 parasitic elements and that a change in any one affects the others, you get some idea of the enormity of the job."

"I still am not sure what you mean by 'tapered currents over the antenna elements.'"

"Let me try to explain. First note that this antenna does not consist of a single divided 'driven' element connected to the feed line and a bunch of solid parasitic directors and reflectors. Instead the boom is divided lengthways into an upper and lower section separated by heavy-duty insulating blocks to provide a modified truss construction. Each fed element is cut in two in the middle and has one half connected to the top part of the boom and the other directly beneath to the lower half. Since the feed-line is connected to the two parts of the boom, that means all divided elements connect to this line.

"Now if we measure the currents in these elements in the presence of a signal, we find not all elements carry significant current at all frequencies. By proper design we can produce currents that gradually increase as we go down the elements and then fall off to produce a curve that satisfies the Fourier Transform Theorem. From one channel to another, the peak of this tapered current may fall on different feed elements, but we must maintain the tapered distribution that provides the maximum IRF. You will find more about this in *Antennas* by J. D. Kraus (McGraw-Hill 1950). And in *Microwave Antenna Theory and Design* by S. Silver (McGraw-Hill 1950). And when it is crystal clear to you, I wish you'd explain it to me!"

"Don't hold your breath," Barney warned, grinning. "I notice you speak of a 'Quantum Line' of antennas. I take it CM makes several using this principle."

"That's right. They market fifteen different models designed to fit all receiving conditions from the near suburban to the deepest fringe areas. The set owner can order an antenna fitted to his needs as far as uhf, vhf, and FM reception in his area is concerned—which brings up another point: with FM stations springing up all over the place, FM interference with TV reception is an increasing problem. So the Quantum, designed to furnish excellent FM reception normally, provides for FM trapping if you need it. An optional FM trap that can be installed in the weatherproof terminal housing located between the boom elements gives 20-dB attenuation of FM signals without affecting the IRF of the antenna. Another feature is this front-end section that looks like a sawfish's snout. It's actually a tunable uhf sector adjustable for peak reception of the uhf channels."

"How is feedline pickup prevented with this antenna?"

"First, the antenna is electrically balanced. By connecting the right-hand sides of the split elements alternately to the top and bottom portions of the boom we achieve transposition in the feed. Also note these controlled-impedance transmission rods that run from the feed points to the weatherproof plastic terminal housing. And see how the boom is insulated from the mast? But even though the antenna itself is carefully balanced, the receiver input may be unbalanced, in which case the feedline will still pick up interference. In that event you may want to employ shielded coaxial cable, and there is an optional balun transformer designed to fit into the terminal housing."

"Those engineers seem to have thought of everything," Barney commented.

"Well, this antenna is certainly a far cry from the first two-element TV antenna I ever saw. Personally, I'm delighted to see serious engineering going into TV antennas by several manufacturers. Optimum TV reception is impossible without a good antenna. I want to get this antenna up on the roof so we'll have a signal to check on cable performance when we need it. You know how that goes. If we have good reason to suspect the CATV signal is not up to par and call Fred, the manager, he reacts as though you doubted his virtue."

"Yeah, I know," Barney agreed with a chuckle. "He is either seeing a perfect picture down there in his office, or something must be wrong with the TV transmitter. Nothing is *ever* wrong with the cable. He feels so sure of this there is no point in sending a technician out to check. But if we can get a perfect picture off the antenna and a lousy picture off the cable, we can make old Fred sweat." ♦

FREE McIntosh CATALOG and FM DIRECTORY

Get all the newest and latest information on the new McIntosh Solid State equipment in the McIntosh catalog. In addition you will receive an FM station directory that covers all of North America.



MX 114

**FM/FM STEREO TUNER
and STEREO PREAMPLIFIER**

CIRCLE NO. 25 ON READER SERVICE CARD

SEND TODAY!

McIntosh Laboratory Inc.
2 Chambers St., Dept. PT-1272
Binghamton, N.Y. 13903

NAME _____

ADDRESS _____

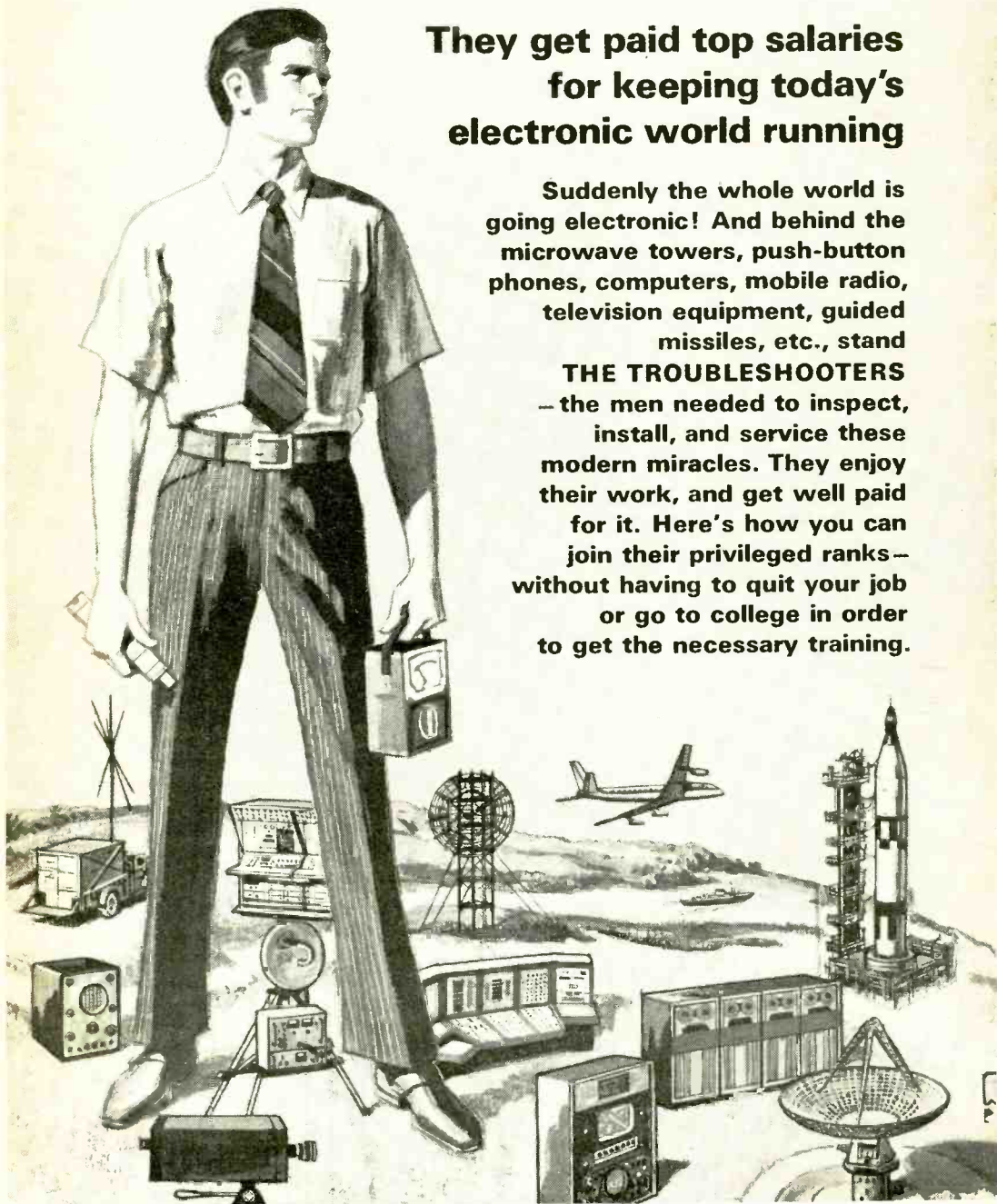
CITY _____ STATE _____ ZIP _____

Join "THE TROUBLESHOOTERS"

**They get paid top salaries
for keeping today's
electronic world running**

**Suddenly the whole world is
going electronic! And behind the
microwave towers, push-button
phones, computers, mobile radio,
television equipment, guided
missiles, etc., stand**

**THE TROUBLESHOOTERS
— the men needed to inspect,
install, and service these
modern miracles. They enjoy
their work, and get well paid
for it. Here's how you can
join their privileged ranks—
without having to quit your job
or go to college in order
to get the necessary training.**



Just think how much in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter . . . keep a whole assembly line moving by fixing automated production controls . . . prevent a bank, an airline, or your government from making serious mistakes by servicing a computer.

Today, whole industries depend on Electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians — The Troubleshooters.

Because they prevent expensive mistakes or delays, they get top pay — and a title to match. At Xerox and Philco, they're called Technical Representatives. At IBM they're Customer Engineers. In radio or TV, they're the Broadcast Engineers.

What do you need to break into the ranks of The Troubleshooters? You might think you need a college degree, but you don't. What you need is know-how—the kind a good TV service technician has—only lots more.

Learn at Home . . . In Your Spare Time

As one of The Troubleshooters, you'll have to be ready to tackle a wide variety of electronic problems. You may not be able to dismantle what you're working on — you must be able to take it apart "in your head." You'll have to know enough Electronics to understand the engineering specs, read the wiring diagrams, and calculate how the circuits should test at any given point.

Learning all this can be much simpler than you think. In fact, you can master it without setting foot in a classroom . . . and without giving up your job!

For over 37 years, the Cleveland Institute of Electronics has specialized in teaching Electronics at home. We've developed special techniques that make learning easy, even if you've had trouble studying before. Our AUTO-PROGRAMMED® Lessons build your knowledge as easily and solidly as you'd build a brick wall — one brick at a time. And our instruction is personal. Your teacher not only grades your work, he analyzes it to make sure you are thinking correctly. And he returns it the same day it is received, while everything is fresh in your mind.

The Science of the Seventies

To keep up with the latest developments, our courses are constantly being revised. CIE students receive lessons in Field Effect Transistors, Digital Switching Units, Microwave Systems, Lasers, Binary Coding and Computer Arithmetic.

In addition, CIE offers an exciting Electronics Technology with Laboratory course that includes 161 space-

age components to let you perform 242 fascinating electronics experiments. You learn the "how" as well as the "why" of Electronics . . . the Science of the Seventies. Many leading companies use CIE courses to train their own employees who are working on the latest electronic equipment.

Get an FCC License — or Your Money Back!

Two-way mobile work and many other types of troubleshooting call for a Government FCC License, and our training is designed to get it for you. But even if your work doesn't require a license, it's a good idea to get one. Your FCC License will be accepted anywhere as proof of good electronics training.

A good way to prepare for your FCC exam is to take a licensing course from CIE. Our training is so effective that, in a recent survey of 787 CIE graduates, better than 9 out of 10 CIE grads passed the Government FCC License examination. That's why we can offer this famous Money-Back Warranty: when you complete any CIE licensing course, you'll be able to pass your FCC exam or be entitled to a full refund of all tuition paid. This warranty is valid during the completion time allowed for your course. You get your FCC License — or your money back.

Mail Card for 2 Free Books

Want to know more? Then fill out and mail reply card or coupon today. We'll send you our two FREE books on opportunities in Electronics. For your convenience, we will try to have a representative call. Act now, and get a high-paying job that much sooner.

APPROVED UNDER G.I. BILL

All CIE career courses are approved for educational benefits under the G.I. Bill. If you are a veteran or in service now, check box for G.I. Bill information.

CIE Cleveland Institute of Electronics, Inc.

1776 East 17th Street, Cleveland, Ohio 44114

Accredited Member National Home Study Council

Learn By Doing...

Electronics Technology with Laboratory Course teaches you the fundamentals. Using space-age components and testing techniques you will apply the principles you learn . . . actually analyze and troubleshoot modern electronics equipment.

Cleveland Institute of Electronics, Inc.

1776 East 17th Street, Cleveland, Ohio 44114

Please send me your two FREE books:

1. Your school catalog, "Succeed in Electronics."
2. Your book on "How To Get A Commercial FCC License."

I am especially interested in:

- | | | |
|---|---|--|
| <input type="checkbox"/> Electronics Technology | <input type="checkbox"/> Broadcast Engineering | <input type="checkbox"/> First Class FCC License |
| <input type="checkbox"/> Electronic Communications | <input type="checkbox"/> Industrial Electronics | <input type="checkbox"/> Electronics Engineering |
| <input type="checkbox"/> Electronics Technology with Laboratory | | |

Name _____ (PLEASE PRINT)

Address _____

City _____ State _____ Zip _____

Veterans and Servicemen:

- Check here for G.I. Bill information.

PE-37

Ampere's Law



BY DAVID L. HEISERMAN

AMPERE'S Law states that a pair of conductors carrying electrical currents exert magnetic forces upon one another. Furthermore, the amount of that force depends upon the amount of current flowing in each conductor, and the distance and angle between them. Andre Marie Ampere, a French physicist and mathematician, announced this new law of nature on September 18, 1820. As if discovering such a law weren't enough, Ampere used it to lay the theoretical foundations for a whole new branch of electricity and physics called electro-dynamics—and he did it in just seven years.

Early Years. Looking back at Ampere's work from our present-day point of view, it appears that the man spent the first forty-five years of his life preparing for his seven years of discovery. Born into a moderately well-to-do and educated family, young Ampere had most of the advantages available to French children reared during the Great Revolution. Moreover, he was a child prodigy who learned geometry and calculus at the age of twelve by reading texts

that were written in their original Latin.

When Ampere was eighteen, his father was executed during the bloody "Reign of Terror" that swept France. The sights and sounds of the revolution, topped off by his father's violent death, shocked Ampere's mind. He spent the following six years of his life wandering aimlessly about the countryside, building sand castles by the sea and composing nonsense poetry.

At the end of that lost period of time, Ampere married and settled down to a more conventional style of living. His brilliant mind had returned, but the family money was gone. So, Ampere took his first job as a professor at the University of Bourgen-Bresses. Barely three years passed before his wife died, shocking Ampere's mind into a stupor for another year.

Napoleon had heard about the talents of this unfortunate young genius, and he offered Ampere a teaching position at a school in Paris. Discouraged with life, but anxious to return to his work, Ampere accepted the position and he remained there for the rest of his professional life.

Ampere began contributing papers on a wide variety of subjects, including chemistry, mathematics, molecular physics and biology. At the time, his special interest was in the theory of games. These papers were important to other scientists, but they were not the sort that fall into the category of special greatness.

A New Discovery. On September 11, 1820, Ampere happened to attend a demonstration of Oersted's new discovery. The demonstration showed that a current flowing through a straight piece of wire makes a compass needle turn to a position at right angles to the conductor. Even while this demonstration was still in progress, Ampere must have thought, "Since one conductor carrying an electrical current can exert a force upon a compass needle, why can't two current-carrying conductors exert forces upon one another?"

Excited by the notion that current-carrying wires produce exactly the same kind of magnetic forces as loadstones and permanent magnets, Ampere immediately dropped all his other work and began investigating this "artificial" source of magnetism. In seven days, Ampere developed the fundamental theories of electro-dynamics, designed and built the experimental setups, performed the necessary experiments, and pre-

sented his findings to the scientific world. No other major scientific discovery has ever been conceived and tested in such a short period of time. Ampere was, indeed, fully primed for this week of great discoveries.

Two highly significant ideas emerged from Ampere's mind and experiments that week. For one thing, he developed what we now commonly call the "right-hand rule." According to this rule, with the thumb of the right hand pointing in the direction of conventional current flow (positive to negative) through a wire, the curled fingers of that hand indicate the direction of the resulting magnetic field. Oersted had already concluded that magnetic lines of force emerge at right angles from the conductor. Ampere, however, perfected the notion by making it possible to predict the sense, or polarity, of that field.

The other important idea in Ampere's first paper concerned the attraction and repulsion of two parallel wires carrying an electrical current. Ampere showed that currents flowing through the wires in the same direction made them attract one another, while currents flowing in opposite directions made the wires repel.

Ampere's discoveries about the direction of magnetic fields around a conductor and the forces acting upon a pair of current-carrying wires are just as important today as they were 150 years ago. What is perhaps even more remarkable is the almost unbelievable simplicity of the lab equipment he used. He managed to open a whole new technology using nothing more than a few lengths of copper wire, a compass, and a couple of Volta batteries.

During the seven years after his preliminary announcement, Ampere's papers became increasingly spiked with complicated equations. His early studies of geometry and calculus were paying off. Other researchers in Europe had picked up some good ideas from Oersted's work, too; but most of these people lacked the high level of mathematical sophistication and creative insight Ampere possessed.

Back to the Laboratory. His work soon reached a point where he had to return to the laboratory to confirm his equations. This time he had to obtain precise figures for the amounts of current flow and forces between the conductors. Using what was then a revolutionary new measuring instrument, the galvanometer, Ampere was able to measure

the amount of current flowing through the wires. His own original work with coils of wire and solenoids, by the way, was directly responsible for the invention of the very galvanometer he used.

Since he also had to know the exact amount of force two conductors exerted upon one another, Ampere devised a couple of specialized instruments. One of them was an ordinary laboratory balance that had a solenoid attached to one side of the beam. This solenoid fit inside a larger one fixed to the bottom of the balance. Current flowing through the two solenoids made the smaller one move inside the larger. By placing calibrated weights upon a weighing pan on the opposite end of the beam, Ampere could determine the exact amount of force the two sets of conductors exerted upon one another.

According to the famous scientist, James Clerk Maxwell, Ampere's fundamental equations had "leaped full grown and fully armed from the brain of the Newton of electricity." Ampere's equations were practically complete even before he set out to demonstrate their validity in the laboratory. Making up equations before running the experiments was contrary to the accepted scientific procedure of the time, but one simple fact silenced all critics—the equations and laboratory experiments always agreed. And to honor this "Newton of Electricity," the International Congress of Electricians named the basic unit of current, the ampere, after him.

Ampere was a hard worker as well as a scientific genius. Even while he was concentrating on the job of building the foundations of electrodynamics, he taught classes at the university. Perhaps this was a mistake. Ampere was noted for stopping his lectures in the middle of a sentence while his mind wandered off onto some new idea or equation. He also had a habit of letting his work at the blackboard meander into some new line of mathematical reasoning, leaving his students to puzzle over the jumble of incomprehensible figures related to some new idea in electrodynamics.

Ampere was, indeed, a classic example of an absent-minded professor. There can be no doubt, though, that he was one of the most successful absent-minded professors of all time. Unlike the blackboards that carried his ideas off into oblivion, Ampere's basic equations stand essentially unchanged to this day. ♦



Test Equipment Scene

By Leslie Solomon, Technical Editor

THERE are four ways to test a transistor. The first is to plug the transistor into a known operating circuit and see what happens; the second is to use the trusty old VOM to measure forward and reverse resistances and hope you don't burn out a junction in the process; the third is to use any of the excellent meter (or tone) read-out in- or out-of-circuit transistor testers; while the fourth is to use a curve tracer.

We can find no fault in the first approach as long as the transistor uses a socket and can easily be replaced; but this method can become troublesome when suspect transistors have to be unsoldered, with the attendant possibilities of circuit board damage in this and the replacement process. The VOM approach is a form of electronic Russian roulette and, unless a low-current, low-voltage ohmmeter is used, should be avoided. The transistor tester using meter or tone readout is excellent as long as all you want to know is whether a particular transistor is good or bad; and this approach can be used in the majority of cases. However, it is the last method—the curve tracer—that we feel presents an excellent approach and opens up new areas of semiconductor testing. Note also that the first three approaches may be used to test bipolars and conventional diodes, but cannot usually be used to test other semiconductors such as FET's, zeners, SCR's etc. How-

ever, the latter can be tested on a curve tracer.

Lack of Knowledge. It would appear that the main reason many people don't use curve tracers is that they don't understand how the devices work. To clear up the mystery, consider the circuit shown here. The collector-to-emitter junction of the tested transistor is swept with a 120-Hz pulsating dc voltage device from an unfiltered full-wave rectifier, while the base is supplied with a number of calibrated steps of low current (usually switch selectable). When the results are displayed on an oscilloscope, a "family" of curves is obtained—one for each step of base current with the vertical representing the collector current and the horizontal the applied collector voltage.

Using this approach, the beta of the transistor can be determined at the desired operating voltage, the breakdown/avalanche voltage can be identified, the amount of leakage can be determined, and the type (npn or pnp) can be ascertained. It is also possible to check saturation voltage, output admittance, and the effects of temperature. Using a pair of switchable sockets, the curve tracer can accurately match a pair of transistors for special audio applications. Most curve tracers can accurately plot voltages for an unknown zener diode and they can be used to test (nondestructively) FET's, UJT's, SCR's, triac's, tunnel diodes, and some types of IC's.

Curve tracers have one more use that can save a lot of time and worry. Have you ever wondered what kind of replacement you would need for an unmarked device? You no longer have to waste time writing all over creation for a replacement or wonder which of the vast number of readily available, low-cost "replacement" transistors you can use. All you have to do is plug the unmarked device into one of the sockets on

Semiconductor Testing

Write for Dixie's Wholesale Stereo Catalog

[save on dynaco & everyone else]

**Save More by Mail from Dixie Hi-Fi...
Write Now for Our FREE 36 Pg. Wholesale Catalog**

When you can save over 50% and no less than 20% on the big names in Hi-Fi — it makes good sense to write for our Free 36 page Wholesale catalog.

