

Popular Electronics

INCLUDING **Electronics World**

HIRSCH-HOUCK LABS COMPARES

CASSETTE TAPES



BUILD:

- A 175-MHz Counter Prescaler
- Stereo Balance Meter
- A 3.6-V Power Supply Regulator

What's Different About

JAPANESE COLOR TV SETS ?

Voice of Canada for the

SWL

TEST REPORTS:

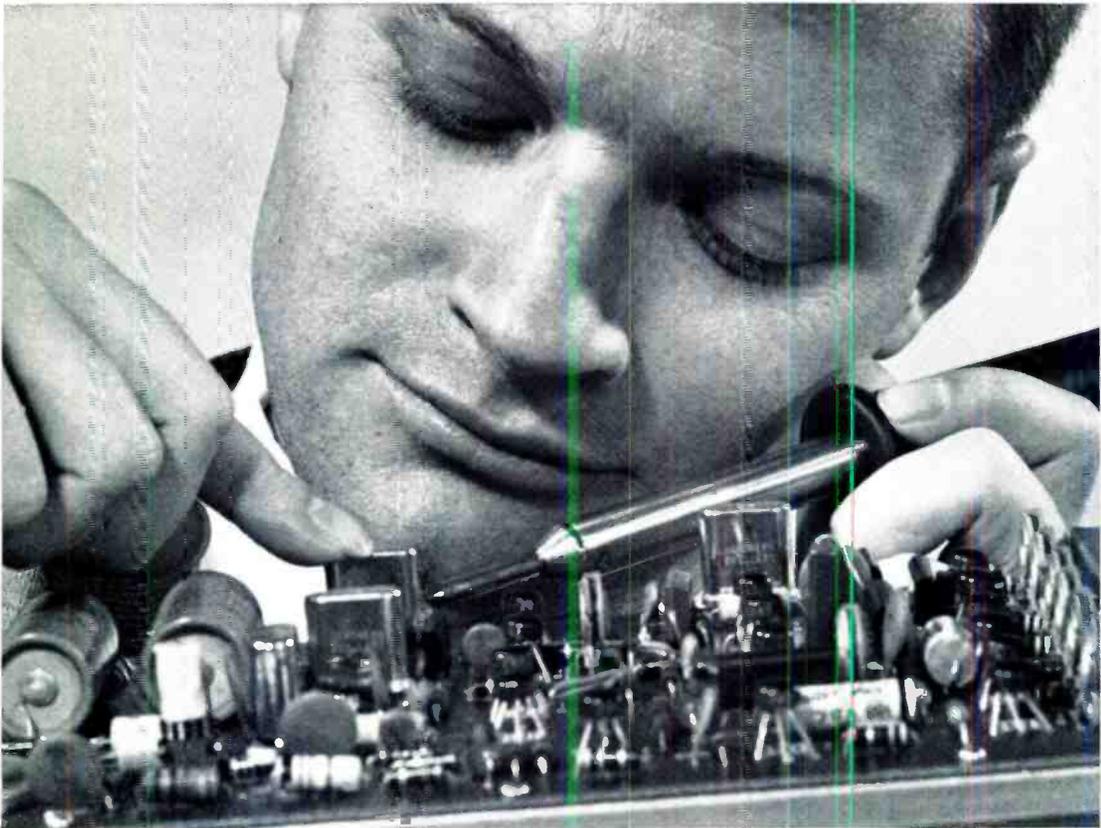
- Ampex AX-300 Tape Deck
- Utah 4-Channel Adapter
- Tram Titan III CB Transceiver
- Simpson 229 Leakage Current Tester
- Heathkit MI-101 Digital Depth Sc

LIGHT BEAM

COMMUNICATIONS

3708015 NLCM 245A60G 01
 SP1615041E2067025AB 020
 M DELSCHLAGER NOV
 BX 245 D73
 BROWNS MILLS NJ 08015

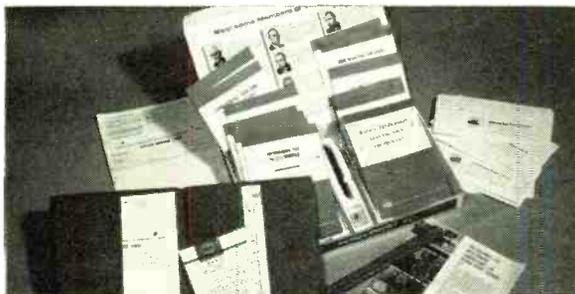
**NRI “hands-on” training in
Television, Communications,
Electronics and Computers
can give you as much
as 2 years of on-the-job
experience.**



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

1-042

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

- 28 PERFORMANCE TESTS OF CASSETTE TAPES** *Julian D. Hirsch*
Comparative ratings of twenty raw tapes with biasing adjusted for optimum
- 33 EARTH STATION FOR SATELLITE EXPERIMENTS**
- 34 COMMUNICATIONS ON A LIGHT BEAM** *David L. Heiserman*
Invisible laser beams may open new communication channels with virtually no limit on capacity
- 44 CANADA'S NEW VOICE ON SHORTWAVE** *Richard E. Wood*
The CBC has big plans for worldwide transmissions
- 46 WHAT'S DIFFERENT ABOUT JAPANESE COLOR TV?** *Forest H. Belt*
A review of what's available in imported sets
- 49 LASER HOLOGRAMS SPEED COMPUTER PARTS ANALYSIS**
- 60 METER ACCURACY SPECIFICATIONS** *John T. Frye*
Interpreting specs is essential to accurate readings
- 63 GANGED SWITCHING QUIZ** *Robert P. Balin*
- 78 MORE SOLID-STATE ELECTRONICS FOR THE NEW CARS** *John D. Drummond*
What Ford and Chrysler have planned for 1972
- 82 ANALOG LOGIC** *James Hannas*

THE SCENES

- 10 STEREO SCENE** *J. Gordon Holt*
The battle of the tapes—cartridges or cassettes?
- 96 COMMUNICATIONS SCENE** *Richard Humphrey*
Nicholas Johnson of the FCC

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
Stanley R. Greenfield, Senior Vice President
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
Lawrence Sporn, Circulation Director

POPULAR ELECTRONICS Including ELECTRONICS WORLD, April 1972, Volume 1, Number 4. 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 1096, Flushing, NY 11352. 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
RICHARD J. HALPERN
Advertising Manager
MADELEINE LITTMAN
Advertising Service Manager
STANLEY NEUFELD
Associate Publisher
FURMAN H. HEBB
Group Vice President
Electronics and Photographs

CONSTRUCTION STORIES

- 42 3.6-VOLT IC POWER SUPPLY REGULATOR** *James A. Fred*
Battery adapter provides power for RTL IC's
- 50 BUILD A SIGNAL DIFFERENCE
STEREO BALANCE METER** *J. R. Laughlin*
- 53 BUILD A 175-MHz PRESCALER** *Daniel Meyer*
Extend the range of your digital frequency counter

PRODUCT TEST REPORTS

- 64 AMPEX AX-300 TAPE RECORDER DECK**
- 66 UTAH STUDIO 4 FOUR-CHANNEL ADAPTER**
- 68 TRAM TITAN III AM/SSB CB TRANSCEIVER**
- 70 SIMPSON 229 AC CURRENT LEAKAGE TESTER**
- 71 HEATHKIT MI-101 DIGITAL DEPTH SOUNDER**

DEPARTMENTS

- 6 EDITORIAL** *Milton S. Snitzer*
Digital circuits and modules for the consumer
- 8 LETTERS**
- 25 NEWS HIGHLIGHTS**
- 84 NEW PRODUCTS**
- 88 NEW LITERATURE**
- 90 ELECTRONICS LIBRARY**

READER SERVICE CARD ON BACK COVER

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 Yagi
Oji Palace Aoyama; 6-25, Minami Aoyama
6 Chome, Minato-Ku, Tokyo 407-1930/6821



Member Audit Bureau
of Circulations

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 1096, Flushing, NY 11352, 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.



Editorial

By Milton S. Snitzer, Editor

DIGITAL CIRCUITS AND MODULES FOR THE CONSUMER

Just recently we attended a special press showing of a new Heath tuner. This component uses pushbuttons on the front panel to set the frequency of the station desired. Digital display tubes show the frequency selected or the frequency to which the tuner automatically scans. Digital circuits are widely used in the tuner for detection and other functions, and frequency synthesis is used to select the operating frequency of the tuner. All the circuits are fixed-tuned using filters and, as a matter of fact, there are only three simple adjustments to make for the entire alignment procedure.

Computer technology is widely used, including simple plastic cards that the user can cut out to permit him to preselect a number of stations he commonly listens to.

It goes without saying that modular techniques are used throughout and all the various integrated circuits and transistors are mounted on a number of separate computer-like plug-in boards. The tuner seems to be truly up to the finest state of the art, both in its features and performance. Construction time is estimated to be around 25 hours while the price is in the \$500 range.