DIXIE, one of the country's top stereo wholesalers, fills all orders promptly. At prices actually lower than "Discounters".

For over 14 years, we've built our mail-order business with Hi-Fi buffs because

we are actually wholesale. (Incidentally, the new Dixie Catalog is full of the new four channel equipment and software.)

We'll immediately answer mail or phone requests for quotes. All items are shipped factory-sealed and guaranteed.

Write today for your Free Wholesale Catalog!



Convenient! BankAmericard & Master Charge
Honored on Mail Orders!



You can't beat the ***dynaco*** system

(Especially when it comes from Dixie!)

Dynaco is just one of many brands you'll find in the new Dixie Catalog. And, whether you assemble the superlative new AF-6 AM/FM Stereo Tuner and the Stereo-400 Power Amp by yourself or get it already wired — You're assured of the ultimate in accuracy and power at the lowest possible cost.



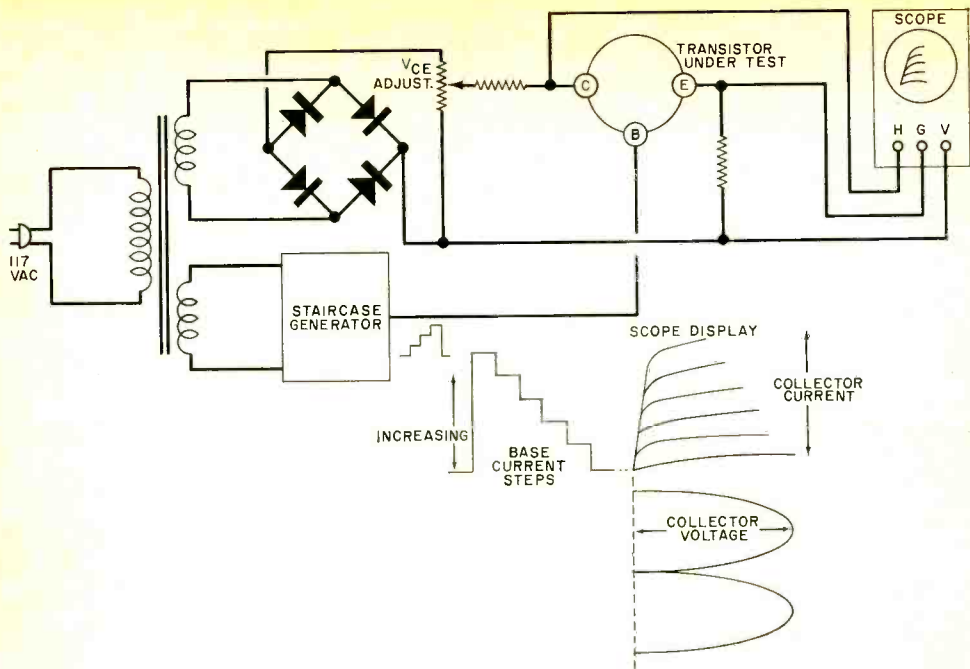
DIXIE

**HI-FIDELITY
WHOLESALE**

Dept. PE-12
10140 Bacon Drive
Beltsville, Md. 20705
Phone 301-937-3090

Write Today for FREE Wholesale Catalog

CIRCLE NO. 15 ON READER SERVICE CARD



The full-wave rectified 120 Hz is used as the collector voltage, while a multi-step staircase voltage is used as base drive. The scope displays a family of curves.

the curve tracer and look at its family of curves. Then start inserting possible replacements in the other socket until you find one replacement that closely matches the unknown's family of curves. Then start keeping records. You will be surprised how much time and money you can save, especially if you have a service shop.

Signature Diagnosis. Unfortunately, the most useful function of a curve tracer has not yet been exploited. This is in an area sometimes called "signature" or "interpretive diagnosis." It involves displaying the family of curves of a transistor when it is tested in the circuit with all the required circuit components attached and working properly. Signature testing provides all the stage information at a glance: Is the transistor good or bad; and are the passive components associated with that particular transistor good or bad?

To conduct a signature test, connect the curve tracer to a known good transistor operating in a circuit that is known to be operating properly. Without supplying power to the circuit, record the transistor trace on the scope. The basic transistor curve will vary according to the types and values of the associated passive components

associated with it; but the curve will be the same for similar stages in similar models. The signature is recorded on the schematic (perhaps using Polaroid film) so that it can be compared with the signatures found when the circuit stops working properly. Armed with the signature of each stage, it is a simple matter to move the probe through each stage until an incorrect one is found. We feel that this approach is so time-saving that schematic publishers will soon start including signatures of TV sets and other types of solid-state equipment.

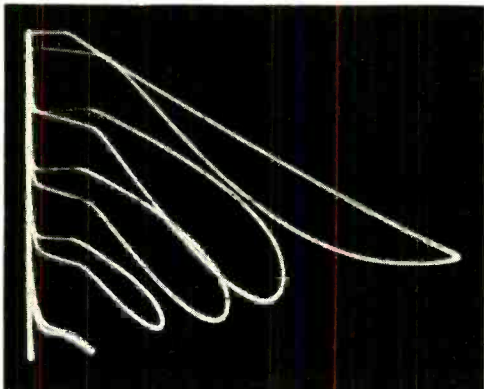
What About IC's? Until recently, IC testers have been few and far between (and very costly), so most hobbyists and technicians have had to do a lot of improvising. We have been experimenting with the use of a curve tracer to check out some of the less-complex linear IC's—where we could gain access to base, collector, and emitter (usually through the substrate). We have come up with a family of curves that permit us to check these types of IC's, both in and out of the circuit. (In the circuit, we used the signature approach.)

Some digital IC's, especially the various forms of gates, are easy to check with a curve tracer. Other, more complex IC's, both

linear and digital, still present problems; but further investigation is warranted.

If the idea of signatures intrigues you, note that RCA provides some of this data with their new transistor tester, while the Jud Williams Co. is presently compiling a series of signature patterns for the bulk of major semiconductor TV chassis.

You may have heard a lot of talk about having to use a dc-coupled scope with a curve tracer; and this may have deterred you from trying one. Although a dc-coupled scope is desirable, there is no reason why you can't use an ac-coupled scope and operate the shift controls to re-position the family of curves. In some ac scopes, there may be a slight "looping" of the curves; but if you use the same scope to record and later observe the signatures, the problem disappears because the curves are all relative.



The above photograph shows a typical "signature" pattern (courtesy of Jud Williams) obtained in an in-circuit test of a solid-state TV chassis. Note that the conventional transistor family of curves has been distorted due to the impedances of the associated passive components. This shows that the transistor is good. The pattern is unique to this circuit, and similar circuits having the same manufacturer's model number. Comparable "looping," although not as great, occurs when an ac-coupled scope is used in conventional transistor testing.

So, take a look at the curve tracers now being sold by B & K, Eico, Jud Williams, Leader, and RCA. (Perhaps others by the time you read this, so keep an eye on your distributor's shelves and catalogs.) If you do a lot of work with semiconductors, you may be overlooking a very useful tool. ♦

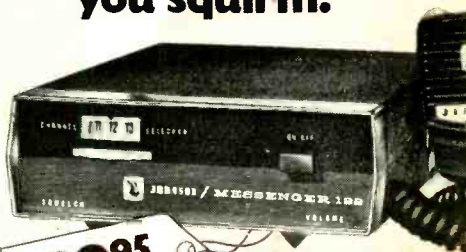
(ACTUAL SIZE)

11 12 13

The channel selector on our new Messenger 122 won't make you squint...

Here's 23-channel CB with true high-visibility illuminated readout. (The kind you can read at a glance while mobile!) It's made possible by a unique rotary drum selector . . . and no other 23-channel radio, at any price, has it. Yet the new Johnson Messenger 122 sells for just \$139.95. And it has U.S.-made Johnson quality straight through! With features like built-in speech compression for greater "talk power". And a ceramic filter to drastically reduce interference from adjacent channels. Plus the convenience of push-button "instant on" that's completely independent from volume and squelch controls—so it's always ready for action. Messenger 122: It's at your Johnson dealer now!

...and its price won't make you squirm.



\$139.95
suggested price



JOHNSON

Waseca, MN 56093



Johnson Quality—Backed by a full 1-year parts and labor warranty with over 600 authorized service centers nationwide.

CIRCLE NO. 23 ON READER SERVICE CARD

Build an Audio Level Meter

ADDING MULTI RANGES TO A LOW-COST DB METER

BY SAMUEL C. MILBOURNE

USERS of audio equipment often have a need to know the level of the audio signal at various points within a system. For this reason, many units come with built-in level (dB) meters. If your present system does not have a level meter, or if you need an extra one, here is your chance to construct one at low cost.

The actual meter used in the prototype is a low-cost panel meter having a $-10/0/+6$ dB scale, built-in rectifier, and series resistor for the basic range. (The meter is available from such surplus dealers as Fair Radio Sales, 1016 E. Eureka St., Lima, OH 45802, for about \$5.) It used 6 mW into a 600-ohm line as 0 dB; but information is supplied here for both 500-ohm and 1-mW circuits.

Calibration. The accompanying table shows the calibration voltages required to cause the meter to indicate at the 0-dB mark for ranges up to $+32$ dB.

Determine the highest range to which you will want to calibrate, pick a transformer having at least the necessary voltage output and build the circuit shown in Fig. 1. Set the voltage-adjustable transformer for minimum output and $R1$ for zero resistance. Only the 600 ohms of $R2$ (500 ohms if your meter requires it) should be in the circuit. For a 6-mW/600-ohm meter, the application of 1.90 volts (from $T2$) should cause the meter to indicate 0 dB. Raise the voltage to that required for $+4$ dB and adjust $R1$ until the meter reads 0 dB. Accurately measure and record the resistance of $R1$ for this setting.

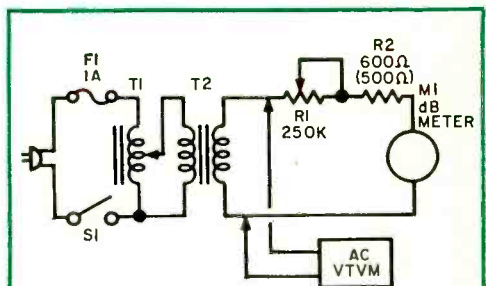
Increase the voltage in the steps shown in the table, measuring and recording the resistance of $R1$ for each step. These values determine the final resistors that are used in the meter circuit shown in Fig. 2. The final accuracy of the meter depends on how

close you can set and read the ac voltage applied in Fig. 1 and how close you can come in selecting the final values of the fixed resistor.

In the prototype, we used the closest standard 5% resistors, obtaining reasonably accurate scale indications. Odd values of resistance can be made by combining two resistors. (For example, to get 51k, use 47k and 3.9k in series. Of course, paralleling can also be used.) Be careful not to overheat resistors when building up pairs as they may change value with heat.

The resistor network may be attached directly to the switch contacts or mounted on a piece of perf board. Use a pair of conventional banana jacks for the connectors.

When the meter is complete, re-run the voltage steps, changing the switch at each range, to check that the meter indicates at the 0-dB point at each switch position. If



PARTS LIST

- F1*—1A fuse and holder
- M1*—dB meter being tested
- R1*—250,000-ohm potentiometer
- R2*—600-ohm, 2-watt resistor (see text)
- S1*—Spst slide or toggle switch
- T1*—Variable autotransformer
- T2*—Transformer with 117V primary; see text for secondary
- Misc.*—Accurate ac vtvm, line cord.

Fig. 1. Circuit to determine resistances.

CALIBRATION VOLTAGES

Range	6mW/600 ohms (volts)	6 mW/500 ohms (volts)	1 mW/600 ohms (volts)
0	1.90	1.73	0.774
+4	3.01	2.75	1.228
+8	4.77	4.35	1.946
+12	7.55	6.90	3.084
+16	12.00	10.93	4.887
+20	19.00	17.32	7.746
+24	30.10	27.50	12.28
+28	47.70	43.50	19.46
+32	75.50	69.00	30.84

the meter does not indicate directly on the 0-dB mark, the value of resistance at that switch position will have to be adjusted. Lower the resistance if the meter indicates in the negative dB region; increase it if the meter is positive.

The finished level meter can be assembled in any type of case, plastic or metal, and each switch position should be marked in some manner.

Use. With a signal applied, set the range switch until the meter is as close to 0 dB as possible. The actual dB level is then the

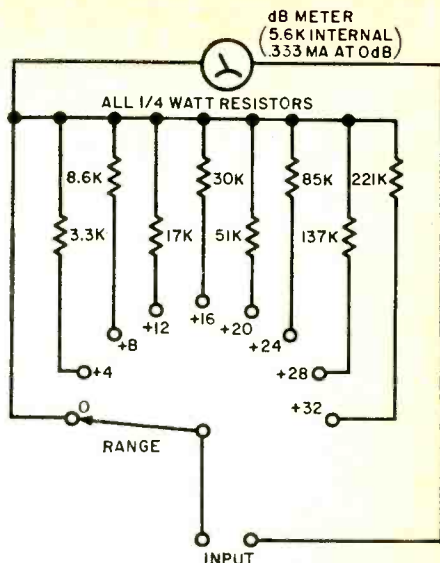


Fig. 2. Final circuit uses resistors as close as possible to test values.

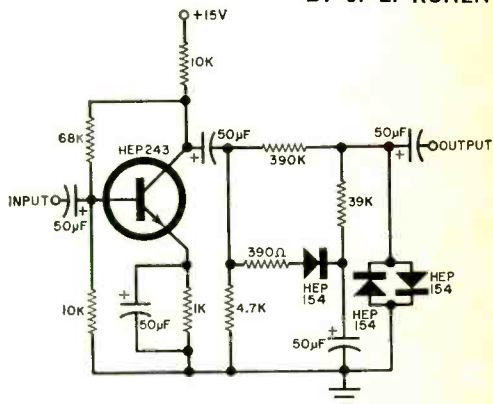
sum of the meter reading and the switch setting. For example, assume the range switch is on +12 dB and the meter indicates -3 dB. The actual level is then +9 dB. ♦

ADD A COMPRESSION AMPLIFIER TO YOUR ELECTRONIC ORGAN

BY J. E. ROHEN

THE OUTPUT signal level of an electronic organ is dependent upon the setting of the foot-pedal volume control, the number of stops or voices switched in, and the number of keys depressed at a given moment. For a fixed volume setting and a fixed number of stops on line, the volume level heard will vary considerably, depending on how many keys are depressed simultaneously. Although the organist can compensate for the changes in volume by using the volume pedal, on a fast change of stops or a quick switch from solo to rhythm, the audio change is too fast for him to react, and a choppy audio burst results.

It is desirable to have a means for keeping the volume level constant when such rapid changes are made. To accomplish this, a compression amplifier like the Organ Leveler shown in the schematic can be used. Unlike compressors used for PA applications, the Organ Leveler can respond to the



Leveling circuit does not affect volume or change the frequency response.

entire range of frequencies generated by the organ without adding coloring to the voices. It can handle large fluctuations in input signal without clipping. ♦



ELECTRO-VOICE SPEAKER SYSTEM

"Interface: A", a new speaker system announced by Electro-Voice, is a direct radiating vented system which is said to have a virtually flat response to below 40 Hz, is down 3 dB at 32.7 Hz and cuts off sharply below 30 Hz. With an 8" woofer, the system has a vent substitute radiator and an active electronic equalizer. A 2½" cone tweeter on the front has an absorbent ring which in effect decreases the size of the tweeter as the frequency increases. A second tweeter at the back of the cabinet reinforces the front tweeter with no on-axis high-frequency boost. The speaker is 22" x 14" x 7¼" and the separate equalizer box is installed using tape input and output jacks or between preamp and amplifier. The equalizer has a rolloff control which slopes high-frequency response (3 or 6 dB down at 10,000 Hz) if room or program material require it.

Circle No. 70 on Reader Service Card

CASIO MINIATURE CALCULATOR

The Mini Calculator, made by Casio, Inc., is suggested for retail at \$59.95. This six-digit-in/twelve-digit-out "four banger" (add, subtract, multiply, and divide) is battery operated on four conventional AA cells. In continuous use, the batteries will last about 11 hours; with intermittent duty, about 14 hours. No decimal point—either fixed or floating—is provided. However,



when performing division, the numbers displayed in the answer are the nearest whole-digit figures, while decimal figures are displayed by depressing the shift key. For all other arithmetic operations, the decimal point is located by interpolation. The readout indicators are 7-segment miniatures.

Circle No. 71 on Reader Service Card

BROWNING MARK III SSB CB BASE STATION

The new Mark III SSB transmitter from Browning Laboratories provides top-notch AM performance plus pure single sideband with 15 watts peak-to-peak input. The 8-step crystal lattice



filter is designed to provide up to 80-dB rejection of the unused portion of the channel to develop maximum voice power. Adjacent channel rejection and sensitivity are high—permitting tuning to very weak signals.

Circle No. 72 on Reader Service Card

E.S. JOHNSON CASSETTE CABINETS

E.S. Johnson Co., Inc., has announced the availability of two cassette cabinet models for luxurious storage of cassette tapes. The design of the units make them ideal for use in the home, office, or school. The cabinets have formed acrylic smoked gray dust covers and side plates of high-impact styrene plastic with wood-grain styrene inserts. The Model CC-12 holds 12 cassettes, while the Model CC-24 holds 24 cassettes in stepped fashion.

Circle No. 73 on Reader Service Card

PERCY HARMS AEROSOL CLEANER

A new aerosol cleaning fluid has been developed by Percy Harms Corp. for use in and on electronic equipment. The cleaner is specially designed to clean without any deleterious effects on plastic, rubber, or painted surfaces. Called Slide-Electronic Contact Cleaner, it will remove oils, greases, fingerprints, dirt, waxy deposits, etc., without leaving a residue. It provides a constant source of clean solvent for selective delivery to chosen areas to be cleaned. It can be used on circuit boards, tape heads, switches, tuners, motors, and other precision components and equipment.

Circle No. 74 on Reader Service Card

TDK CHROMIUM-DIOXIDE TAPE CASSETTES

The first chromium-dioxide cassettes to embody the reliability and quality assurance of TDK design and construction were announced recently by TDK Electronics Corp. The TDK Krom-0₂ cassettes are recommended only for use on those recorders specifically designed to match the characteristics of CrO₂ tape. On such equipment, the TDK Krom-0₂ cassettes will establish new performance standards with respect to frequency response, signal-to-noise ratio, distortion, and output uniformity. High frequency output in the range between 10 kHz and 15 kHz is about 9 dB higher than

with conventional ferric-oxide cassettes. Signal-to-noise ratio is improved by 3 dB or better.

Circle No. 75 on Reader Service Card

KOSS INTRODUCES "HEAR-THROUGH" PHONES

For those listeners who want the full sound reproduction of fine stereo headphones but also desire to hear some outside noises, Koss Corp. has introduced a new concept in high-velocity, micro-weight headphones. The Model HV-1 phones provide wide-range, extended bass sound reproduction while allowing the listener to hear noises such as a telephone or doorbell. A high-velocity driver element is featured in each earcup; it was specially developed by Koss to achieve lighter weight without sacrificing high performance standards. The Model HV-1 phones weigh only 9 ounces.

Circle No. 76 on Reader Service Card

MOBILE SSB ANTENNA FROM SWAN

The first mobile single-sideband antenna that automatically adjusts to the frequency selected by the radio operator has been announced by Swan Electronics. Designated the Model 55B antenna, it has a motor drive control unit that remotely stops at the selected switch position. According to Swan, one antenna can service five ham bands and tune to them automatically. With a high-Q coil, the new antenna will not heat up during operation or tune-up. It

operates on a 1000-watt peak envelope power rating with an unbreakable Lexan ceater post. The antenna covers the 10-, 15-, 20-, 40-, and 75-meter amateur bands and can be used on surface vehicles, mobile homes, trailers, and boats.

Circle No. 77 on Reader Service Card

ADVENT STEREO CASSETTE PLAYER

The Advent Model 202 is the first stereo cassette player to incorporate the Dolby System of noise reduction and is the first device to exploit the full potential of cassettes as a



uniquely convenient, flexible high-performance playback medium. In addition to the Dolby System, the Model 202 incorporates low-noise wideband electronics, quality transport mechanism with inaudible wow and flutter, and

**The most important accessory
for your tape player/recorder**

**THE AMPEX
STEREO TAPE
CATALOG
Volume 2 yours
FREE**

It's all here... the most complete selection of pre-recorded stereo tapes ever put between two covers... for your open reel, 8-track cartridge or cassette player-recorder.

This entertainment guide lists over 5000 selections and 140 labels. Pop, rock, folk, soul, jazz, classical and spoken word selections too; all categorized by type of music and listed alphabetically by artist for easy reference. Remember... the harder they are to get the easier they are to find in the Ampeg Stereo Tape Catalog. A must for the serious enthusiast.

Get yours today! For your free copy send 50¢ for postage and handling now! Someone beat you to the coupon?

Write AMPEX, 2201 Lunt, Elk Grove Village, Illinois 60007, Dept. A-228.

AMPEX
2201 Lunt, Elk Grove Village
Illinois 60007
Attention: Dept. A-228.

Gentlemen: Please send me your free 1972 Ampeg Stereo Tape Catalog. I enclose 50¢ for postage and handling.

My Tape preference is:

Open Reel Cassette 8-Track

Name _____

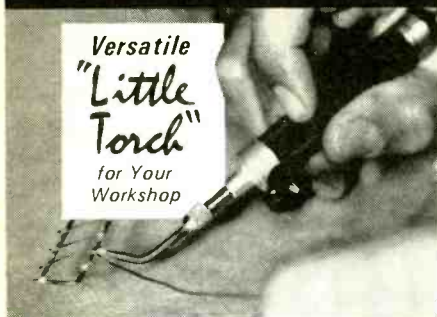
Address _____

City _____ State _____ Zip _____

CIRCLE NO. 3 ON READER SERVICE CARD

NEW!

Versatile
"Little
Torch"
for Your
Workshop



An amazing new miniature torch brazes, welds, solders and heats with surprising precision. You solder any appliance electrical part. You weld auto parts, braze household devices and toys easily, with professional accuracy, at half the normal cost. The Little Torch welds any size metal from tiny .002" wire to 16 gauge steel. Is economical to use, easy to operate—an invaluable addition to your home and workshop tools. Send for your FREE brochure telling all about the Little Torch, today.

Tescom
CORPORATION

Instrument

(U.L. APPROVED)

DEPT. 12-33

2600 NIAGARA LANE NO., MINNEAPOLIS, MINN. 55441

CIRCLE NO. 41 ON READER SERVICE CARD

Special New Digital Multimeter Kit
3½ Digits—Volts—Ohms—Current—Capacity
Introductory Price
Under \$90

**TREMENDOUS SAVINGS
ON PC KITS!**

Mod.	5	5V Power Supply	5.00
"	12AV	12V " "	5.20
"	15AV	15V " "	5.20
"	125	Nixie & IC Pwr Supply	8.00
"	13	Time Base Generator Crystal Controlled	12.00
"	7K	Decade Counter Kit With 8754-0-9 Without Latch	7.00
"	8K	Same as above With Latch	8.00
"	19K	Decade Resistor Box Kit—4 Decades 1 to 11,111 Ω	14.95

Send For Free Flyers On Linears,
Readouts, Resistors & Other Bargains

DIODES

1N4148	100 for 3.00
1N4001	60 for 3.00
1N4004	40 for 3.00
1N4007	20 for 3.00
1N4729A	15 for 3.00
1N4734A	15 for 3.00

Min. order \$3.00. On orders less than \$10.00 enclose .50 for postage and handling. Send check or M.O.

EDWARDS ELECTRONICS

The John Edwards Electronics Co.
P.O. Box 465, Glen Ellyn, Ill. 60137

CIRCLE NO. 45 ON READER SERVICE CARD

special playback equalization to take full advantage of chromium-dioxide tapes. The Model 202's technical specifications are extremely impressive for a cassette player.

Circle No. 79 on Reader Service Card

MARANTZ LOW-PRICED STEREO RECEIVER

The new Marantz Model 2010 AM/stereo FM receiver delivers 20 continuous watts at all frequencies between 40 Hz and 16,000 Hz into 8-ohm speaker loads. IM distortion and THD are typically 0.5 percent at full rated



output. The receiver has tape monitoring for a three-head tape deck, switching for main and remote speakers, loudness and FM muting switches, separate bass and treble tone controls, slide-type balance control, and a phone jack. An illuminated dial pointer backs up the black-out dial which is set into a gold-anodized front panel.

Circle No. 80 on Reader Service Card

MOODY MACHINE PRODUCTS SCREWDRIVERS

Moody Machine Products Co., Inc., is offering a small high-quality No. 52 utility screwdriver set for use by hobbyists and do-it-yourselfers. The set contains six interchangeable screwdriver blades in sizes 0.025", 0.040", 0.055", 0.070", 0.080", and 0.10". Each blade is made of hardened nickel plated tempered tool steel. The set comes with a securely locking chuck-type handle with a swivel top and a knurled grip. The blades and handle fit neatly into a pocket-size plastic case.

Circle No. 81 on Reader Service Card

NU-CONCEPT DTL/TTL TESTER

A rugged pocket-size digital test probe, the "Dy-Nos-Stick," marketed by Nu-Concept Computer Systems, Inc., enables service personnel and design technicians to trace elec-



POPULAR ELECTRONICS Including Electronics World

tronic logic quickly and simply and to diagnose digital malfunctions. The probe contains color-coded lamps which indicate logic levels. A memory feature which detects pulses as low as 3 ns in duration permits the tester to be used unattended. A gating feature allows the probe tip to be activated only when an auxiliary lead is in the selected logic state.

Circle No. 81 on Reader Service Card

JERROLD ALL-CHANNEL ANTENNA AMPLIFIER

A new two-receiver antenna signal amplifier—the Model TA-82 Colorcaster II—which amplifies all vhf and uhf TV and FM broadcast signals is available from Jerrold Electronics. Its gain at each output is stated as 8 dB in the vhf-TV and FM broadcast bands, and 5 dB in the uhf-TV band. The Colorcaster II's input and output impedances are nominally 300 ohms, providing for a quick match to commonly used twin-lead cable. The response of the amplifier is said to be flat within 0.5 dB/channel, while isolation between outputs is stated at not less than 15 dB.

Circle No. 82 on Reader Service Card

REALISTIC DOLBY CASSETTE TAPE DECK

Dolby noise reduction circuitry is featured in Radio Shack's new Realistic Model SCT-6 stereo cassette tape deck for "at home" recordings that are said to be as good as professionally made tapes. During playback of Dolby-ized tapes, the built-in Dolby system



reduces the noise introduced by the recording process and at the same time provides truer high-fidelity reproduction than is possible through conventional tape recording processes. A tape bias switch on the SCT-6 permits the use of either standard or chromium-dioxide tape formulations.

Circle No. 83 on Reader Service Card

SBE ANNOUNCES NEW HAM TRANSCEIVER

A new uhf amateur receiver designed for operation in the 420- to 450-MHz band was recently announced by Linear Systems, Inc., with the advance information on their Model SB-450. The SBE SB-450 comes equipped with two crystals already installed for operation on two of the 12 channels allotted.

Circle No. 84 on Reader Service Card

AT LAST! PROFESSIONAL HOME PROTECTION EVERYONE CAN INSTALL AND AFFORD.

Model FC-100
\$69.95
WIRED



- Start your custom Burglar/Hold-up/Fire Alarm System with the FC-100. Add on Sensors, Alarms and Accessories to suit your own needs.
- "Do-it-Yourself" Installers Handbook included. No technical knowledge needed — No soldering.
- 100% Professional in Design, Reliability, Performance.



'Fail Safe'-SYSTEM BY EICO

A New Concept in "Do-it-Yourself" Home Protection

FREE 32 PAGE EICO CATALOG

For latest catalog on EICO Test Instruments, Stereo, EICOCRAFT Projects, Environmental Lighting, Burglar/Fire Alarm Systems, and name of nearest EICO Distributor, check Reader Service Card or send 25c for First Class mail service.



EICO, 283 Malta Street, Brooklyn, N.Y. 11207

CIRCLE NO. 17 ON READER SERVICE CARD

Now... the most enjoyable, do-it-yourself project of your life—a Schober Electronic Organ!



You'll never reap greater reward, more fun and proud accomplishment, more benefit for the whole family than by assembling your own Schober Electronic Organ.

You need no knowledge of electronics, woodwork or music. Schober's complete kits and crystal-clear instructions show you — whoever you are, whatever your skill (or lack of it) — how to turn the hundreds of quality parts into one of the world's most beautiful, most musical organs, worth up to twice the cost of the kit.

Five superb models, with kit prices from \$500 to around \$2,000, each an authentic musical instrument actually superior to most you see in stores.

Get the full story FREE by mailing the coupon TODAY for the big Schober color catalog, with all the fascinating details!

The Schober Organ Corp., Dept. PE-46
43 West 61st Street, New York, N. Y. 10023

- Please send me Schober Organ Catalog.
 Enclosed please find \$1.00 for 12-inch L.P. record of Schober Organ music.

NAME _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____

CIRCLE NO. 35 ON READER SERVICE CARD

NEW GIFT IDEA!

WAHL "ISO-TIP" Cordless SOLDERING IRON

Give the
greatest
advance
in soldering
since
electricity!



"Iso-Tip" cuts soldering free from cord and plug! Solders up to 100 joints on a battery charge. Heats in 5 seconds. New working freedom at work, home or in the field! Complete with charger. See your electronic wholesaler or order direct. Model No. 7500 \$19.95

WAHL® CLIPPER CORPORATION

2902 Locust Street • Sterling, Illinois 61081
(815) 625-6525

"Manufacturing excellence for over 50 years"

CIRCLE NO. 44 ON READER SERVICE CARD



*New low cost digital multimeter \$299

- 26 ranges to measure ac/dc voltages from 100 microvolts to 1200 V, ac/dc currents from 100 nanoamperes to 2 amperes and resistance from 100 milliohms to 20 megohms.
- Guaranteed to stay within specifications for one full year. Fluke gives you the best specs and strongest warranty on the market today for the lowest cost of ownership ever.
- Wide choice of options including rechargeable battery pack, digital printer output, deluxe test leads, high-voltage probe, RF probe, 200-amp ac current probe, carrying case, dust cover and rack mounts.
- Unique self-zero feature eliminates offset errors.
- Rugged high-impact case with securely mounted internal electronics.
- Service centers throughout U.S., Canada, Europe and Far East for 48-hour turnaround repairs.



P. O. Box 7428,
Seattle, Washington 98133.

Get all the details from your nearest Fluke sales office. Dial toll-free 800-426-0361 for address of office nearest you.

CIRCLE NO. 46 ON READER SERVICE CARD

110



Electronics Library

BASIC ELECTRONIC INSTRUMENT HANDBOOK

edited by Clyde F. Coombs, Jr., et al.

As the editor points out, this is not a book about "measurements" but an attempt to give the reader a clear understanding of the instruments themselves and how they work together. Instruments covered range from ac and dc voltmeters and ammeters to counters, frequency analyzers, function generators, and waveguide devices. In all cases, theory of operation and typical uses of the instruments are given.

Published by McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020. Hard cover. 800 pages \$28.50.

99 WAYS TO IMPROVE YOUR SHORTWAVE LISTENING

by Len Buckwalter

Divided into ten sections, each of which deals with a particular phase of shortwave listening, this book covers antennas and their installation, receivers, accessories, listening techniques, special signals and frequency bands, interference sources, troubleshooting tips, etc. Supported by numerous photographs and line illustrations, it is easy to understand and should be a good source of information for the newcomer to SWL'ing, the established hobbyist, or the technician.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN46268. Soft cover. 144 pages. \$3.95.

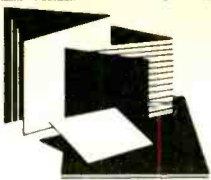
MODERN SOUND REPRODUCTION

by Harry F. Olson

Written for the layman as well as the engineer or technician, this book describes the newest and most important elements, systems, and accessories used in high-quality sound reproducing. It highlights such things as the effects of electrical and acoustical noise; quadraphonic sound reproduction on magnetic tapes and discs; theory and performance of transistor and integrated circuit audio amplifiers; and the modifications and embellishments that are used to heighten the impact of recordings.

Published by Van Nostrand Reinhold Co., 450 W. 33 St., New York, NY 10001. Hard cover. 328 pages. \$17.50.

POPULAR ELECTRONICS Including Electronics World



New Literature

SUPEREX STEREOPHONES CATALOG

Listed and fully described in the new No. 5733 catalog from Superex are the company's entire line of stereo headphones ranging from top-of-the-line electrostatic and dynamic types to budget-priced dynamics. Also listed are a compact stereo amplifier and accessories such as a headphone volume control box with extender cord, 20' and 15' extender cords, ear cushion covers, and a control box for amplifiers and receivers that do not have headphone jack outputs. Address: Superex Electronics Corp., 151 Ludlow St., Yonkers, NY 10705.

PEARCE-SIMPSON CB RADIO CATALOG

Antennas and antenna mounts and mobile and base-station transceivers for the CB'er as well as a 144-175-MHz scanning monitor receiver and a 146-148-MHz, 25-/1-watt ham transceiver are described in a new catalog available from Pearce-Simpson. The catalog gives complete specifications and price information for all listings. Address: Pearce-Simpson, P.O. Box 800, Biscayne Annex, Miami, FL 33152.

PIONEER SPEAKER SYSTEMS DATA SHEET

A full-color brochure which employs photos, text, technical specifications lists, and graphs to describe the R Series speaker systems can be obtained from Pioneer. Described in detail are the company's Model CS-R700 system employing a 12" woofer and horn-type mid-range and tweeter drivers in a three-way arrangement; Model CS-R500 system employing cone-type woofer and midrange speaker and horn-type tweeter in a three-way set-up; and the Model CS-R300 two-way system employing cone-type drivers. Address: U.S. Pioneer Electronic Corp., 178 Commerce Rd., Carlstadt, NJ 07072.

FIRST ANNUAL OLSON CATALOG

Olson Electronics has published its first annual catalog. Featuring products of many major brands, as well as their own brand names, it includes audio components, CB equipment, TV, kits and hobby items, antennas, tools and hardware, parts, tubes, and books. Olson will continue to publish tabloids to supplement the catalog. Address: Olson Electronics, 260 S. Forge St., Akron, OH 44327.



12 REASONS YOUR CAR NEEDS TIGER CDI

Instant starting in any weather - Eliminates tune-ups - Increases gas mileage - Increases horsepower 15% - Improves acceleration and performance - Spark plugs last up to 70,000 miles - Reduces engine maintenance expense - Amplifies spark plug voltage to 45,000 volts - Maintains spark plug voltage to 10,000 RPM - Reduces exhaust emissions - Dual ignition switch - An Unconditional LIFETIME GUARANTEE - Installs in 10 minutes on any car with 12 volt negative ground - No rewiring - Most powerful, efficient and reliable Solid State Ignition made.

SATISFACTION GUARANTEED or money back.
TIGER 500 assembled \$49.95
TIGER SST assembled 39.95
TIGER SST Simpli-Kit 29.95
 Post Paid in U.S.A.

Send check or money order with order to:

Tri-Star Corporation

Dept. W, P. O. Box 1946
 Grand Junction, Colorado 81501

DEALER INQUIRIES INVITED

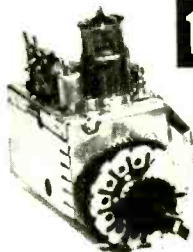
Circle No. 43 on Reader Service Card

TUNER SERVICE

VHF, UHF, FM or IF Modules . . .

Fast **8** hr. Service!
 . . . All Makes

1 YEAR GUARANTEE



VHF-UHF-FM	\$ 9.95
UV-COMB.	\$16.95
IF-MODULE	\$12.50

Major Parts charged at Net Price
 P.T.S. is overhauling more tuners for more technicians than any other tuner company in the world!

LIKE TO DO IT YOURSELF?
 Send one Dollar (redeemable) for our 60 pages of top information

TUNER REPLACEMENT GUIDE AND PARTS CATALOG

For fastest service, send faulty tuner with tubes, shields and all broken parts to:

PTS ELECTRONICS, INC.

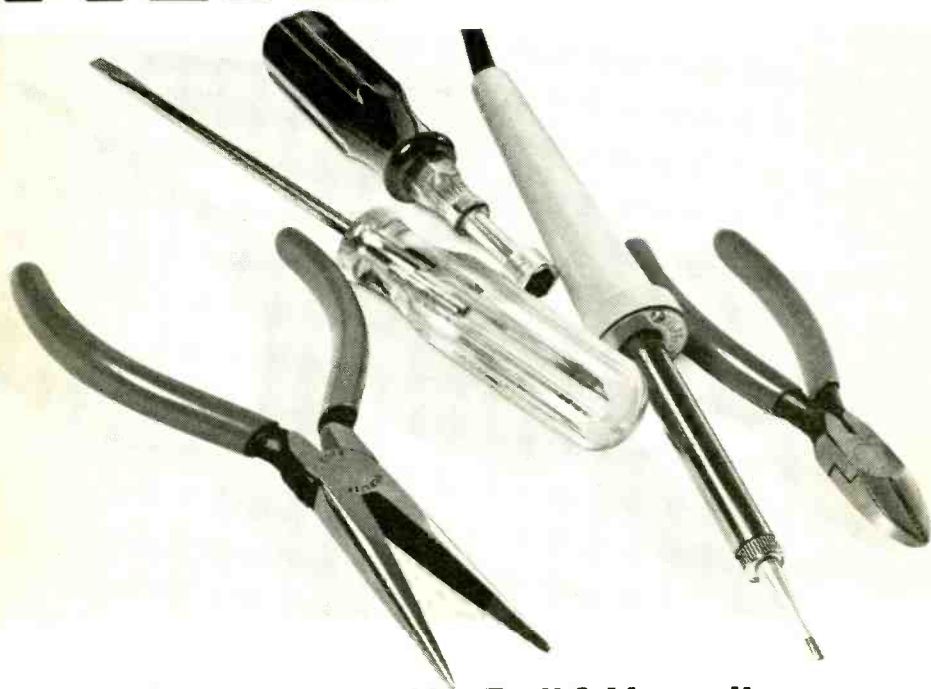
"Precision Tuner Service"



HOME OFFICE—
 Box 272 • Bloomington, Ind. 47401 • Tel. 812. 824-9331
WEST—
 Box 41354 • Sacramento, Calif. 95841 • Tel. 916. 482-6220
SOUTH—
 Box 7332 • Longview, Tex. 75601 • Tel. 214. 753-4334
SOUTHEAST—
 Box 6887 • Jacksonville, Fla. 32205 • Tel. 904. 389-9952
EAST—
 Box 3189 • Springfield, Mass. 01103 • Tel. 413. 734-2737
MOUNTAIN—
 Box 4245 • Denver, Colo. 80204 • Tel. 303. 244-2818

Circle No. 29 on Reader Service Card

IF YOU CAN USE ANY OF THESE TOOLS...



...you can build yourself a Bell & Howell
solid state 25-inch color TV...

and maybe
build a whole
new future
while you're
at it!



Try it. Build this beaut of a color TV yourself. You'll enjoy the personal satisfaction—especially if you're already handy with a set of tools. And you'll pick up a pretty thorough knowledge of home entertainment electronics along the way.

Who knows? Maybe that's your bag. Maybe you'll find yourself enjoying the process of building your color TV as much as the end result. If you do, you've got a heck of a career opportunity waiting for you in a big, booming industry: home entertainment electronics. You might even end up with a business of your own in color TV servicing.

Fix stereo systems . . . FM-AM radios . . . phonographs . . . tape recorders

Even if you're not interested in a full time electronics career, you can earn extra money part time—or else just enjoy electronics as a hobby. With your new skills, you can build and service stereo hi-fi systems—including FM-AM radios . . . phonographs . . . open reel tape recorders and cassette or cartridge player/recorders. You could even build yourself a complete "home entertainment communications center"—complete with the new gadgetry of cartridge television when it comes out. The skills you build up by following this brand-new program are more than enough to service almost any type of home entertainment electronic device.

Not just a "kit"—a complete at-home learning program in home entertainment electronics systems

Don't confuse this program with an ordinary hobby kit. It's much more than that. It's a complete at-home learning program prepared by skilled instructors at Bell & Howell Schools. You're getting as much as the guy who's planning a lifetime career in electronics—even if you're not planning a career yourself.

Follow simple, step-by-step instructions

It doesn't matter if you've never had any training in electronics before. Nobody's going to start throwing "diodes" and "capacitors" at you right off. You start with the basics. You take it one step at a time. You walk before you run. And you'll be amazed at how quickly you start to feel comfortable with things that seemed complicated at the beginning.

Attend special "help sessions" if you like

In case you should run into a sticky problem or two—one that you can't handle on your own—come in and see us. We've scheduled help sessions every few Saturdays at the Bell & Howell Schools and in many other cities throughout the U.S. and Canada. Drop by. Meet an expert instructor in person. Talk over any rough spots with him—and with other students. You'll enjoy the chance to "talk shop".

Master the most up-to-date solid state circuitry

Solid state is here to stay. Not just color TV but almost every type of electronic device will eventually move farther and farther in the direction of total solid state circuitry. Get to know the most advanced "trouble-shooting" techniques for these sophisticated circuits. You'll find an almost irresistible demand for your skills.

Why you should know electronics

No matter where you look, the amazing technology of electronics is becoming a bigger and bigger part of the picture. More and more automotive parts and diagnostic instruments are electronic. Many large manufacturing plants are controlled almost entirely by electronic systems—in the hands of a few skilled

electronics technicians. The increasing use of two-way radio . . . the huge promise of cable television . . . the astonishing growth of electronic data processing all open doors to exciting new career opportunities for the man with thorough training in electronics. In fact, the day may come when the man who does *not* have electronics skills will be severely handicapped in many industries.