The Heath tuner, as well as new digital tuners from Scott and Sherwood, seem to signal the beginning of a new era for the consumer—an era of digital circuits in equipment that had used all linear or analog circuits in the past.

What are the implications of this type of equipment as far as the consumer is concerned? First of all, it offers many more features than could possibly be made available with simpler gear. Second, it is more complex than components we have been used to. Third, it advances the technical state of the art with digital circuits, pushing performance to the maximum attainable. Fourth, it recognizes the problems of construction and servicing by using the modular approach.

All of this makes us wonder about the kind of technician or electronics hobbyist we will have in the future to use this type of equipment. First, such a man will have to be more knowledgeable with respect to digital circuits. Second, he will have to be able to approach troubleshooting logically and systematically. And third, he will have to be assisted by manufacturers, such as Heath, Scott, Motorola, RCA, Zenith, and others, designing equipment that is modular in nature so that it can be serviced easily and conveniently.

So it appears that digital circuits, once found only in computers, are coming more and more into use for consumer electronic equipment, whether it is a digital electric clock or a hi-fi tuner.

Another introductory offer to new members of the ELECTRONICS AND CONTROL ENGINEERS' BOOK CLUB

	<p>107/971 ELECTRONIC CIRCUITS: PHYSICAL PRINCIPLES, ANALYSIS AND DESIGN by P. M. Chirlian Pub. price, \$15.50 Club price, \$13.25</p>		<p>286/515 INTEGRATED CIRCUITS: A Basic Course for Engineers and Technicians by R. G. Hibberd Pub. price, \$9.95 Club price, \$8.45</p>	
	<p>637/458 DESIGNING WITH TTL INTEGRATED CIRCUITS by Texas Instruments Inc. Pub. price, \$18.50 Club price, \$13.50</p>		<p>497/265 ELECTRONIC SWITCHING, TIMING AND PULSE CIRCUITS, 2/e by Pettit & McWhorter Pub. price, \$12.50 Club price, \$8.95</p>	
	<p>404/437 SOURCEBOOK OF ELECTRONIC CIRCUITS by J. Markus Pub. price, \$19.75 Club price, \$14.75</p>		<p>313/059 HANDBOOK OF SEMI-CONDUCTOR ELECTRONICS, 3/e by P. Hunter Pub. price, \$27.50 Club price, \$21.50</p>	
	<p>259/607 COMMUNICATION SYSTEM ENGINEERING HANDBOOK by D. H. Hamsher Pub. price, \$29.50 Club price, \$22.50</p>		<p>308/470 ACTIVE FILTERS: LUMPED, DISTRIBUTED, INTEGRATED, DIGITAL & PARAMETRIC by L. P. Huelsman Pub. price, \$16.50 Club price, \$13.95</p>	
	<p>158/215 AN INTRODUCTION TO ELECTRONIC COMPUTERS, 2/e by G. B. Davis Pub. price, \$12.50 Club price, \$9.30</p>		<p>124/035 HANDBOOK OF PHYSICS, 2/e by Condon and Odishaw Pub. price, \$34.75 Club price, \$14.95</p>	
<div style="border: 2px solid black; padding: 10px; transform: rotate(-5deg);"> <h2 style="text-align: center;">ANY ONE</h2> <p style="text-align: center;">of these great professional books</p> <h1 style="text-align: center;">for only \$ 1.00</h1> <p style="text-align: center;">VALUES FROM \$9.95 to \$34.75</p> <p style="text-align: center;"><i>Special \$1.00 bonus book comes to you with your first club selection</i></p> </div>		<p>494/754 ENGINEERING MANUAL, 2/e by R. H. Perry Pub. price, \$12.50 Club price, \$9.95</p>		<p>621/616 WAVE GENERATION AND SHAPING, 2/e by L. Strauss Pub. price, \$16.50 Club price, \$13.95</p>
		<p>654/301 ENGINEERING MATHEMATICS HANDBOOK by J. J. Tuma Pub. price, \$9.95 Club price, \$8.45</p>		<p>209/731 STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS, 10/e by Fink and Carroll Pub. price, \$32.50 Club price, \$24.95</p>

Save time and money by joining the
Electronics and Control Engineers' Book Club



HERE is a professional club designed specifically to meet your day-to-day engineering needs by providing practical books in your field on a regular basis at below publisher prices.

How the Club operates: Basic to the Club's service is its publication, the *Electronics and Control Engineers' Book Club Bulletin*, which brings you news of books in your field. Sent to members without cost, it announces and describes in detail the Club's featured book of the month as well as alternate selections which are available at special members' prices.