So maybe you're *not* planning a career in electronics. It still makes sense to get the kind of know-how that may turn out to be indispensable in a lot of *other* career areas—like medical research, broadcasting, engineering, business management, construction and many more.

Why you should get your training from Bell & Howell Schools

Skilled instructors at Bell & Howell Schools—carefully selected for their knowledge, experience and teaching ability—plan each program with the utmost care and attention. Each year, they spend over \$200,000.00 improving programs and materials and keeping them in step with new developments in electronics.

Many thousands of people have used their Bell & Howell Schools training as the foundation for new careers and businesses of their own in electronics. Even if all you want is an interesting hobby, you can hardly *help* becoming a skilled expert.

You build and keep the exclusive Bell & Howell Schools Electro-Lab®—a complete laboratory-in-the-home

To make sure you get practical experience with instruments used daily by professionals, in addition to the 25-inch color TV, you build and keep a Design Console, an Oscilloscope and a Transistorized Meter (see details at right). These are the three instruments you'll work with constantly—both during your program and thereafter.

CONSIDER THESE ADVANTAGES:

Help Sessions We've scheduled "help sessions" every few Saturdays at the Bell & Howell Schools and in many other cities throughout the U.S. and Canada. Top instructors give you expert guidance and you meet other students, too.

Resident Study After you complete your program, you can transfer to any of the resident schools for more advanced study, if you wish.

Lifetime National Placement Assistance When you complete your course, we help you locate a position in the field of Electronics that fits your background and interests. This unique service is available at any time after you graduate.

Veterans' Benefits We are approved by the state approval agency for Veterans' Benefits. Check the box for details.

Student Financial Aid We are an eligible institution under the Federally Insured Student Loan Program. Check the box for details.

Build yourself a big, beautiful, solid state Bell & Howell 25-inch color TV. It may be the start of something even bigger.



Detach postage-paid reply card below and mail today for free information about . . .

■ **Bell & Howell Solid State 25-inch color TV** Ultra-rectangular 315 sq. inch screen lets you view more of the image. 25,000 volts . . . 46 transistors . . . 57 diodes . . . 4 IC's with another 54 transistors and 15 diodes . . . 3 stage solid-state, high-gain IF . . . 24 channel detent UHF/VHF power tuning . . . varactor UHF tuner . . . automatic fine tuning.

■ **Design Console** Use this to rapidly "breadboard" circuits without soldering. Equipped with built-in power supply . . . test light . . . speaker . . . patented plug-in modular connectors.

■ **Oscilloscope** Portable 5-inch wide-band oscilloscope offers bright, sharp screen images . . . calibrated for peak-to-peak voltage and time measurements . . . 3-way jacks for leads, plugs, wires.

■ **Transistorized Meter** Combines most desired features of vacuum-tube voltmeter and quality multimeter. Registers current, voltage and resistance measurements on a large, easily-read dial. Features sensitive, 4-inch, jewel-bearing d'Arsonval meter movement.

For Free Information, Mail Card Today!

If card has been removed, write:

DeVRY INSTITUTE OF TECHNOLOGY

ONE OF THE



BELL & HOWELL SCHOOLS

4141 Belmont, Chicago, Illinois 60641

333R2

TV kit not available in Canada

Popular Electronics

INCLUDING **Electronics World**

INDEX VOLUMES 1 AND 2 JANUARY-DECEMBER 1972

AUTOMOTIVE

Anti-Collision Systems for Autos (Holder)	48 Oct.
Auto Battery Voltage Monitor (Morris)	58 Aug.
Solid-State Electronics for the New Cars, More (Drummond) (Part 1)	63 Jan.
Solid-State Electronics for the New Cars, More (Drummond) (Part 2)	78 Apr.
Vehicle Alarm System (DiElsi)	51 June

COMMUNICATIONS

Amateur Station Helps Land Two Aircraft	46 July
Canada's New Voice on Shortwave (Wood)	44 Apr.
Chasing DX on the FM Band (Wood)	40 May
Class "E"—CB of the Future?	37 Feb.
Communications on a Light Beam (Heiserman)	34 Apr.
Communications Satellites (Buckwalter)	28 Mar.
Crystal-Controlled Musical Instrument Tuner, Build a (Olson)	55 Dec.
Directory of Mobile CB Transceivers (Houck)	26 Aug.
Public Weather Broadcasts from Coast to Coast (Granoff)	42 May
Receivers for the Shortwave Listener (Part 1) (Hirsch)	28 Nov.
Receivers for the Shortwave Listener (Part 2) (Hirsch)	49 Dec.
Report on Proposed Class "E" CB Band (Humphrey)	67 Dec.
What Do Hams Do? (Waters)	66 Mar.

CONSTRUCTION

Aquarium Heater Control for Fish Fanciers (Donkin)	70 Sept.
Constructing PC Boards (Sullivan & Brodsky)	34 Sept.
Contact Protects Panel Markings (Kunc)	72 Sept.
Decid-o-tron, Build the (Newmire)	96 Nov.
Differential-Temperature Basement Ventilator (Ashe)	31 July
Digital Logic Trainer, Build a (Cazes)	42 Sept.
Distortionless Preamplifier, Build a (Bongiorno)	58 June
Electro-Chemical Hygrometer (Giannelli)	33 Oct.
General-Purpose Alarm, Build a (Brown)	64 Sept.
Head 'N' Tails (Crawford)	35 Jan.
Intrusion Alarm, Infrared (Olson)	51 Mar.
Light Minder (Erst)	91 Sept.
PC Market, A Look at the (Burawa)	46 Jan.
Pest Control, Electronic (Greenlee)	47 July
Sound-Activated Photoflash Attachment (Leshkowitz)	74 Dec.
Speed Timer for Model Cars, Build a (Harms)	43 Nov.
Steam Whistle, Electronic (Simonton)	51 May
Strobe Cube, Build a (Shaw)	54 Nov.
Surf Synthesizer, Build the (Simonton)	45 Feb.
SW Converter, A Simple (Lisle)	96 Mar.
Synthesizer, Four-Channel (Bongiorno)	32 May
Touch-Plate Power Switch (Nunley)	50 Aug.
Transistor Power Supply, Inexpensive (Tooker)	35 May
Transmitter for the Neglected Band (White)	58 Jan.
Tuner for the Neglected Band (White)	68 Feb.
Zener Diode Substitution Box, Build a (Sula)	36 Oct.
3.6-Volt IC Power Supply Regulator (Fred)	42 Apr.

DEPARTMENTS

Editorial (Snitzer)	
Popular Electronics—Including Electronics World	16 Jan.
New Developments in Audio	6 Feb.
Parts for Construction Projects	6 Mar.
Digital Circuits and Modules for the Consumer	6 Apr.
Hearing Aids and Hi-Fi	6 May
Engineering Enrollments Down Sharply	6 June
The IEEE Show Was Down to Earth	6 July
Apollo Without Electronics	6 Aug.
The New/Com Show	6 Sept.
The Hi-Fi Power Rating Hassle	6 Oct.
Electronics in the Kitchen	6 Nov.
Video Cartridges, Cassettes, and Compatibility	6 Dec.
Out of Tune	
Pioneer PL-12A Record Player (Jan. '72)	8 Feb.
VHF Frequency Converter (Dec. '71)	8 Feb.
Build a 175-MHz Prescaler (Apr. '72)	89 July

EDUCATION

Education and Opportunities (Heiserman)	107 Sept.
Guide to Home Study Education in Electronics, A (Frenzel)	48 Sept.

ELECTRONIC MUSIC

Add a Compression Amplifier to your Electronic Organ (Rohen)	105 Dec.
Art and Technology of Electronic Music, The (Heiserman)	40 Feb.
Optimum Fuzz Adapter, Build the (Anderton)	34 July

FEATURES

Alpha Brain Waves & Biofeedback Training (Waite)	33 Dec.
British Radars for Pleasure Boats (Englert)	40 July
Color Code Charts	12 Aug.
Computer Core Memories Still Handmade	49 Feb.
Electronic Security Systems (Frye)	28 Sept.
Electronics at Disney World (Lacy)	44 Aug.
Electronics Monitors Hospital Patients (Bukstein)	34 Nov.
End of an Era, The	16 Mar.
Field Service Representative, The (Kallis)	62 Aug.
Hawaii's Tallest Towers	84 May
Industrial Robots, A Look at (Lacy)	48 May
Jobs for Lasers (Collins)	47 June
Kodak Enters Video Recorder/Player Market	46 June
Medical Electronic Equipment and Hospital Safety (French)	32 Jan.
Medical Electronics Technician, The (Holmgren)	103 Oct.
Minicomputers—What They Are and What They Can Do (Heiserman)	32 June
Novel Use for LED (McMahan)	47 Sept.
Nuclear Radiation—Insidious Polluter (Belt)	26 Feb.
PA Sound Systems (Sumburg)	43 Oct.

Quiz, Ganged Switching (Balin)	63 Apr.
Test Your Knowledge of Semiconductors (Shippee)	53 Aug.
Treasure Detectors for Land Use (Lawrence)	52 Sept.
Underwater Treasure Detectors (Lawrence)	60 Oct.

HI-FI/STEREO

Bass Reflex Enclosures the Easy Way, Build (Weems)	32 Sept.
Cassette Tapes, Performance Tests of (Hirsch)	28 Apr.
4-Channel Universal Decoder, Build a (Nichols)	28 Dec.
Comeback of the Bass Reflex (Weems)	49 Nov.
Crystal-Controlled FM Tuner Design (Peter)	51 July
Dolby Technique for Reducing Noise, The (Horowitz)	31 Aug.
Four-Channel Cartridge Tape Players, Survey of (Hirsch)	26 May
Four-Channel Sound (Cawfield)	26 June
Growth of CBS SQ—A Status Report	65 Nov.
Hi-Fi Headphones, How to Use (Ashe)	76 July
Hi-Fi Loudspeakers: Facts & Fallacies (Part 1) (Brociner)	40 Aug.
Hi-Fi Loudspeakers: Facts & Fallacies (Part 2) (Brociner)	60 Sept.
How Good are Cassettes? (Maynard)	8 Oct.
How to Select a Cassette Recorder (Hirsch)	12 July
Labyrinth Speakers for Hi-Fi (Weems)	40 Jan.
Legal Booby Traps in Tape Recording (Lincoln)	12 June
Outdoor Hi-Fidelity Loudspeaker Roundup (Hirsch)	26 July
Reel-to-Reel Tape Recorder, How to Select a (Hirsch)	47 Mar.
TV Antenna, Choosing a (Belt)	42 Feb.

NEW DEVELOPMENTS IN ELECTRONICS

Acoustic Microscope, An	42 Oct.
Airborne Test Antenna, New	62 Jan.
Army Buys Tactical Landing System	51 Jan.
Automated Radiological Diagnosis System	97 Jan.
Battery-Powered Locator Beacon for Aircraft	34 Aug.
Earth Station for Satellite Experiments	33 Apr.
First American-Made Quartz Watch	46 Mar.
Laser Holograms Speed Computer Parts Analysis	49 Apr.
Laser Machining Produces Electronic Circuits	30 Aug.
Liquid-Core, Low-Loss Optical Fiber	59 July
Luggage Inspection System	37 Oct.
Mobile Teleprinter System for Law Enforcement	72 Oct.
New Hologram Crystals Permanently Store Images	77 Aug.
New IR Laser Communicator	98 Mar.
New Thermal Viewer Has Civilian Uses	40 June
Radio Emergency Call Boxes	54 Dec.
Satellite Pictures Show Earth's Resources	68 Nov.
Selectavision Magtape System	48 Nov.
Solid-State Radiographic Screens	35 Aug.
Rechargeable Alkaline Battery, The (Milbourne)	104 Nov.
Transparent Ceramics for Electro-Optics (Hey)	63 Oct.

PRODUCT TEST REPORTS

A. A. E. Model T-101 Transistor Tester	88 Dec.
Advent 201 Cassette Tape Deck	76 Feb.
Advent Loudspeaker, The Smaller	62 May
Ampex AX-300 Tape Recorder Deck	64 Apr.
Audiotest Model 30-5104 Speaker System	77 June
Bilectro "One Hander" Soldering Tool	80 Jan.
Bird Ham-Mate 4350 R-F Wattmeter	84 Aug.
Dual Model 1218 Automatic Turntable	78 Sept.
Dynascan Cobra 130 CB Transceiver	82 Aug.
E. F. Johnson Messenger 124-M CB Transceiver	82 Mar.
Eico EC-4700 4-Channel Stereo Adapter	79 Feb.
Eico Solid-State Model 239 FET VOM	84 Jan.
Eico SS-500 Security Alarm System	86 Aug.
Electra Bearcat III Monitor Receiver	84 Oct.
Estes Transroc Radio Control Transmitter	69 May

Heathkit AR-1500 AM/Stereo FM Receiver	80 Dec.
Heathkit IM-102 Digital Multimeter Kit	68 July
Heathkit IO-103 And IO-105 Triggered-Sweep Oscilloscopes	80 Aug.
Heathkit MI-101 Digital Depth Sounder	71 Apr.
Heathkit Model CO-1015 Ignition Analyzer	86 Oct.
Heathkit Model IC-2008 Digital Calculator	82 Sept.
Hitachi IA-1000 Integrated Stereo Amplifier	73 Aug.
Hobby Hill Conduct-0-Tape	71 July
James Model C-7835 Intrusion Detector	84 Sept.
JFD Stellar-2001 All-Channel TV Antenna	88 Feb.
Kikusui ORC-27A Audio Signal Generator	88 Mar.
Koss KRD-711 Red-Dieal Stereo Headphones	82 Feb.
Koss Model K2+2 Quadraphonic Headphones	82 Oct.
Kurz-Kasch Auto-Probe	82 June
Kurz-Kasch LP-520-GM Logic Probe	86 Dec.
Lafayette LA-44 Four-Channel Stereo Amplifier	78 Mar.
Lafayette RK-48 2/4-Channel Cartridge Tape Player	76 Jan.
Lafayette SQ-M 4-Channel Decoder	84 Dec.
Leader Instruments TV Field Strength Meter	80 June
Leader LS-5 Electronic Oscilloscope Switch	85 Feb.
Lee Model EC Signal-Tracing Probe	86 Nov.
Midland 13-873 SSB/AM Transceiver	80 Feb.
Mura Therym Temperature Probe	81 June
Pace 100-S CB Transceiver	66 July
Pearce-Simpson Cougar 23 CB Transceiver	84 Nov.
Pioneer PL-12A Record Player	78 Jan.
Production Devices Model 85 Transistor Tester	83 Sept.
Rectilinear III Lowboy Speaker System	78 Oct.
Rotel Model RA-610 Stereo Amplifier	80 Oct.
SBE "Catalina" 23-Channel CB Transceiver	82 Jan.
Sencore CG-22 Color-Bar Generator	87 Dec.
Sencore Color Model CG159 Generator	86 Jan.
Sencore FE160 Senior Field Effect Multimeter	90 Mar.
Shure M688 Stereo Microphone Mixer	64 July
Shure V-15 Type II (Improved) Stereo Phono Cartridge	80 Mar.
Signal Science Whistle Switch	91 Mar.
Simpson 229 AC Current Leakage Tester	70 Apr.
Simpson 460 Digital VoltOhmmeter	84 Feb.
Simpson Model 260 Series 6 VOM	68 May
Suporex Model FF-1 Headphones	64 May
Suporex Model PEP-77D Electrostatic Headphones	82 Nov.
Teac Model AT-100 Stereo FM Tuner	78 Nov.
Techniques 5200 Negative Art Kit	66 May
Telex Model CS-7 Communications Headphones	76 June
TFE Model PP-1A Step Generator	81 Nov.
Tram Titan III AM/SBB CB Transceiver	68 Apr.
Triplet Model 603 Solid-State VOM	80 Sept.
Triplet Model 990 Maintenance In A Case	78 June
Toyo CH-702 2/4-Channel Cartridge Tape Player System	77 Jan.
Utah Studio 4 Four-Channel Adapter	66 Apr.
Wahl ISO-Tip Cordless Soldering Iron	70 July
Weston 1250 Digital Frequency Counter	84 Mar.

TELEVISION

Cable TV—Where It Is & Where It's Going (Belt)	26 Jan.
Color TV Projection System	35 June
Digital Logic Tunes TV Receivers	60 Nov.
Identification by Instant Replay TV	90 Sept.
Multiset Coupling Systems for your TV Antenna (Wolf)	28 Oct.
New IC's and Circuits for Color TV	50 Feb.
New In-Line Color Tube Simplifies Convergence	86 Sept.
Play Electronic Tag on Your TV (Anderson)	61 Nov.
Solid-State TV Camera Sensor	55 Mar.
Squaring Off on Two Solid-State TV Cameras	66 Oct.
TV Signal Splitter (Lewart)	83 June
What's Different About Japanese Color TV? (Belt)	46 Apr.

What's in a Color-TV Signal (Belt)	44 Dec.
X-Rays from TV No Longer a Hazard	35 July

TEST EQUIPMENT

Audio Level Meter, Build an (Milbourne)	104 Dec.
Digital Volt-Ohmmeter Plug-In Module (Meyer)	60 Mar.
Impedance Meter, Build an (Rakes)	68 Oct.
Linear-Scale Ohmmeter, A (Beene)	45 May
Preamplifier for Your Scope, A (Gorgenyi)	47 Aug.
Precision Lab Power Supply (Ball)	32 Feb.
Power-Line Booster/Reducer (Tooker)	62 Oct.
Rise-Time Measurements (Herzog)	60 Aug.
Semiconductor Curve Tracer, Build a Versatile (Keith)	41 June
Signal Difference Stereo Balance Meter, Build a (Laughlin)	50 Apr.
Slow Turn-On Protects Power Supply (Tooker)	73 Sept.
Tach-Dwell Meter (Olsen)	42 Nov.
Wheatstone Bridge, Inexpensive (West)	34 Mar.
175-MHz Prescaler, Build a (Meyer)	53 Apr.

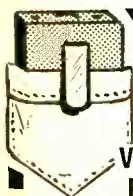
THE SCENES

Communications Scene (Humphrey)	
Incentive Licensing For Hams: Progress or Discrimination?	52 Jan.
Case For a National CB Organization, The	64 Feb.
Marine Gear Windfall For Hams	100 Mar.
Nicholas Johnson of the FCC	96 Apr.
Harbor Police: Communications Afloat	68 June
Automatic Identification of Transmitters	65 Aug.
New Regulations and the Marine Radio Technician	96 Sept.
Search and Rescue Network	100 Oct.
Communications Scene (Parrish)	
Scanners For Monitoring VHF & UHF	102 Nov.
Mac's Service Shop (Frye)	
Radio Interference: Causes & Cures	94 Jan.
Getting the Most from Your Service Dollars	102 Feb.
TVI From the Victim's Viewpoint	70 Mar.
Meter Accuracy Specifications	60 Apr.
Versatile Pocket Calculator, A	58 May
Single Sideband for the CB'er	64 June
Salvaging Ducked Radios	60 July
Shelf Life of Capacitors and Batteries	68 Aug.
New Breed of Test Equipment	87 Sept.
Electronics and Car Thievery	88 Oct.
Philosophy of a Kit Manufacturer	88 Nov.
New TV Antenna, A	90 Dec.
Solid State (Garner)	102 Jan.
Stereo Scene (Holt)	
How Good Need a Turntable Be?	7 Jan.
Basic Hi-Fi Trouble-Shooting	10 Feb.

Tracking Distortion in Phono Cartridges	10 Mar.
The Battle of the Tapes	10 Apr.
Choosing the Stereo System That's Right For You	10 May
Choosing the Sound You Want	14 Aug.
The Discrete Quadraphonic Disc	12 Sept.
Connections & Interconnections— Keeping Things Straight	10 Nov.
Galaxy of Gadgets, A	12 Dec.
Surplus Scene (Burawa)	
Today's Surplus Dealers	116 Jan.
Solid-State Parts Market, The	118 Mar.
Small-Parts Market, The	97 June
More Companies To Get Acquainted With	97 July
In The Battle For First Place, The Buyer Wins	97 Aug.
What's Available In Test Equipment	117 Sept.
Get To Know Your Dealers	117 Oct.
Realistic Look At The Mail-Order Business, A	117 Nov.
New York's Walk-in Dealers	119 Dec.
Television Scene (Belt)	
New Color Sets and Programs	112 Jan.
Trinitron—Still A Mystery?	94 Feb.
RCA Toes the Color Line	76 May
Picking A Good TV Man	78 July
Test Equipment Scene (Prentiss)	
Why Triggered Sweep Oscilloscopes?	68 Jan.
Test Equipment Scene (Solomon)	
VOM's, VTM's and TVM's	114 Mar.
Digital Instruments: What, Why and Who	84 June
Vectorscopes For Showing Color TV Angles	82 July
Probes For Servicing	100 Sept.
Power Supplies—Power To The Circuit	96 Oct.
Sine Waves and Scopes	98 Nov.
Semiconductor Testing	100 Dec.