When you want to examine the Club's feature of the month, you do nothing. The book will be mailed to you as a regular part of your Club service. If you prefer one of the alternate selections—or if you want no book at all for that month—you notify the Club by returning the convenient card enclosed with each *Bulletin*.

As a Club member, you agree only to the purchase of four books over a two-year period. Considering the many books published annually in your field, there will surely be at least four that you would want to own anyway. By joining the Club, you save both money and the trouble of searching for the best books.

MAIL THIS COUPON TODAY

ELECTRONICS AND CONTROL ENGINEERS' BOOK CLUB
582 Princeton Road, Hightstown, N.J. 08520

Please enroll me as a member of the Electronics and Control Engineers' Book Club and send me the two books indicated below. I am to receive the bonus for just \$1.00, and my first selection at the special Club price shown. These books are to be shipped on approval, and I may return them both without cost or further obligation. If I decide to keep the books, I agree to purchase as few as four books during the next two years at special Club prices (at least 15% below list).

Write Code No. of
bonus book
here

Write Code No. of
first selection
here

Name _____
Address _____
City _____
State _____ Zip _____

E33180

CIRCLE NO. 19 ON READER SERVICE CARD

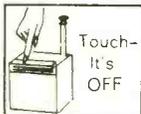
SQUARE DEALS

BY REALISTIC® AT OVER 1350
RADIO SHACK STORES

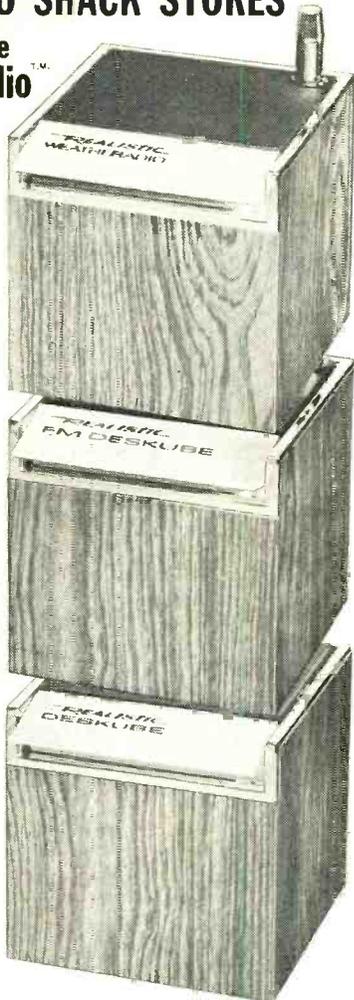
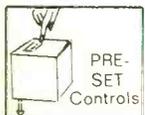
Our Exclusive
Weatheradio™
"Talking
Barometer"
15⁹⁵*



**FM
Deskube**™
15⁹⁵*



**AM
Deskube**™
9⁹⁵*



Unique 3" Square Matching Radios

Our **Weatheradio** gets 24-hour U.S. Gov't. weathercasts on 162.55 MHz. It's battery powered and pre-set for instant, automatic listening. Just touch the Play Bar to turn on-off. Simulated rosewood.

Our **FM Deskube** gets good music instantly, automatically. Hidden controls—pre-set any station, tune it in again and again with a touch of your finger. AFC, telescopic antenna, battery powered.

Our **AM Deskube** makes it a threesome. Get complete three-radio coverage that covers only 27 square inches.

*POSTPAID IN USA—ADD APPLICABLE SALES TAXES.



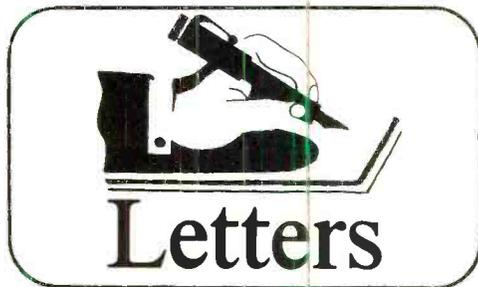
At Your
Nearby
Store
Or By
Mail

radio shack

AND ALLIED RADIO STORES
A TANDY CORPORATION COMPANY

2725 West 7th Street Fort Worth, Texas 76107

CIRCLE NO. 2 ON READER SERVICE CARD



SUBSTITUTIONS VERBOTEN!

I'm building an amplifier from an old issue of **POPULAR ELECTRONICS**. I have been putting replacement transistors in right and left, but they keep burning up. I've checked the circuit for wiring errors and everything seems to be okay. Now I'm going to try putting in the transistors called for.