TUTORIAL

Ampere's Law (Heiserman)	98 Dec.
Analog Logic (Hannas)	82 Apr.
Controlling DC Motors (Fleming)	36 Mar.
Field-Effect Transistor, The (Shippee)	76 Aug.
Flip-Flop with Op Amps (Garland)	58 July
Fuses for Electronics (James)	43 July
How and Why of the SCR, The (Wujek)	69 Nov.
How Much Current is Fatal?	31 Jan.
Nuclear Radiation & Detection (Part 1—Types of Radioactivity) (Eilo)	53 Oct.
Nuclear Radiation & Detection (Part 2—Radioactivity Detectors) (Eilo)	66 Nov.
Nuclear Radiation & Detection (Part 3—Radiological Survey Meters) (Eilo)	62 Dec.
Ohm's Law, The Origin of (Heiserman)	46 May
Simple Solid-State Circuits for the Experimenter (Huffman)	66 Sept.
Solid-State Receivers, Fundamentals of (White)	58 Feb.



SONAR PAGE

VOICE and TONE POCKET PAGER

Model SP 2518 **\$265.00**
FCC Type Accepted
under part 15, subpart C

The SONAR PAGE is complete with a 110VAC charger, operating frequency crystal, two precision tone reads and plug in earpiece. Less Battery.
Nickel Cadmium Battery \$10.00 ea.



FOR BUSINESS MEN • HOSPITAL PERSONNEL • DOCTORS • SALESMEN • SERVICEMEN • PROFESSIONAL HELP • EXECUTIVES • POLICEMEN & FIREMEN
A basic necessity that has become indispensable to the man on the move. SONAR PAGE adds hours of productivity and eliminates costly delays. SONAR PAGE instantly locates and directs specific messages to you. SONAR PAGE can reach you whether you are indoors, outdoors, or in your car.
• Designed for total large city coverage • Small, lightweight and comfortable to wear (only 7 oz.) • Works in difficult noisy weak fringe areas • Greater battery life • Crisp, "Voice Fidelity" Audio • "False-Proof" tone decoding • Non-Directional "Hi-Q" Antenna eliminates dead spots • Compatible with existing two-tone sequential VHF systems.

SONAR RADIO CORP., 73 Wortman Ave., Brooklyn, N.Y. 11207
Please send me information on SONAR PAGE. Dept. 750

Name _____
Address _____
City _____ State _____ Zip _____

CIRCLE NO. 39 ON READER SERVICE CARD

POPULAR ELECTRONICS Including Electronics World



Surplus Scene

By Alexander W. Burawa, Associate Editor

NEW YORK'S WALK-IN DEALERS

THERE was a time—and not too long ago, either—when hobbyists, experimenters, and hams could take New York City's subway downtown, get off at Canal or Cortlandt Street, and be in the heart of Surplus Row. Now, the situation has changed drastically. Forced out by the World Trade Center complex, many dealers have been forced to relocate, while a few have abandoned the scene altogether.

Where once Cortlandt Street used to be Surplus Row, no surplus dealers now exist. The situation is basically the same on Vesey Street. But Canal Street is holding its own; perhaps because it is too far uptown to be in the way of "progress." Be that as it may, not even Canal Street has even a ghost of a resemblance to old Surplus Row.

On the south side of Canal is Richman Electronic Trading Corp. (380 Canal St., New York, NY 10013), which deals in all types of electronic devices, including test instruments, parts, 7400 series digital and 700 series linear IC's, and even kits. Under the last heading, they have a 0-9 decimal counting unit kit which retails for \$7.00. It includes a Nixie® readout tube with socket, circuit board, and three IC's (7441, 7445, and 7490). By the time this column appears, Richman will be well into the mail-order business.

At 32 Canal St. is American Surplus Trading Co. While they are in the mail-order business, they deal mostly with companies in need of sophisticated radar, communication, test equipment gear, etc. However, they do have a walk-in section where customers can buy anything in stock from radar equipment to grab-bag specials on components.

On the north side of the street, there are Omnibus Electronic Industries, Inc., (383 Canal) and Charles Rosen Communication

Equipment Co., Inc. (343 Canal). Omnibus is primarily an outlet for sophisticated, used test equipment, but they also have a large, diversified stock of transistors and diodes, RTL, TTL, and linear IC's, and standard components and hardware. They do mail-order business and will send a large current flyer on request.

Charles Rosen handles nothing but parts and communication equipment. He has pulled out of the mail-order business and is now strictly a local walk-in. He is one of the casualties of the tight-money situation. Says Mr. Rosen, "The equipment just isn't there." Which means that since government has been economizing, little in the way of communication gear is being dumped on the surplus market.

Still in the downtown area of Manhattan is Cortlandt Electronics Inc. (16 Hudson St., New York, NY 10013). They're in the kit business, too, with an inventory of 25 different kits available. In addition, they are big on solid-state components and fluorescent and gas-discharge alpha-numeric readout devices.

For our last entry, we had to travel up to the Midtown area to drop in on Advance Electronics Co. (54 West 45 St., New York, NY 10036) where we were met with a real surprise. From having dealt (anonymously, of course) with Advance for many years, we were prepared to find the usual stock of surplus test equipment, parts, and chassis. However, here too, we also found them in the kit business. For example, they are currently marketing a complete 20-MHz (with 50-100-MHz option built in) 5-digit frequency counter kit for about \$150. Advance is a mail-order company which, in addition to their inventory of test gear, is a supplier of transistors, RTL and TTL digital IC's, and 741 Op-Amp IC's. ♦

ELECTRONICS MARKET PLACE

NON-DISPLAY CLASSIFIED: COMMERCIAL RATE: For firms or individuals offering commercial products or services, \$1.50 per word (including name and address). Minimum order \$15.00. Payment must accompany copy except when ads are placed by accredited advertising agencies. Frequency discount: 5% for 6 months; 10% for 12 months paid in advance. **READER RATE:** For individuals with a personal item to buy or sell, \$1.00 per word (including name and address. No minimum! Payment must accompany copy. **DISPLAY CLASSIFIED:** 1" by 1 column (2 1/8" wide), \$185.00. 2" by 1 column, \$370.00. 3" by 1 column, \$555.00. Advertiser to supply cuts. For frequency rates, please inquire.

GENERAL INFORMATION: First word in all ads set in bold caps at no extra charge. All copy subject to publisher's approval. All advertisers using Post Office Boxes in their addresses **MUST** supply publisher with permanent address and telephone number before ad can be run. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st). Send order and remittance to Hal Cymes. **POPULAR ELECTRONICS** Including **ELECTRONICS WORLD**, One Park Avenue, New York, New York 10016.

FOR SALE

FREE! bargain catalog. Fiber optics, LED's, transistors, diodes, rectifiers, SCR's, triacs, parts. Poly Paks, Box 942, Lynnfield, Mass. 01940.

GOVERNMENT Surplus Receivers, Transmitters, Snooper scopes, Radios, Parts, Picture Catalog 25¢. Mesnna, Nahant, Mass. 01908.

ROCKETS: Ideal for miniature transmitter tests. New illustrated catalog, 25¢. Single and multistage kits, cones, engines, launchers, trackers, rocket aerial cameras, technical information. Fast service. Estes Industries, Dept. 18-D, Penrose, Colorado 81240.

LOWEST Prices Electronic Parts. Confidential Catalog Free. **KNAPP**, 3174 8TH Ave. S.W., Largo, Fla. 33540.

ELECTRONIC PARTS, semiconductors, kits. **FREE FLYER**. Large catalog \$1.00 deposit. **BIGELOW ELECTRONICS**, Bluffton, Ohio 45817.

ABOUT YOUR SUBSCRIPTION

Your subscription to **POPULAR ELECTRONICS** is maintained on one of the world's most modern, efficient computer systems, and if you're like 99% of our subscribers, you'll never have any reason to complain about your subscription service.

We have found that when complaints do arise, the majority of them occur because people have written their names or addresses differently at different times. For example, if your subscription were listed under "William Jones, Cedar Lane, Middletown, Arizona," and you were to renew it as "Bill Jones, Cedar Lane, Middletown, Arizona," our computer would think that two separate subscriptions were involved, and it would start sending you two copies of **POPULAR ELECTRONICS** each month. Other examples of combinations of names that would confuse the computer would include: John Henry Smith and Henry Smith; and Mrs. Joseph Jones and Mary Jones. Minor differences in addresses can also lead to difficulties. For example, to the computer, 100 Second St. is not the same as 100 2nd St.

So, please, when you write us about your subscription, be sure to enclose the mailing label from the cover of the magazine—or else copy your name and address exactly as they appear on the mailing label. This will greatly reduce any chance of error, and we will be able to service your request much more quickly.

WE SELL CONSTRUCTION PLANS. **TELEPHONE:** Answering Machine, Speakerphone, Carphone, Phonevision. Auto Dialer, Touch Button Dialer, Central Dial System. **TELEVISION:** \$35.00 Color Converter, Video Tape Recorder. \$25.00 Camera. **HOBBYIST:** Electron Microscope, 96 Hour Tape Music System, Ultrasonic Dishwasher, Radar-Oven. Plans \$4.95 each. **NEW ITEM:** Electronic Pocket Calculator, \$7.50. **COURSES:** Telephone Engineering \$39.50. Detective Electronics \$22.50, Integrated Circuit Engineering, \$49.50. **NEW SUPER HOBBY CATALOG** plus year's subscription to **Electronic New Letter AIRMAILED \$1.00**. Don Britton Enterprises, 6200 Wilshire Blvd., Los Angeles, Calif. 90048.

RADIO—T.V. Tubes—35¢ each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

CONVERT any television to sensitive, big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans. \$2.00. Relco-A33, Box 10563, Houston, Texas 77018.

MECHANICAL, ELECTRONIC devices catalog 10¢. Greatest Values—Lowest Prices. Fertik's, 5249 'D', Philadelphia, Pa. 19120.

SENCORE, B&K Test Equipment Unbelievable Prices. Free Catalog and Price Sheet. Fordham Radio, 265 East 149th Street, Bronx, N.Y. 10451.

METERS—Surplus, new, used, panel or portable. Send for list. Hanchett, Box 5577, Riverside, CA 92507.

PYROTECHNICAL chemicals, casings, tools, supplies, fuse, literature. Giant, illustrated catalogue/handbook includes formulas, instructions—50¢, with samples—\$1.00. Westech, Box 593, Logan, Utah 84321.

BUILD YOUR OWN SPACE-AGE TV CAMERA



ONLY KNOWN SOLID-STATE CAMERA KIT! Ideal for experimenters, home, education, industry, etc. * High quality * Backed by over six years of lab & field testing * Fully Guaranteed * Connects to any TV set without modification * Step-by-step construction manual * Model XT11A Series D complete with vidicon \$129.99 postpaid anywhere in USA & Canada (less vidicon tube \$115.99)

PHONE or WRITE for CATALOG.

DIAL 402-969-3771

Many other kits, parts and plans available including stereo kits, focus-calls, vidicon tubes, const. plans, audio subcarrier kit, etc.

1301 BROADWAY

ATV Research

DAKOTA CITY, NEBR. 68731

ELECTRONIC COMPONENTS—Distributor prices, Free catalog. Box 2581, El Cajon, California 92021.

ANTIGRAVITY, experiment and theory, Rushed—\$2.00. U.S. Inquiries. Intertech 7A3, Box 5373, Station-F, Ottawa, Canada.

JAPAN HONG KONG DIRECTORY. World products information. \$1.00 today. Sekai Shogyo Annai, Hillyard, Washington 99207.

EUROPEAN and Japanese bargains catalogs. \$1 each. Dee, P.O. Box 9308, North Hollywood, Calif. 91609.

BURGLAR Alarm Systems equipment, dealers and private. Write: United Security, Box 2428, Dublin, Calif. 94566.

FREE Catalog. Parts, circuit boards for Popular Electronics projects. PAIA Electronics, Box C14359, Oklahoma City, OK 73114.

50 MEGAHERTZ LOW COST COUNTER



Here is a new item, featured because of numerous customer suggestions.

We have taken the basic power supply, chassis and cover from our clock kit, and by substituting a new front panel and printed circuit board, have made a lowest cost frequency counter. The unbelievable low cost is due to our use of our large stock of unused surplus tubes, the new 74196 50 MHz decade counter, and the commonality of parts with our other kits. Readout is to six decades, time base is 1 second, 0.1 seconds, or external. Design is modular, for ease of construction, compactness, and expandability.

- 50 MHz six digit counter, using line frequency as time base, complete except for cover \$97.50
- Optional crystal controlled time base plug-in conversion \$23.50
- Cover, blue or black anodized \$ 4.50

BUILD YOUR OWN ELECTRONIC CALCULATOR FOR ONLY \$108.00!



A complete calculator kit, complete with self contained power supply and case, indispensable in the home, office or school. Simple enough for a child to build. Some of the features of the calculator are as follows:

- MOS Integrated circuits (extra large scale integrated) reduce the number of components to a minimum; for easy assembly • Displays eight digits on large size seven segment displays • Full function complementary keyboard features addition, subtraction, multiplication, division, alternate display, multiplication by a constant, clear all, clear entry, and decimal point set • Sixteen digit entry and sixteen digit results are possible with alternate display key • Leading zeros suppressed • Chain operation • All integrated circuits and displays are socket mounted and replaceable.

So reliable and simple to build, we can make this guarantee: If for any reason you cannot succeed in getting your calculator to function properly after completing construction, for a flat handling fee of \$10.00, B and F will repair and ship back your calculator anywhere in the USA. This applies regardless of the age of the assembler, barring gross negligence or the use of acid core solder in construction.

DIGITAL CLOCK KIT WITH NIXIE DISPLAY

We have well over 20,000 nixies in stock, and because of this bargain purchase we can sell a complete digital clock kit for less than the usual cost of the display tubes only. We provide

a complete etched and thru plated circuit board, all integrated circuits, complete power supply, display tubes, C, sockets, and a nice front panel with polished brass. We have never seen anyone offer this kit for less than \$100.00 before. Includes BCD outputs for use as a timer option. May be wired for 12 or 24 hour display. Indicates hours, minutes, seconds.

- Clock Kit, complete less outside cover \$57.50
- Aluminum blue or black anodized cover (specify) \$ 4.50

SHRINK TUBING SPECIAL. Assortment of 200 pieces of shrink tubing, diameter: 1/8" to 1/2", length 1/2" to 2". \$1.25 Price

KEYBOARDS



Three keyboards are available: 20 key calculator keyboard, 40 key alphanumeric, and 12 key touch tone. All have separate contacts carried out to edge connector.

- Touch Tone Keyboard \$ 9.50
- Calculator Keyboard \$14.50
- Alphanumeric Keyboard \$29.00

LIGHT EMITTING DIODE NUMERIC DISPLAY



This display is excellent for small portable electronics, such as DVM's, calculators, etc. Equivalent to Monsanto MAM 3A. Operates from 5 volts, 20 milliamperes, with 47 ohm dropping resistor. \$3.25 Each

- Complete counter kit, 7490, 7475 plus 7447, printed circuit board, lead readout \$9.50

LATEST HARD-TO-GET SEMICONDUCTORS

- M55 4988 silicon unilateral switch. Useful for voltage sensitive switch, sweep generators, etc. \$1.00
- M15 A64 PNP high current Darlington transistor. Super-high gain in small package. 2/51.00
- M15 A14, same as above, NPN. 2/51.00

THIS MONTH'S FEATURE ITEM

POCKET CALCULATOR KIT



This is the kit you have been waiting for. So compact it actually fits in a shirt pocket (3-13/16" x 4-5/8" x 1-1/4"). It performs every function you would expect in a desk calculator, including constant and chain operation, and full floating decimal. The unit is powered by self contained batteries, and uses 8 digit LED displays. The calculations are performed by a single 40 pin integrated circuit, which can truly be called large scale integration (LSI).

As a student, engineer, salesman, accountant, or anyone who would like fast accurate answers, this calculator fills the bill, and at a price that unquestionably makes this the lowest priced high quality calculator available.

Pocket Calculator Kit \$75.00

RECHARGEABLE BATTERY/CHARGER KIT

This option allows the throw away alkaline battery to be replaced with a nicad battery, and includes a charger to recharge this battery. The unit may be run during the recharge cycle.

Battery/Charger Kit \$17.50

LOGIC AND OPERATIONAL AMP SUPPLIES



- Figure A, potted logic supply, 5 Volts at 1 Ampere, short circuit proof, ultra high regulation, ultra low ripple \$16.00
- Figure A, potted Op Amp supply, +15 Volts, and -15 Volts at 0.5 Amperes. Mfg. by Analog Devices, similar to their model 902. Short circuit proof, ultra high performance \$29.00
- Figure B, 5 Volt 1 Amp supply, regulated by Fairchild 9205, short circuit protected. \$9.75
- Same as above, in kit form \$7.75
- Mating connector for above \$1.00
- 5 Volt 5 Amp regulated supply, by Blutryne, foot shown. \$29.00

LIGHT EMITTING DIODES

Monsanto MV 50 or equivalent LED's. Now less expensive than filamentary bulbs. At this price wire them into logic circuits as status indicators, build low cost counters or use them as panel lights. Rated at 10 - 40 MA @2V.

- 10 LED's \$3.00
- 100 LED's \$25.00
- 1000 LED's \$200.00

LOUDSPEAKER SYSTEM COMPONENT SPECIAL!!



We have made an excellent purchase of an excess inventory of a local manufacturer's speaker systems although we aren't allowed to mention the manufacturer's name, the specs should make it self evident. The woofer is a 12" free edge facioacoustic suspension unit, with voice coil and a 2 lb magnet. The mid-range is a 5" unit, and the tweeter is of the dome type, for best high frequency dispersion. Crossover between woofer and mid-range is by an R-L-C network, while high frequency crossover is by an R-C network. Balance controls are provided for both mid-range and tweeter. Plans for a suitable enclosure are provided.

- Speaker System \$29.00 ea / \$2 for \$55.00

CALCULATOR CHIP SPECIAL



B and F has purchased a quantity of MOS large scale integration chips for calculators. We are not allowed to mention the manufacturer's name, however, the specs should make them self-evident.

- Set "X" Four 21 pin I.C.'s, BCD output, 16 digit, fixed automatic decimal point, possible memory expansion constant \$29.00
- Set "Y" Single 40 pin, 7 segment output, 12 digit, fixed automatic decimal, no constant \$15.00
- Set "Z" Single 40 pin I.C., 7 segment output, 8 digit, floating point, constant \$19.50

LINEAR DEVICES, OP AMPS, REGULATORS

- 709 High performance Op-Amp \$ 5.50
- 711 Dual Comparator \$ 5.50
- 723 Regulator \$1.25
- 741 Compensated Op-Amp \$ 5.50
- 558 Dual 741 \$1.00
- LM309 5 Volt 1 amp Regulator, TO-3 \$2.25

FAIRCHILD VOLTAGE REGULATOR

Fairchild UGH7805 5 Volt 1 amp voltage regulator. Perfect for logic supplies, very compact. \$1.95

AIRCRAFT/AUTO/BOAT QUARTZ CRYSTAL CHRONOMETER



Revolutionary, was the reaction of our customers when they saw our latest kit. Measuring only 2-1/2" x 2-1/2" x 1", and accurate to 10 seconds a month, this chronometer promises to entirely replace mechanical clocks in cars, boats and airplanes.

Fits into a standard 2-1/4" instrument panel cutout. The displays are bright L.E.D. displays that should last a lifetime. Settle controls are recessed and operate from a pointed object such as a pencil point or paper clip, in order to keep non-authorized hands off. The clock should only have to be reset at very great intervals, or in the event of power loss (i.e. replacing battery in car). The clock is wired so that the timing circuits are always running, but the displays are only lit when the ignition is on, resulting in negligible power drain. The low price is only possible because of a new one chip MOS clock circuit, developed for quartz crystal wristwatches.

Operates from 10-15 Volts D.C. An accessory unit which mounts on the back adapts the unit to 20-28 Volts for twin engine aircraft and larger boats using 24 Volt ignition. Know how disgusted you are with the usual car clock? Order this fine unit now for rallying, sports events, navigation, or just to have a fine chronometer that will give you a lifetime of superbly accurate time.

- Quartz Chronometer, Kit Form \$59.50
- Quartz Chronometer, Wired \$99.50
- 24 Volt Adapter \$10.00

HIGH POWER SCR's



SCR's - invaluable for high power applications, motor speed controls, lighting circuits, welding controls, etc. Never before at this low price. Brand new, packaged devices, complete with data sheet and 24 page consumer applications manual.

- 2N5062 Plastic 100V 1 amp \$35
- 2N5064 Plastic 200V 1 amp 40
- 2N4169 100V/8 amp stud 1.45
- 2N4170 200V/8 amp stud 1.65
- 2N4172 400V/8 amp stud 1.95
- 2N3525 400V/3 amp press fit 65
- 2N1772/C15A 100V/8 amp stud 1.75
- 2N1774/C15B 200V/8 amp stud 1.95
- 2N1777/C15D 400V/8 amp stud 2.50
- 2N1844/C20A 100V/12 amp stud 1.75
- 2N1846/C20B 200V/12 amp stud 1.95
- 2N5169 200V/20 amp stud 3.75
- 2N5170 500V/20 amp stud 6.75
- 2N5171 700V/20 amp stud 6.75
- 2N3896/C30A 100V/25 amp stud 2.95
- 2N3897/C30B 200V/25 amp stud 3.95
- 2N3899/C30E 500V/25 amp stud 4.95

SANKEN HIGH POWER, HIGH PERFORMANCE HYBRID VOLTAGE REGULATORS

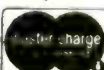


These hybrid regulators are easy to use, requiring no external components. Excellent for operational amplifier supplies, logic supplies, and other high performance applications. All regulators have less than 50 millivolts ripple and better than 1% line and load regulation, some models far exceeding this specification.

- S1320E 12 Volts, 1 Ampere \$2.25
- S1310E 15 Volts, 1 Ampere \$2.25
- S1320E 24 Volts, 1 Ampere \$2.25
- S1305E 5 Volts, 1 Ampere \$2.25
- S1335A 5 Volts, 3 Amperes \$7.00

ALL ITEMS WHERE WEIGHT NOT SPECIFIED

POSTAGE PAID IN THE U. S. A.
Phone in charges to (617) 531-5774 or (617) 532-2323.
BankAmericard - Mastercharge. \$10.00 minimum. No C.O.D.'s please.



\$10.00 Minimum Charge



B. & F. ENTERPRISES

Phone (617) 532-2323
P.O. Box 44, Nahorah, Massachusetts 01937

GET "Music Only" FM Programs. SCA Adaptor fits any FM tuner or receiver. Free list of stations with order. Kit \$14.50 (with Squelch \$19.50) Wired and Tested \$25.00 (with Squelch \$29.95). All plus postage and insurance. Thousands Sold. SWTPC, Box E32040, San Antonio, Tex. 78284.

FREE Kit Catalog: Shortproof powersupply \$39.50. Ultrasonic Alarm \$37.25. SWTPC, Box B32040, San Antonio, Tex. 78284.

FIRE & BURGLAR ALARMS

1972 Handbook & Catalog

Save Hundreds of Dollars

Learn the cost of Professional Alarm Equipment. Know how it is installed. Discover how you can save Hundreds-Of-Dollars by installing your own system. See the latest in technology such as LASER BEAMS, INFRARED BODY HEAT DETECTORS and ELECTRONIC SIRENS. 1972 "Handbook & Catalog", 84 pages, just \$1.00 postage and handling. \$1.00 is credited to first order.



ALARM COMPONENT DISTRIBUTORS

33 New Haven Ave., Dept. P.E., Milford, Conn. 06460

FREE Kit Catalog: Color Organs \$11.00. Psychedelic Strobes \$17.50. Professional quality-lowest prices. SWTPC, Box F32040, San Antonio, Tex. 78284.

TEST EQUIPMENT, Aerospace-Laboratory Grade. Request your needs; will mail appropriate catalogs (we have 24 catalog categories). Only for Engineers, Businesses, Schools and advanced Technicians. Goodheart, Box 1220PE, Beverly Hills, Calif. 90213.

AMATEUR SCIENTISTS, Electronics Experimenters, Science Fair Students . . . Construction Plans—Complete, including drawings, schematics, parts list with prices and sources . . . Robot Man—Psychedelic shows—Lasers—Emotion/Lie Detector—Touch-Tone Dial—Quadrasonic Adapter—Transistorized Ignition—Burglar Alarm—Sound Meter . . . over 60 items. Send 25¢ coin (no stamps) for complete catalog. Technical Writers Group, Box 5594, State College Station, Raleigh, N.C. 27607.

SURPLUS electronics for everyone. Free catalog. U.S. inquiries. ETCO, 464 McGill, Montreal, Canada.

ELECTROENCEPHALOPHONE: brainwave monitor. Professional feedback instruments. J&J, 8102-E, Bainbridge, Wash. 98110.

LATEST snooping countermeasures: Manual \$10.00. Negeye, Box 1036X, Anderson, Indiana 46015.

WE SELL CONSTRUCTION PLANS—gold recovery unit!—silver recovery unit—infra-red scope—x-ray fluoroscope—alternator adapter—200 watt inverter—electronic insect trap—burglar alarm system—chemical formulary (home products)—electro-plate—plans \$5.00—plus many more!—ask for FREE catalog—Creative Products, 1551 East Loop 820, Dept. E-1272, Fort Worth, Texas 76112.

DIAGRAMS—TV, Radio, etc. \$2.00. Techservas, Box 1167, Berkeley, Ca. 94701.

IN-PIANO humidity control system. Safe, fully automatic. Stops expensive piano problems. Hughes Electronics, Box 6487, Asheville, N. C. 28806.

AUTON for CHRISTMAS! New Principle Ignition AUTON ONE \$5.00, AUTON TWO \$11.00, AUTON THREE \$17.50. Postpaid, Guarantee, Information: Price Autonics, Box 1581B, National City, California 92050.

DIGITAL ELECTRONICS! Complete schematics, parts lists, theories—Discrete Component Digital Clock, \$3.00—Sound Sensitive Switch, \$1.50. Increase technical competence, hobby skills—Complete Course in Digital Electronics is highly effective, \$10.00. Limited—Clock plans included with Course! Free literature. DYNASIGN, Box 60A5, Wayland, Mass. 01778.

AUTOMOBILE BURGLAR SYSTEM with system connected even HOT-WIRING will not start motor, \$7.95 complete. Deluxe-Horn blows when ignition is on or HOT-WIRED \$12.95. VANSONS MFG. & SALES, 10175 Breidt, Tuijunga, Calif. 91042.

XENON Strobelight Flashtubes FT 106 50W \$2.50, 2/4, 10/\$16, 100/\$125. Plans 50¢. Mindlight, POB 2846PE, Van Nuys, California 91404.

ELECTRONIC IGNITION: Boosts Voltage. Only \$19.95. Box 2002, Huntington Beach, Calif. 92647.

A NEW INSTRUMENT TO USE WITH YOUR SCOPE



MULTITRACER

Use with your present Oscilloscope to trace Resistors, Capacitors, Transformers, Diodes, Transistors, Zeners, Triodes, most Semiconductors, IC's, etc. Also shows continuity, in-circuit and go/no-go checks. Complete with diagrams and instructions. No internal scope connections. For medium or small production runs or for hobbyist, experimenter, engineer, or ham.

ONLY \$19.95—CHECK OR MONEY ORDER

WHY PAY MORE?

BOX 14, LESCO ELECTRONICS, SKOKIE, ILL. 60076

ALPHA/THETA feedback instruments—\$25. Sensitive circuit of \$70 unit. Ultimate ease of use. Inner Space Electronics, Box 308PE, Berkeley, Ca 94701.

CONSTRUCTION PLANS: Laser . . . \$3.00. Missile Tracker . . . \$3.00. Catalog 25¢. ESP Experimenters Kit . . . \$3.00. Howard, P.O. Box 35271, Detroit, Michigan 48235.

ELECTRONIC ORGAN KITS, KEYBOARDS for music synthesizers and organs. Independent and divider tone generators, diode keyer systems. I.C. circuitry. Many components. 25¢ for catalog. DEVTRONIX ORGAN PRODUCTS, Dept. C, 5872 Amapola Drive, San Jose, Calif. 95129.

CORE MEMORY. 4K by 1 bit 2½ D Core Planes \$10.00, Driver Boards \$3.00 each. Other core stacks available, 3000 IC's \$250.00, and other computer parts. Please write your needs to: Computers, Box 27, Liberty, Ind. 47353.

FREE Catalog lists resistors, tubes, transistors, rectifiers, condensers, tools, tuners, etc. Hytron Hudson, Dept. PE, 2201 Bergenline Ave., Union City, N.J. 07087.

SCOPES, Counters, Meters, Bridges, Precision Instrumentation Components. Industrial and Government Surplus. G-R, Tektronix, H-P, Weston and others. Many "one of a kind" specials. Send name and address for free "Bargain Bulletins" to: Lawrence Instruments, P.O. Box 744, Sunbury, Pa. 17801.

CAPACITIVE DISCHARGE IGNITION IS HERE TO STAY ----- IT'S THE BEST!

Our CAPTRON compares feature by feature with all others. Don't buy a high priced limited production unit when our mass produced design sells for only \$29.95ppd. Completely assembled.

Order Today! from 12 volt negative 30 days if not satisfied | 12 volt negative ground only.

GENERAL ANALOG 3014F S. HALLADAY ST. DEPT C SANTA ANA, CALIF. 92705



HEAR Police/Fire dispatchers. Catalog of exclusive callbooks of "confidential" channels. Send 8¢ stamp. Communications, Box 56-PE, Commack, N.Y. 11725.

SOUND SYNTHESIZER kits—Surf \$11.95, wind \$11.95, wind chimes \$16.95, electronic songbird \$6.95, musical accessories, many more. Catalog free. PAIA Electronics, Box J14359, Oklahoma City, OK 73114.

CD IGNITION Systems. Wholesale. Southland, Box 3591, Baytown, Texas 77520.

PRINTED Circuit Boards solder plated Glass-epoxy; send negative; Preparation of tape-ups \$3.50 negatives \$4.50. Boards five sq. in. or larger \$.25 sq. in.; Min. order \$10. Discount on large quantities; General Printed Circuits, Box 4013, Downey, Calif. 90241.

UNIQUE electronic components. Free catalog. Chaney, Box 15431, Lakewood, Colorado 80215.

LIGHT EMITTING DIODES

FLV 100 VIS LED'S	\$.65
GaAs 1R LED'S	.65
MIRD 14B Photo darlington	.65

LSI CALCULATOR CHIP

A 40 Pin DIP unit that adds, subtracts, multiplies & divides. Used in a 12 digit calculator. 7 segment MOS levels. Data sheet included \$12.95

7400	.21	7475	.65
7401	.21	7476	.40
7402	.21	7480	.60
7404	.25	7481	1.10
7410	.21	7483	1.10
7413	.50	7486	.45
7416	.45	7490	.65
7420	.21	7492	.65
7430	.21	7493	.65
7440	.21	7495	.65
7441	1.00	74107	.45
7442	1.10	74121	.49
7445	1.10	74145	1.10
7447	1.10	74154	1.25
7448	1.10	74182	1.00
7450	.21	74192	1.60
7460	.21	74193	1.60
7472	.30	8570	1.50
7473	.40	8590	1.50
7474	.37		

7 segment 5V, 8 MA, 16 pin DIP display. 250,000 hrs. lifetime \$3.25.

TANTULUM CAPACITORS

4.7 MFD AT 20V	\$.5/\$1.00
10 MFD AT 20V	.4/\$1.00
4.7 MFD AT 100V	\$.50
11 MFD AT 100V	\$.75

2N3055 7 amp NPN Silicon Transistor	\$1.00
-------------------------------------	--------

TRANSISTOR SPECIALS

2N3584 NPN Si	TO-66	35W	250V	2A	10MHx100Hfe	\$1.50
2N965 PNP GE	TO-18	15W	7V	1A	300	40 \$1.00
2N1605 NPN GE	TO-5	15W	24V	1A	14MHx125	5 \$1.00
2N5324 PNP GE	TO-3	60W	250V	10A	20	35 \$1.50
2N2360 PNP GE	TO-33	06W	20V	05A	980	32 \$.50
2N1015DNPN Si	TO-82	150W	200V	7.5A	025	10 \$1.45
2N2015 NPN Si	TO-36	150W	50V	10A	012	26 \$.90
2N3724 NPN Si	TO-5	.8W	30V	1A	250	60 3/\$1.00
2N3772 NPN Si	TO-3	150W	60V	30A	2	30 \$1.25
2N6109 PNP Si	TO-220	36W	40V	4A	.8	60 50c
2N5296 PNP Si	TO-220	36W	40V	4A	.8	60 55c

*Match pair push pull amplifier

REGULATED POWER SUPPLIES MODEL SE904 SE902	FULL WAVE BRIDGES	
	PRV	2A 6A
Output Voltage (VDC)	-15	-15
Output Current (MA)	50	100
Line (105-125 VAC)	\$18.95	\$26.95
	200	.90 1.20
	400	1.10 1.40
	600	1.25 1.60

NE 565 PHASE LOCK LOOPS \$3.25

TEN TURN TRIM POTS
500 OHM, 10K, 20K, 25K, 50K \$.75
or 3 for \$2.00

14 Pin Dip Socket \$3.00
16 Pin Dip Socket \$5.00 ea.

TRIACS

PRV	1A	10A	15A	20A
100	.30	.60	.85	1.05
200	.65	.85	1.25	1.45
300	.75	1.10	1.45	1.65
400	.90	1.35	1.75	1.90
500	1.20	1.55	2.00	2.20

*Press Fit
TIS43 UJT's .50
2N3819 N Channel FET's .45
D13T PROC. UJT's .50

Silicon Power Rectifiers

PRV	1A	3A	12A	50A
100	.06	.09	.30	.85
200	.07	.16	.35	1.25
400	.09	.20	.45	1.50
600	.11	.30	.70	1.30
800	.15	.40	.85	2.30
1000	.20	.55	1.10	2.75

Silicon Control Rectifiers

PRV	6A	10A	20A	70A
100	.30	.45	1.00	3.50
200	.50	.75	1.25	6.50
300	.60	.90	1.50	
400	.70	1.10	1.75	9.50
500	.80	1.25	2.00	
600	.90	1.40	2.25	11.00

IN4886 POWER VARACTOR \$4.95

SCHOTTKY IC'S

74500	.95	74540	.95
74503	.95	74551	.95
74504	1.05	74573	1.15
74505	1.05	74574	1.75
74510	.95	745108	1.95
74511	.95	745112	2.25
74520	.95	745153	2.25
74522	.95	745157	2.25

DECADE COUNTER KIT

Consisting of:
1-Nixie tube & socket (8754)
1-7490
1-7475
1-7441
\$4.75

PA234 1 Watt Audio Amps	\$1.25
PA264 5 Watt Regulator	\$1.25
LM 309K 5V 1 Amp Regulator	\$2.25
709C OPER. AMP	\$.39
741 OPER. AMP	\$.39
748 Adjust 741	\$.44
Dual 709	\$.95
723 Regulator	\$.75
TVR-2002 high power 723	\$1.00

NIXIE TUBES

Similar to Raytheon 8754 long-life tubes, with socket & data sheet \$1.85

Terms: FOB Cambridge, Mass. Send check or Money Order. Include postage. Average Wt. per package 1/2 lb. No C.O.D.'s.

Minimum Order \$3.00
Rated companies 30 days net

Send \$.20 for our catalog featuring Transistors and Rectifiers: 325 Elm St., Cambridge, Mass.

SOLID STATE SALES

Post Office Box 74A

Somerville, Mass. 02143

Tel. (617) 547-4005

CIRCLE NO. 37 ON READER SERVICE CARD

MICROPHONES—Slightly Defective—need re-soldering mostly. Values up to \$20.00 each. Special: 3 microphones for \$9.95 ppd. Microphones, 4535 Huntington Dr. South, Los Angeles 90032.

BURGLAR-FIRE alarm supplies and information. Free catalog. Protecto Alarm Sales, Box 357-G, Birch Run, Michigan 48415.

SWL'S FREE antenna info, catalog of insulators, wire, coax, balun. Palomar Engineers, Box 455, Escondido, Calif. 92025.



HDE DIGITAL CLOCK Kit \$59.95

- With ALL parts & Pre-Finished Case
- Oiled Walnut/ Black Aluminum Case
- Compact — Only 3 1/2" x 3 1/2" x 7"
- LARGE 7-segment neon display
- EASY TO BUILD — illustrated step-by-step instructions — theory section
- QUANTITY DISCOUNT 10% off on 3

An ideal GIFT ITEM
Factory wired and tested — \$89.25 ppd.

All parts but set switches mount on 2 P. C. boards. Excellent construction manual and quality parts make assembly a pleasure. Add-on accessory modules available. Phone or write for FREE literature for more information on this 6-digit 1 C. clock kit along with other exciting new HDE digital kits. Electronic games - test equipment. Master Charge, Bank Americard or C.O.D. orders gladly accepted. Phone: (817) 731-1301

HDE Hunnicutt Digital Electronics, P. O. Box 9793, Ft. Worth, Texas 76107

MOVABLE CROSS-HATCH GENERATOR, Kit \$18.50. Kits featured in POPULAR ELECTRONICS and other magazines. Free Catalog. PHOTOLUME, Box 139, New York, NY 10016.

SEMICONDUCTOR SUPERMART—FREE CATALOG listing Motorola, RCA, Fairchild, National, HEP transistors and integrated circuits. Other components for building Popular Electronics projects. Circuit Specialists Co., Box 3047, Scottsdale, AZ. 85257.

WANT to build . . . Electromagnetic rocket? Lightning-Bolt generator? Plans \$2.00. Lasers, brainwave machine. Or Psychedelic items? Strobes, color organs, alpha inducers, trance lights. Or Ham equipment, CB gear, Hi-Fi, Stereo. Catalog of 100 plans, 50c. TA, Box 1266E, South Lake Tahoe, CA 95705.

TUBE TESTER

GOVERNMENT SURPLUS

MULTIMETER



TV-7 Tube Tester. \$59.95 Portable with carrying case. Dynamic Mutual Conductance Type.



ME-6D Multi-meter. \$37.50 Dual Scale 500 microvolts to 500 volts. RMS. Operates on 117 volts, 60 cycle, one phase.

Takes all standard base & sub-miniatures. Adapters available for 2C39, 4X4150, \$4.95 Ea.

For full details & Info: Write/Call:

ARTKO Corp. 6401 S. Tucson Blvd.

Tucson, AZ 85706, Dept. DH. Tel: (602) 295-7611

PLANS AND KITS

FREE Kit Catalog: Why does every major College, University, Technical School, Research & Development Center buy from us? Because we have the highest quality and lowest prices. Free catalog. SWTPC, Box H32040, San Antonio, Tex. 78284.

FREE Kit Catalog: Amazing new Universal Digital Instruments with plugins as featured in Popular Electronics. Unbeatable prices. SWTPC, Box D32040, San Antonio, Tex. 78284.

ANTIGRAVITY DEVICE. Brochure rushed free. AGD, Box 3062-ZD, Bartlesville, Oklahoma 74003.

AM CAR RADIO BOOSTER. FET Tuned RF amplifier for car radios or any AM radio. 30 DB gain. Plans \$3.00, Kit \$18.00, Wired \$29.95. Free literature. Check or M.O. R.R. Faulkner, Box 26, Redondo Beach, Calif. 90277.

FREE Kit Catalog: Digital Microlab \$29.95. Also Segmented and Nixie Readouts, Timebases, Scaler, Electronic Digital Clocks (all featured in Popular Electronics) SWTPC, Box C32040, San Antonio, Tex. 78284.

"DISTANCE Crystal Set Construction" Handbook—50¢. "Coil Winding"—50¢. Catalog 25¢, refundable. Laboratories, 1477-L, Garden Grove, Calif. 92642.

FREE CATALOG! Tremendous electronics bargains. Compukits, Box 4192H, Mountain View, Calif. 94040.

STEREO MULTIPLEX ADAPTER, Kit \$19.50, Op-Amp Circuit design Kit, \$10.00. Free Catalog. PHOTOLUME, Box 139, New York, NY 10016.

UNIQUE AND Unusual project plans. Super catalogs airmailed. Design Systems, Box 586, Endicott, New York 13760.

WANTED

QUICKSILVER, Platinum, Silver, Gold, Ores Analyzed. Free Circular. Mercury Terminal, Norwood, Mass. 02062.

QUICK CASH . . . for Electronic Tubes, Semi-Conductors, Equipment (Receivers, Transmitters, Scopes, Vacuum Variables etc.) Send Lists now! Write: Barry Electronics, 512 Broadway, New York, NY 10012. (212) 925-7000.

HIGH FIDELITY

DIAMOND NEEDLES and Stereo Cartridges at Discount prices for Shure, Pickering, Stanton, Empire, Grado and ADC. Send for free catalog. All merchandise brand new and factory sealed. LYLE CARTRIDGES, Dept. P, Box 69, Kensington Station, Brooklyn, New York 11218.

STEREO Components at lowest prices. Send for free catalog. Carston, Box 1094-A, Danbury, Conn. 06810.

FREE Kit Catalog. Amplifiers: Lil Tiger \$11.10, Universal Tiger \$30.00. Preamp \$44.50 (Featured in Popular Electronics) Mixer-6 Input \$13.75. SWTPC, Box A32040, San Antonio, Tex. 78284.

McGEE RADIO COMPANY
World's Best Selection of Speakers
Almost Every Size From 1½ to 18"
WOOFERS - TWEETERS - CROSSOVERS
MANY HIGH FIDELITY KITS.

McGee's Speaker Catalog
Sent Free Upon Request

NORELCO HI-FI SPEAKERS

An Added Full Line of Norelco Hi-Fi Speakers
For The System Builder

McGEE RADIO COMPANY,
1901 McGee Street PE,
Kansas City, Missouri 64108

ELECTRICAL SUPPLIES AND EQUIPMENT

PLATING Equipment. Portable Platers, Supplies and "Know-How." Build your own tanks for nickel, chrome, etc. Easy-to-install PVC liners. Rectifier components—all sizes. Schematics, parts lists, formulas, operating instructions for all plating. Guaranteed to save you 25%-75%. Some good units for sale. Write for details. Platers Service Company, 1511-PE Esperanza, Los Angeles, Calif. 90023.

TUBES

RADIO & T.V. Tubes—36¢ each. Send for free Catalog. Cornell, 4213 University, San Diego, Calif. 92105.

ELECTRONIC TUBES, Semiconductors, Equipment, Telephones, Public Address, Intercoms, CB, Walkie-Talkies, etc. Quality Merchandise Only! Serving Engineers, Purchasing Agents, TV/Hi-Fi Servicemen and Hams for 28 years. Domestic and Export. Write for Catalog or call (212) 925-7000. **BARRY ELECTRONICS**, 512 Broadway, New York, N. Y. 10012.

RECEIVING & INDUSTRIAL TUBES, TRANSISTORS. All Brands—Biggest Discounts. Technicians, Hobbyists, Experimenters—Request **FREE** Giant Catalog and **SAVE!** **ZALYTRON**, 469 Jericho Turnpike, Mineola, N.Y. 11501.

SAVE money on parts and transmitting-receiving tubes, foreign-domestic. Send 25¢ for giant catalog. Refunded first order. United Radio Company, 56-P Ferry Street, Newark, N.J. 07105.

TUBES "Oldies", latest. Lists free. Steinmetz, 7519 Maplewood, Hammond, Indiana 46324.

TUBES receiving, factory boxed, low prices, free price list. Transleteronic, Inc., 1306 40th Street, Brooklyn, N.Y. 11218A, Telephone: 212-633-2800.

TAPE AND RECORDERS

OLD Radio Programs on cassettes or reels. High quality, low prices, thousands to choose from, professional equipment, catalog 50¢. Remember Radio Inc., Box 2513, Norman, Okla. 73069.

RENT 4-Track open reel tapes—all major labels—3,000 different—free brochure. Stereo-Parti, 55 St. James Drive, Santa Rosa, Ca. 95401.

MEMOREX recording tape, audio & video lowest prices, write for free information. Bergetz Systems Co., Box 1181, Melrose Park, Ill. 60161.

SCOTCH MAGNETIC TAPE (USED)

#150, 1 mil polyester, 3600 ft. on 10½ in. fiberglass reels, used once, \$1.99; 1800 ft., 7 in. reels, 99¢—guaranteed to perform as good as new or money refunded. (Bulk, no box). Used 10½ in. fiberglass reels (small hole) 50¢. New hinged boxes: 10½ in., 39¢, 7 in., 9¢ (All plus postage by weight & zone)

SAXITONE TAPE SALES

1776 Columbia Rd., N.W. Washington, D.C. 20009



TOP 25 popular recordings each month on one stereo tape. Details free. Romar Sales, Box 204, New Milford, New Jersey 07646.

B-TRACK TAPES! Regularly \$6.98. Some as low as \$1. Choose from top names in Rock, Jazz, and Western, also Party tapes. Distributors inquiries invited. Send \$2 for a sample and list. Tape World, Dept. 11, PO Box 4119, Houston, Texas 77014.

BLANK 8-track tape cartridges, 1st line tape & cartridge, 25 to 60 minutes, \$1.75 each ppd., quantity discounts available, California residents add 5% tax. AUDIODYNE, P.O. Box 825, San Jose, California 95106.

REPAIRS AND SERVICES

TV Tuners rebuilt and aligned per manufacturers specification. Only \$9.50. Any make UHF or VHF Ninety day written guarantee. Ship complete with tubes or write for free mailing kit and dealer brochure. JW Electronics, Box 51C, Bloomington, Indiana 47401.

NEGATIVES FOR ETCHED CIRCUITS from this magazine or your 4x5 drawing \$1.00. C&F, 302 So. 12th, Newark, N.J. 07103.

Fall 15¢ Gate Sale:

FALL 15¢ GATE SALE

Here's how it works:

For every IC you buy from us at our regular low prices, you get to buy one of the following gates for 15¢ each.

7400, 7401, 7403, 7404, 7405, 7408, 7409, 7410, 7411, 7418, 7420, 7421, 7430, 7440, 7450, 7451, 7453, 7454, and 7460.

THIS OFFER GOOD UNTIL DECEMBER 31, 1972

Catalog Number	Qty. Quantity Per Item (10's)		Multiples of 10 Per Item (5's)		Catalog Number	Qty. Quantity Per Item (10's)		Multiples of 10 Per Item (5's)	
	100	1000	100	1000		100	1000	100	1000
7300	26	25	21	22	7190	1.89	1.79	1.68	1.47
7301	26	25	24	22	7191	1.89	1.79	1.68	1.47
7302	26	25	21	22	7196	1.98	1.87	1.76	1.54
7303	26	25	22	21	7197	1.62	1.51	1.41	1.29
7304	26	25	21	22	7197	1.62	1.51	1.41	1.29

Catalog Number	Qty. Quantity Per Item (10's)		Multiples of 10 Per Item (5's)		Catalog Number	Qty. Quantity Per Item (10's)		Multiples of 10 Per Item (5's)	
	100	1000	100	1000		100	1000	100	1000
7400	26	25	21	22	7400	1.11	1.08	1.02	.96
7401	26	25	21	22	7401	1.11	1.08	1.02	.96
7403	26	25	21	22	7403	1.11	1.08	1.02	.96
7404	26	25	21	22	7404	1.11	1.08	1.02	.96

Catalog Number	Qty. Quantity Per Item (10's)		Multiples of 10 Per Item (5's)		Catalog Number	Qty. Quantity Per Item (10's)		Multiples of 10 Per Item (5's)	
	100	1000	100	1000		100	1000	100	1000
7410	26	25	21	22	7410	1.11	1.08	1.02	.96
7411	26	25	21	22	7411	1.11	1.08	1.02	.96
7418	26	25	21	22	7418	1.11	1.08	1.02	.96
7420	26	25	21	22	7420	1.11	1.08	1.02	.96

TRANSISTORS & DIODES

IN270 .45 14 .13 .12 .11 .10
 IN2514 .30 .28 .26 .24 .22 .20
 IN9011 .10 .09 .08 .07 .06 .05
 IN9014 .10 .09 .08 .07 .06 .05
 IN4002 .11 .10 .09 .08 .07 .06

All IC's are supplied in R-11, -16, or 23-pin DIP (Dual in-line) plastic or ceramic package except for NE553, NE560, NE570, and NE580 which come in TO-9 package.

We give 1-2 data sheets upon request, so ask for these data sheets that you NEED, even for those listed below that you are not buying. (All orders over \$25.00 will send you one 270-page COMPLETE IC DATA BOOK FREE. All other orders over \$100.00 will send you one 270-page LINEAR DATA BOOK FREE. All other orders over \$500.00 will receive both books. Orders over \$1000.00 will receive a complete LIBRARY of DDD-21-A & LINEAR data & application books totaling 1,000 pages FREE. PLEASE NOTE: Data books are shipped separate from your order. Please allow two weeks for delivery.

UNIVERSAL DECADE COUNTING UNIT

1. Easy to read single plane LED or Filament-type Readout with built-in glow wiring.
2. 2800 Outputs, Broadcast Lamp Test, Ripple-Blanking and Counter-Reset are available.
3. 30-pin Module.
4. 100's Sockets for all IC's and Readout.
5. Top plated UL-90, Zinc Copper, Glass Epoxy Board.
6. 7-pin choice of 1 or 2 hole leads on one P.C. Board.
7. Grouping of 2 or more readouts on the same display board.
8. Display board mounted perpendicular to counter/divider board.
9. Uplink beam counting and counter preset functions available with 74192.
10. 60/300 typical cycle rate with 74196.
11. Up to 1000's of 1 or 2 hole leads on one P.C. Board.
12. Used in a series of 4 universal phase modules, for frequency counting, time measurements, event counting, TVM, magnitude comparison, etc.
13. I.C.'s, Boards only, are available for \$3.00 per decade.

Price (Per Decade):
 Basic Unit consisting of 74190, 74117, Filament-type 7-Segment Readout, \$9.00
 Options:
 For LED Readouts instead of Filament-type, add \$2.00
 For 7475 (later), add \$1.25
 For 74176 instead of 7490, add \$0.50
 For 74192 instead of 7490, add \$1.00
 For 74196 instead of 7490, add \$0.75
 For fully assembled and tested unit, add \$9.50



Large "N" 7-Segment LED Readout similar to the popular MAN-1 but with improved brightness. Has left-hand decimal point. Fits in a DIP-28 package. Expected life: Over 100,000. Regularly \$12.95 in quantity. This one BRAND NEW with full data sheet and Space-SAVING APPLICATION Note. Needs a 7417 for driver and DM-1 CURRENT LIMITING RESISTOR PER SEGMENT. We supply you with one of our thousand FROM STOCK. Also available: 10 OVERFLOW digit at the same price. Moving from Venus & Overflows digit allowed.

Package of 5, 1W Minimum Res. \$0.4

In-board type of 7-segment display. With right-hand decimal point. Rated by per segment at 110V supply at 5V. 10-seg life of 50,000 hours. Needs a 7417 as a driver to DIP package. Part # 8125.

MINI IC SOCKET PINS - for those economical pins instead of soldering onto IC to PCB boards. Sold in continuous strips in multiples of 100 pins only.
 100 to 200 \$1.00
 200 to 500 \$1.50
 500 to 1000 \$2.00
 1000 to 2000 \$2.50
 For \$1.20 per 1000 additional 1000's \$7.00
 For \$1.20 per 1000 additional 1000's \$7.50

ALL-RESISTOR 1/4 WATT 1% TOLERANCE 100% VALUES
 From 270 to 220K 1/4 WATT 1% \$9

ULTRAVIDE CAPACITORS - 50V 100V 1000V
 3.75, 10, 12, 15, 20, 22, 25, 27, 30, 33, 39, 50, 56, 68, 75, 82, 100, 120, 150, 180, 200, 220, 250, 270, 300, 330, 360, 390, 470, 500, 560, 600, 750, 820, 1000, 1200, 1500, 1800, 2000, 2200, 2500, 2700, 3000, 3300, 3600, 4700, 5000, 5600, 6000

100V 1000V 1000V 1000V
 0.01µF EACH 10¢
 0.02µF EACH 11¢
 0.05µF EACH 12¢
 0.1µF EACH 13¢
 0.2µF EACH 14¢
 0.5µF EACH 15¢
 1µF EACH 16¢
 2µF EACH 17¢
 5µF EACH 18¢
 10µF EACH 19¢
 20µF EACH 20¢
 50µF EACH 21¢
 100µF EACH 22¢
 200µF EACH 23¢
 500µF EACH 24¢
 1000µF EACH 25¢

VOLTAID REGULATORS - Internally short, overload and short-circuit proof regulators need no external components to set. With data sheet and application notes. TO-18 Package.
 LM317, 15V, 100mA \$2.85
 LM317C, 15V, 100mA \$3.85
 LM337, 15V, 100mA \$3.85
 20 Watt 100V Board Type HEAT SINK \$1.20

STANDARD PWRB-252-AT Lamp Transformer, Ideal for use with LM-series. Each \$1.00

QUANT. IN LINE	Wire-wrap Type	BRAND NEW	NEW with gold plated pins
1-999	100-210	250-999	1000-1999
11	PISS	0.10	0.25
12	PISS	0.75	0.85
		0.20	0.20
		0.60	0.95

ORDER DESK 1-800-325-2595 (TOLL FREE)

Solid State Systems, Inc. PHONE (314) 443-3673
 P.O. BOX 773
 COLUMBIA, MO. 65201 TWX 910-760-1453

FORMS RATED PERMITS 30 DAYS. Orders CHECK or MONEY ORDER with order. Add \$3.50 to orders under \$5.00 for postage & handling. For UPS or FIRST CLASS add 5¢ and for AIR MAIL add 6¢ for each order; we pay the balance. If you are served by UPS in your area, we strongly recommend this service with its built-in \$100 insurance. LED orders are FOB Columbia, with \$4.00 for additional. Canadian orders please add \$1.50 for INSURANCE.

MISSOURI RESIDENTS Please add 4% Sales Tax.

WRITE OR CIRCLE READER SERVICE CARD FOR OUR CATALOG OF PARTS & SERVICES. IT'S FREE.

COMPUTER BOARD MONTH



3 BOARD SPECIAL. 1 board loaded with DIP ICs, 1 with 2 to 5 trim pots, and 1 loaded with transistors. All have resistors, capacitors, diodes and much more.

STOCK NO.F9380 3 Boards \$2.00 9/5.00

LATE DESIGN BOARD



Contains SN7470, SN7400, SN15844 ICs, 4 2N4274, 1 2N4916, 1 2N4248, resistors, capacitors etc. NEW. STOCK NO.F9294 1.50 ea.

HONEYWELL, 4 1/2x12, ALL TIME FAVORITE

Filled with all types of parts. Transistors, diodes, zeners, heat sinks, trim pots etc. Many different styles. STOCK NO.9082
2 different boards \$1.00 12/5.00 25/10.00

Send for new 48 page catalog, loaded with new items. Please include sufficient postage. Excess will be refunded. MINIMUM ORDER \$3.00



DELTA ELECTRONICS CO.

BOX 1, LYNN, MASSACHUSETTS 01903
PHONE (617)-388-4705

CIRCLE NO. 13 ON READER SERVICE CARD

INSTRUCTION

LEARN ELECTRONIC ORGAN SERVICING at home all makes including transistor. Experimental kit—trouble-shooting. Accredited NHSC, Free Booklet. NILES BRYANT SCHOOL, 3631 Stockton, Dept. A, Sacramento, Calif. 95820.

LEARN WHILE ASLEEP, Hypnotize! Strange catalog free. Auto-suggestion, Box 24-ZD, Olympia, Washington 98501.

ASSOCIATE DEGREE IN ELECTRONICS through correspondence instruction. G.I. Bill approved. Free catalog. Grantham, 1509 N. Western, Hollywood, California 90027.

FCC First and Second Tests. \$8.95. Electronic Tutoring, Box 24190, Cleveland, Ohio 44124.

LOGIC trainers catalogs 50¢. UTI, POB 252, Waldwick, N.J. 07463.

EARN College Degrees at home. Many Subjects. Florida State Christian College, Post Office Box 1674, Fort Lauderdale, Fla. 33302.

HIGHLY effective college-level home study programs in Electronics Engineering and Engineering Mathematics. (Our 27th Year). Free Literature. Cook's Institute, Dept. 15, Box 10634, Jackson, Miss. 39209.

AVIATION ELECTRONICS TECHNICIAN—Prepare for exciting career in new field of "Avionics". Train at nation's largest aeronautical school. Indicate if eligible for G.I. Benefits. Spartan Airschool, International Airport, MM, Tulsa, Oklahoma 74151.

HIGH SCHOOL DIPLOMA for adults. Earn State Diploma. Accepted by Civil Service, business, colleges. Low cost. No tedious study. Money-back guarantee. Details: H-S Program, Suite 2504, 1221 Avenue of Americas, New York, N.Y. 10020.

ON THE AIR announcer training at R.E.I. features individual realistic preparation for your Radio/TV career. R.E.I.'s engineering course features intensive training for the FCC First Phone! Complete either course in just five (5) weeks! Call 1-800-237-2251 toll free for brochure. Write: R.E.I., 1336 Main Street, Sarasota, Florida 33577.

F.C.C. TYPE Exams Guaranteed to prepare you for F.C.C., 3rd., (\$7.00), 2nd., (\$12.00), 1st., (\$16.00), phone exams; Complete package, \$25.00. Research Company, Dept. A, Rt. 2, Box 448, Calera, Alabama 35040.

F.C.C. EXAM MANUAL

The Original Test-Answers exam manual that prepares you at home for FCC First and Second class licenses. Includes Updated multiple choice tests and key Schematic diagrams. PLUS - "Self-Study Ability Test." -- ONLY: \$9.95 Postpaid.



COMMAND PRODUCTIONS P.O. BOX 26348-P
RADIO ENGINEERING DIVISION SAN FRANCISCO, CALIF. 94126

SHORTCUTS To Success! Highly Effective, Profitable Short Courses. (75 Choices). Study At Home. Diploma Awarded. Our 27th Year. Free Literature. CIEE-D, Box 10634, Jackson, Miss. 39209.

TAPE RECORDING COURSE: Taught by studio engineers. Free information. NNA, Box 721F, Rye, New York 10580.

FCC FIRST CLASS LICENSE through tape recorded instruction. Also Radiotelegraph and Radar Endorsement. Radio License Training, 1060D Duncan, Manhattan Beach, Calif. 90266.

MOVIE FILMS

8MM-SUPER 8-16MM MOVIES! Biggest Selection! Lowest Prices! Free Catalog! Cinema Eight, Box 245-PE, N.Y.C. 10028.

DO-IT-YOURSELF

PROFESSIONAL ELECTRONIC PROJECTS—\$1.00 up. Catalog 35¢. PARKS, Box 15201A, Seattle, Wash. 98115.

PERSONALS

MAKE FRIENDS WORLDWIDE through international correspondence. Illustrated brochure free. Hermes, Berlin 11, Germany.

MAKE friends for travel, matrimony, fishing, etc. Send age and \$1 for bulletin "Introductions." Amity, P.O. Box 2471, Detroit, Michigan 48231.

RECORD telephone conversations privately—automatically. Leave recorder unattended. Robert's, Box 49PE, Parkridge, Illinois 60068.

BUGGED??? . . . Electronic Detector locates hidden transmitters. Literature 25¢. Security Devices, Box 671, Westwood, New Jersey 07675.

INVENTIONS WANTED

INVENTIONS wanted. Patented; unpatented. Global Marketing Service. 2420-P 77th, Oakland, Calif. 94605.

INVENTORS! Don't sell your invention, patented or unpatented, until you receive our offer. Eagle Development Company, Dept. 9, 79 Wall Street, N.Y., N.Y. 10005.

PATENT Searches including Maximum speed, full airmail report and closest patent copies. Quality searches expertly administered. Complete secrecy guaranteed. Free Invention Protection forms and "Patent Information." Write Dept. 9, Washington Patent Office Search Bureau, Benjamin Franklin Substation, P.O. Box 7167, Washington, D.C. 20044.

FREE "Directory of 500 Corporations Seeking New Products." For information regarding development, sale, licensing of your patented/unpatented invention. Write: Raymond Lee Organization, 230-GR Park Avenue, New York City 10017.

INVENTORS: Protect your ideas! Free "Recommended Procedure". Washington Inventors Service, 422T Washington Building, Washington, D.C. 20005.

FREE PAMPHLET: "Tips on Safeguarding Your Invention." Write: United States Inventors Service Company, 708-T Carry Building, Washington, D.C. 20005.

BOOKS

FREE catalog aviation/electronic/space books. Aero Publishers, 329PE Aviation Road, Fallbrook, California 92028.

FREE book prophet Elijah coming before Christ. Wonderful bible evidence. Megiddo Mission, Dept. 64, 481 Thurston Rd., Rochester, N.Y. 14619.

GOVERNMENT SURPLUS

GOVERNMENT Surplus. How and Where to Buy in Your Area. Send \$1.00. Surplus Information, Headquarters Bldg., Box 30177-PE, Washington, D.C. 20014.

ELECTRONIC Equipment and Parts. Big 36 page Free Catalog. Send for your copy today! Fair Radio Sales, Box 1105-P, Lima, Ohio 45802.

JEeps Typically from \$53.90 . . . Trucks from \$78.40 . . . Boats, Typewriters, Knives, Airplanes, Clothing, Multimeters, Oscilloscopes, Transceivers, Photographic, Electronics Equipment. Wide-variety, condition. 100,000 Bid Bargains direct from government nationwide. Complete sales directory and surplus categories catalog \$1.00 (Deductible on orders from separate included catalog). Surplus Service, Box 820-J, Holland, Michigan 49423.

GOVERNMENT SURPLUS. Complete sales directory \$1.00. Surplus Publications, Box 26062Z, Los Angeles, Calif. 90026.

BUSINESS OPPORTUNITIES

I MADE \$40,000.00 Year by Mailorder! Helped others make money! Start with \$10.00—Free Proof. Torrey, Box 318-N, Ypsilanti, Michigan 48197.

\$200.00 DAILY In Your Mailbox! Your opportunity to do what mail-order experts do. Free details. Associates, Box 136-J, Holland, Michigan 49423.

START small, highly profitable electronic production in your basement. Investment, knowledge unnecessary. Postcard brings facts. Barta-PEB, Box 248, Walnut Creek, California 94597.

FREE CATALOGS. Repair air conditioning, refrigeration. Tools, supplies, full instructions. Doolin, 2016 Canton, Dallas, Texas 75201.

MAILORDER MILLIONAIRE helps beginners make \$500 weekly. Free report reveals secret plan! Executive 1K12, 333 North Michigan, Chicago 60601.

FREE BOOK "999 Successful, Little-Known Businesses." Work home! Plymouth BGM, Brooklyn, New York 11218.

MAKE \$1.00 per sale selling engraved metal Social Security plates. **FREE SALES KIT.** Engravaplates, Box 10460-200, Jacksonville, Florida 32207.

FREE SECRET BOOK "2042 Unique, Proven Enterprises." Beat inflation with fabulous, successful "Little Knowns." Work home! Haylings-B4, Carlsbad, Calif. 92008.

PIANO TUNING learned quickly at home. Tremendous field! Musical knowledge unnecessary. GI Approved. Information Free. Empire School, Box 327, Miami, Florida 33145.

DECEMBER 1972



GREGORY ELECTRONICS
Reconditioned & Used
FM 2-WAY RADIO SAVINGS

Partial List—Send for New Catalog

GENERAL ELECTRIC Voice Commander III

FULLY SOLID STATE FM
Transmitter-Receiver

132 to 174 MHz

1 WATT OUTPUT

1/2 MICRO-VOLT SENSITIVITY

Size: 9.5" x 5.3" x 1.7"

High performance, completely self-contained two-way FM radio. Compact, lightweight, easily operated and hand-carried.

Housed in high-impact 2-section case. All external hardware polished stainless steel.

Proper charges available separately. \$15. each.

Lots of 5
less 10% . . . \$133.20
Lots of 10
less 15% . . . \$125.00

\$148.



Includes rechargeable nickel cadmium battery pack and charger. (Crystals & tuning, add \$50.)

PROGRESS LINE STRIPS physically complete, sold as is only. LOW BAND VHF

Power supply, 30 watts, less vibrator	MA E13 MA	E16 MA	E33 MA	E36 MA	E42
Power supply, 60 watts, less vibrator					
TX narrow band					
less final tubes					
Note: MA E42					
wide band	\$18.	\$25.	\$25.	\$30.	\$12.
RX wide band					
less ovens	\$18.	\$18.	\$18.	\$18.	\$12.
1-1/2" Progress Line Case, consisting of front basket and front plate with lock					\$10.
Low band dual front end, 2 freq. strip					\$20.



GREGORY ELECTRONICS CORP.

249-P Rt. 46, Saddle Brook, N.J. 07662
Phone: (201) 489-9000

CIRCLE NO. 21 ON READER SERVICE CARD

Planning to move?

Let us know 6 to 8 weeks in advance so that you won't miss a single issue of **POPULAR ELECTRONICS INCLUDING ELECTRONICS WORLD**

Attach old label where indicated and print new address in space provided. Also include your mailing label whenever you write concerning your subscription. It helps us serve you promptly.

Write to: P.O. Box 2774, Boulder, Colo., 80302 giving the following information.

If you have no label handy, print OLD address here.

name _____ please print

address _____

city _____

state _____ zip-code _____

Change address only.

Extend subscription. Enter new subscription.

(1) 5 yrs. \$21 (2) 3 yrs. \$15. (3) 1 year \$6

Payment enclosed (1 extra issue per yr. as a BONUS)

Bill me later.

0728

name _____ please print

address _____

city _____ state _____ zip _____

Add'l postage: \$1 per year outside U.S., its possessions & Canada.

Popular Electronics

INCLUDING **Electronics World**

DECEMBER 1972

ADVERTISERS INDEX

READER SERVICE NO.	ADVERTISER	PAGE NO.
3	Ampex	107
5	Audionics, Inc.	9
6	B. & F. Enterprises	121
	Bell & Howell Schools	20, 21, 22, 23, 112, 113, 114, 115
8	Bose	71
	CREI, A Division of the McGraw-Hill	
	Continuing Education Company	58, 59, 60, 61
9	Cleveland Institute of Electronics	94, 95, 96, 97
7	Colira Communications, Dynascan Corporation	24
4	Conway Electronic Enterprises Limited	39
10	Cook's Institute of Electronics Engineering	87
12	Crystek	87
13	Delta Electronics Co.	126
14	Delta Products, Inc.	85
15	Dixie Hi-Fidelity Wholesalers	101
16	Drake Company, R.L.	88
17	EICO	109
18	Edmund Scientific Co.	130
45	Edwards Electronics	108
1	Electro-Voice, Inc.	FOURTH COVER
2	Electro-Voices, Inc.	FOURTH COVER
46	Fluke	110
19	Grantham School of Engineering	13
21	Gregory Electronics Corp.	127
22	Heath Company	72, 73
23	Johnson	103
CLASSIFIED ADVERTISING		120, 122, 123, 124, 126, 127, 128, 129

READER SERVICE NO.	ADVERTISER	PAGE NO.
24	Lafayette Radio Electronics	27
25	McIntosh Laboratory Inc.	93
26	MITS Micro Instrumentation & Telemetry Systems, Inc.	10, 11
	National Radio Institute	SECOND COVER, 1, 2, 3
	National Technical Schools	40, 41, 42, 43
28	Olson Electronics	89
29	PTS Electronics, Inc.	111
20	Panasonic	19
47	Pickering & Co., Inc.	16
30	Poly Paks	128
31	RCA Electronic Components	81
32	RCA Institutes, Inc.	76, 77, 78, 79
33	Radio Shack and Allied Radio Stores	15
34	Sams & Co., Inc., Howard W	91
35	Schober Organ Corp., The	109
36	Shure Brothers, Inc.	17
37	Solid State Sales	123
38	Solid State Systems, Inc.	125
39	Sonar Radio Corp.	118
40	TDK Electronics Corp.	8
41	Tescom Corporation	108
	Texas Instruments Incorporated, Components Group	7
43	Tri-Star Corporation	111
44	Wahl Clipper Corporation	110

SPORTS BOOKS

PRO FOOTBALL—An inside look at the world of NFL. Play-by-play descriptions, up-to-date info on players, coaches, trends. 8 1/2x11", 320 oversized pages, 179 illustrations. Special Christmas offer, \$14.95 Delivered. Other Gift Suggestions Include Pop Priced Hard Cover Books: Jackie Stewart, World Champion, \$4.95; Spirit of America, Craig Breedlove, \$5.95; What's It Like Out There?, Mario Andretti tells you, \$5.95; Faster, Stewart's Grand Prix Diary, \$7.95. **SPORTLITE**, New Book Dept., 20 N. Wacker Dr., Chicago, IL 60606.

RUBBER STAMPS

RUBBER address stamps. Free catalog. 45 type styles. Jackson's, Box 443G, Franklin Park, Ill. 60131.

MUSICAL INSTRUMENTS

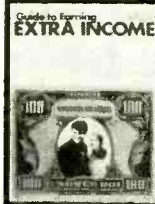
30% **DISCOUNT** name brand musical instruments. Free Catalog. Freeport Music, 455N, Route 110, Melville, N.Y. 11746.

MISCELLANEOUS

WINEMAKERS: Free illustrated catalog yeasts, equipment. Semplex, Box 12276P, Minneapolis, Minn. 55412.

Guide to Earning EXTRA INCOME

A ZIFF-DAVIS PUBLICATION



Packed with fresh ideas, expert advice and valuable details on money-making ideas — full and part-time — for both men and women. Provides in depth coverage in many important areas of income opportunities . . . mail order — franchising — vending machines — direct selling — house parties — plus many special features on seasonal business opportunities and money-saving ideas. 1972 Oct./Nov. issue now available. Only 75c.

Order from the Ziff-Davis Service Division, 595 Broadway, New York, New York 10012. Enclose an additional 25c for postage and handling.

LIVE IN THE WORLD OF TOMORROW... TODAY! NEW PRODUCTS, NEW MATERIALS, NEW IDEAS!

UNUSUAL ECOLOGICAL AND PHYSICAL PROJECTS FOR BOYS

UNIQUE HARD-TO-FIND BARGAINS FOR FUN, STUDY OR PROFIT

SPECIAL VISUAL EFFECTS PROJECTOR SET



parties, photography. Complete Stock No. 71.212AV

Buzzing, amazing garage visual effects. Fantastic variety. Incredibly beautiful. Special packaging, often contains all necessary apparatus. Create dazzling, exploding, fiery bursts of color like "Symphony of Spheres". "Chromatic Starbursts", "Crystal Starbursts". Features 35mm 500 W. fan cooled projector—produces big image at short distance. Accents two six inch wheels (1-1/2" kaleidoscope & Hexidoscope). 2 cylindrical accessories (3" Colored Cloud & 3" Hexidoscope w/ six internal mirrored walls). Perfect for entertaining.

\$79.95 Ppd.

"FISH" WITH A MAGNET



Stock No. 70.570AV
Stock No. 85.152AV

Go treasure hunting on the bottom! Fascinating fun & sometimes profitable! Tie a line to our 3 1/2-lb. Magnet—drop it overboard in bay, river, lake or ocean. Troll it along bottom—your "treasured" haul can be outboard motors, anchors, other metal valuables. 5 1/2-lb. Magnet is war surplus—Alnico V Type—Gov't. cost \$10. Lifts over 150 lbs. on land—much greater weights under water.

No. 70.571AV . 5 1/2 lbs. . . . \$14.00 Ppd.
No. 60.215AV . 1 1/2 lbs. . . . \$5.75 Ppd.
3 1/2 lbs. (40 lbs.) . . . \$8.75 Ppd.
15 3/4 lbs. (350 lbs.) . . . \$33.95 F.O.B.

SLIDE-SHOW "BRAIN & VOICE"



No. 71.619AV

Show Center, with built-in slide-sound synchronizer, is a cassette recorder too. One unit on-site recording! Unique controls focus, activate feedback cycles on projector. Digital counter to index; individual channel easability; monitor switch to project external sound thru speaker; record music, narration at same time, 10-level vol. control. AC/DC. Includes cable for Kodak Carousel, patch cord (radio, hi-fi), earphone, remote microphone, blank cassette, 4 "C" batt., insurs. 5 1/2 lbs.

\$171.50 Ppd.

NEW ELECTRONIC CALCULATOR—\$99.50



No. 78.000AV

First American-made value w/big machine capabilities. Add, subtract, multiply, divide, do mixed calculations silent answers in milli-seconds. 8 digit entry & readout w/16-digit cap. Auto. precise to the decimal. Also features fixed decimal, constant key, underflow, zero suppression, minus signal for true credit balance, error correction, keyboard roll over memory. Solid state modular const. only 3-lb. Year guarantee (normal use).

\$99.50 Ppd.

PHOTOCELL RELAY SYSTEM BUY! AVAILABLE AGAIN! SURPLUS PRICED!



Stock No. 60.662AV

Self-contained unit adapted easily to operate burglar alarms; people, car, conveyor package counters; annunciators; garage door openers; warning systems; assembly-line controls, etc. Once built for expensive copying machines. Includes cadmium sulfide photocell, single-pole double-throw relay, silicon rectifier, capacitor, resistor, 0.5x lamp, 125v socket. Uses 110v AC. Metal case (11x8x3 3/4") 1 1/2 oz. Insurs.

\$6.95 Ppd.



MAIL COUPON FOR GIANT FREE CATALOG!

164 PAGES • MORE THAN 4000 UNUSUAL BARGAINS!
Completely new Catalog. Packed with huge selection of telescopes, microscopes, binoculars, magnets, magnifiers, prisms, photo components, ecology and Unique Lighting items, parts, kits, accessories—many hard-to-find surplus bargains. 100's of charts, illustrations. For hobbyists, experimenters, schools, industry.

EDMUND SCIENTIFIC CO.

300 Edscorp Building, Barrington, N.J. 08007
Please rush Free Giant Catalog "AV"

Name _____
Address _____
City _____ State _____ Zip _____

ASTRONOMICAL TELESCOPE KITS

Grind your own mirror for powerful telescopes. Kit contains fine annealed pyrex mirror blank, tool, abrasives, diagonal mirror and eyepiece lenses. Instruments you build range in value from \$75.00 to hundreds of dollars.



Stock No. 70.003AV . . . \$10.75 Ppd.
Stock No. 70.004AV . . . \$16.95 Ppd.
Stock No. 70.005AV . . . \$24.50 Ppd.
Stock No. 70.006AV . . . \$44.50 FOB
Stock No. 70.007AV . . . \$123.25 F.O.B.

3" ASTRONOMICAL TELESCOPE

See moon shots, orbits, stars, phases of Venus. Planets show up 80 to 150 power. Aluminumized, overcoated 3"-diam. f/10 primary mirror, ventilated cell. Equatorial mount with locks on both axes. 60X eyepiece and mounted Barlow lens. 3X finder telescope, hardwood tripod. FREE "Star Chart." "How to Use Your Telescope."



Stock No. 85.050AV . . . \$32.95 Ppd.
Stock No. 85.102AV . . . \$61.50 Ppd.
Stock No. 85.105AV . . . \$99.50 F.O.B.
Stock No. 85.086AV . . . \$239.50 F.O.B.

FEATHERWEIGHT TREASURE FINDER

Best, easiest to use solid state metal detector at its price. U.S. made! Only 3 lbs! 3" search head detects penny at depth of 5" silver dollar at 8". Bag of coins at 18". Easily works thru dirt, sand, wood, water (30" deep) and rock with no power loss. Detects your "find" sharply with "sound on" loudspeaker. Comes ready to go. One-tuner control; all transistor; adjus. stem; perfect balance. Incls 9v batt. FREE TREASURE GUIDE To 101 Treasure Hiding Places.



Stock No. 80.175AV . . . \$39.95 Ppd.

NEW! ELECTRONIC DIGITAL COMPUTER KIT

Solve problems, play games, predict weather with this actual working model of giant electronic brains. Amazing new fun way to learn all about computer programming—logic, decimal, binary systems. Laws of Sets—even do your own programming after completing simplified 116 page instructive booklet. Includes step-by-step assembly diagram. Circuit easily changed. Readout from illuminated control panel. Req. 2 "D" batt. (not incl.). Best model we've seen—for home, school, industry.



Stock No. 71.434AV . . . \$31.50 Ppd.

AMAZING NEW Wankel Engine KIT

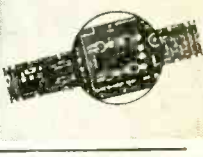
Thrill to the fun of building your own see-through motorized model of revolutionary pistonless type engine, rights for which GM recently paid \$50 million! Only engine experts think economically modifiable to meet new pollution standards. Replaces piston, cylinder, crank assemblies with rotating discs (sections removed for firing chambers). Smaller than conventional; fewer parts, greater reliability, same speed w/less horsepower. Feat: flashing plugs, rubber fan belt, stick-shift on-off switch. Req. 2 "D" batt. (not incl.).



No. 71.424AV (4 1/2"x5 1/2"x9") \$6.75 Ppd.
5 1/2 Page Wankel Engine Book
Stock No. 9.439AV . . . \$15.25 Ppd.

DIGITAL COMPUTER LOGIC LAB

Fascinating new way to learn computer types, binary systems, truth tables, logic. Make ring counter, shift register and binary counters. Work with reaction timer, electronic coin flipper. Experiment with memory, counting & arithmetic circuits. 4 assembled module circuits (clock, solid-state and gates, flip-flop, display). 30 patch cords for 100% of circuit computer experiments. No electronic know-how needed! 74 pg. illustr. manual explains all. Req. 6v batt. (not incl.)



Stock No. 71.403AV . . . \$39.75 Ppd.

BLACK-LIGHT BARGAIN PACK

It's two lamps in one! Versatile fixture works with 15w 18" black-light or fluorescent tubes. Low-cost pkg. includes both with slim, flat, white baked-enamel metal case (18x3 3/4x1 1/2/10"). Light up posters, displays, achieve magical black-light decor! Use for ceiling, shelves, counters, cabinets. Has modern plastic diffuser (fluor. use only), built-in 110v outlet for accessories or other lamps. push-button switch, side & back mounting holes. Insurs. incl.



Stock No. P-71.720AV . . . \$12.95 Ppd.

EDMUND SCIENTIFIC CO. BARRINGTON, NEW JERSEY 08007

CIRCLE NO. 18 ON READER SERVICE CARD

ORDER BY STOCK NUMBER • SEND CHECK OR MONEY ORDER • MONEY-BACK GUARANTEE

300 EDSCORP BLDG. BARRINGTON, NEW JERSEY 08007

Printed in U.S.A. POPULAR ELECTRONICS Including Electronics World

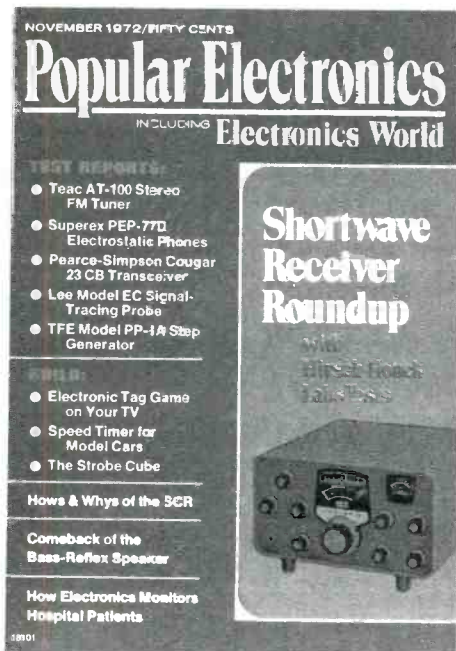
Popular Electronics

INCLUDING Electronics World

READER SERVICE

FREE INFORMATION

Here's an easy and convenient way for you to get additional information about products advertised or mentioned editorially (if it has a reader service number) in this issue. Just follow the directions below... and the material will be sent to you promptly and free of charge.



1. On the attached postage-free card, print or type your name and address on the lines indicated.

2. Circle the number(s) that corresponds to the key number(s) at the bottom or next to the advertisement or editorial mention that is of interest to you. (Key numbers for advertised products also appear in the Advertisers' Index.)

3. Simply cut out the card and mail. No postage required.



**Dreaming about
a pair of \$300
condenser
microphones?**

**Think seriously
about these:
\$39.75* each!**



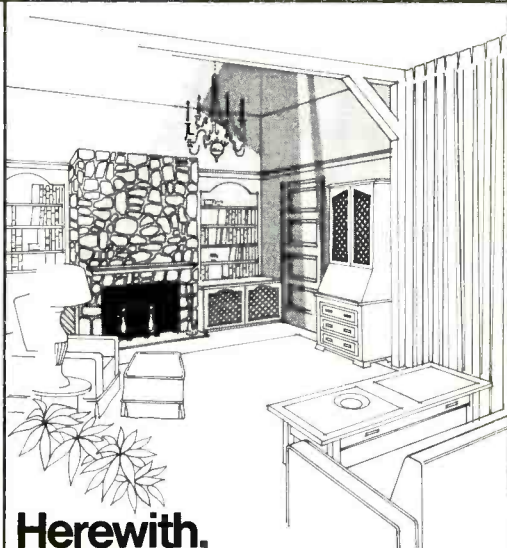
**Model 1710 Electret
Condenser Omnidirectional Microphone**

All of the great condenser advantages are here without compromise. Flat, extended range, excellent transient response, high output, low noise, and ultra-clean sound. But the new E-V electret condenser microphones need no high voltage power supply. Just an AA penlite battery to operate the built-in FET impedance converter. The result is studio performance without complications and at a dramatically lower price.

There are 4 new E-V electret microphones, including cardioid models, from \$39.75 to just \$75.00, audiophile net. Second-generation designs with unusually high resistance to heat and humidity. Hear them today at your nearby Electro-Voice sound-room. Or write for details.

More U. S. recording studios use Electro-Voice microphones than any other brand.

*Suggested retail price. Microphones shown on Model 421 Desk Stand, \$12.00 each.

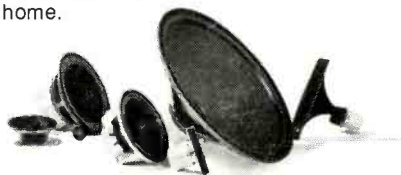


**Herewith,
five helpful ideas
for adding music
without disturbing
your decor.**

PROBLEM: How do you add a stereo (or 4-channel) system to your living room without upsetting the appearance of the room or adding unwanted furniture?

ANSWER: Use Electro-Voice Custom Loudspeakers that mount almost anywhere. For instance, you can build them into a present bookcase, mount them in a wall (perhaps behind a semi-transparent drape), mount them in a closet door, even put speakers in the ceiling, or install them in existing furniture.

There are sizes and models of E-V Custom Loudspeakers to fit your available space, your budget, and your taste in sound. Write today for complete catalog information and a list of Electro-Voice dealers who'll help you put hi-fi in its place... in your home.



CIRCLE NO. 1 ON READER SERVICE CARD

CIRCLE NO. 2 ON READER SERVICE CARD

ELECTRO-VOICE, INC., Dept. 1224P, 630 Cecil Street, Buchanan, Michigan 49107
In Europe: Electro-Voice, S.A., R metsstrasse 49, 2560 Nidau, Switzerland
In Canada: EV of Canada, Ltd., Gananoque, Ontario

**Gulton
COMPANY**

Electro-Voice®