Name Withheld

This letter shows what can, and often does, happen when the builder indiscriminately substitutes parts for those specified. This is not to say that substitutes cannot be used; but careful consideration should take place and the risks weighed whenever substitutions are contemplated. If you cannot get the components specified in the Parts List, reasonable care should be taken when attempting a substitution. Just because one transistor may look like another is no reason to assume that it will behave in a similar manner.

IT'S MECK, NOT KWAJALEIN

I read with interest and enjoyed "Giant Billboard Antennas For Space-Age Radars" (December 1971). The story was basically well written by Mr. Lacy and was quite factual. I would, however, like to point out one small error in the article; that was the mention of the radar at Kwajalein Island. The MSR, or Missile Site Radar, is located on the island of Meck in the Kwajalein Atoll.

RICHARD V. DUTCHIK
Kwajalein Missile Range,
Marshall Islands

HANDS ACROSS THE BORDER

I find **POPULAR ELECTRONICS** including **ELECTRONICS WORLD** the most informative and interesting of all electronics magazines published. The articles I most enjoy are those on audio hi-fi amplifiers and preamplifiers. At school, I have built several of your audio construction projects—most of them from scratch. We are even able to make exact replicas of the printed circuit boards. The only problem we encounter with any regularity is in obtaining some of the parts specified, mainly transistors and transformers.

If at all possible, would you please try to give consideration to the Canadian students who are trying very hard to build your projects? It would help enormously if you would list parts availability in Canada.

We all enjoy the projects which are challenging to build and sometimes require a little thinking to get to working properly. Please keep these projects coming and you will have a lifetime subscriber.

DOUGLAS J. KISS
Edmonton, Alberta, Canada

Wherever possible, we have during the past year or so tried to list Motorola HEP equivalents for most of the transistors specified in our Parts Lists. These are readily available through most of the Canadian mail-order houses and many local suppliers. Transformers are another story; it has been our experience that all the builder need do is use any transformer that has the proper primary and secondary impedances as the one specified in the Parts List, giving due consideration to the power-handling capacity.

ELECTRONIC MUSIC CLUB UNDER WAY

Due to the high level of interest in electronic music, as evidenced by such construction projects as your "Psych-Tone" (February 1971) and "Drummer Boy" (July 1971), I am at present forming an electronic music club. It will feature a newsletter for the exchange of circuits and other information. Plans are in the works for exchanging tape recorded electronic music composed by members. I invite interested readers to contact me directly for details.

BERNARD A. HUTCHINS
508 Highland Rd.
Ithaca, NY 14850

NOW IT'S ANIMAL GUIDANCE SYSTEMS

Mr. Lawrence's article "Animal Guidance Systems" in the December 1971 issue of *ELECTRONICS WORLD* is an exquisite piece of satire loaded with irony. It now seems that our weapons specialists have decided that future human survival will depend on jam-proof delivery of nuclear warheads. But with the rapidly approaching stalemate in the game of electronic countermeasures (in which I have some military experience), man is forced to turn to the animal world to solve his problem.

In the early part of this century, the passenger pigeon was systematically exterminated by man; so, now his surviving cousins are being recruited to help develop a more efficient means of systematic human self-destruction in the latter part of this century. A better example of poetic justice would be almost impossible to find, pathetic as it is.

WILEY W. KNIGHT
New Orleans, La.

When you go 23-channels ...go First Class



First Class design. At Johnson we build two-way radio equipment for more kinds of users (including industrial, police, and government) than any other company in America. **Engineering experience** that results in the most advanced CB radios you can buy! **First Class construction.** Here in Waseca, Minnesota, our patient and skilled people assure you of top construction standards. We even manufacture many parts others must buy from outside suppliers—so we can be sure of top reliability. **First Class service.** Only Johnson has 400 authorized service centers nationwide. Fast warranty and repair service is nearby wherever you live—and parts are always available. **First Class value.** Compare features. Compare on-the-air performance. Compare price. Compare Johnson, made right here in Waseca, Minnesota, USA with equipment made anywhere else.

MESSENGER 123
23-channel mobile
\$139⁹⁵

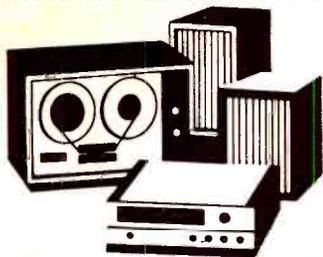
MESSENGER 223
23-channel base
\$199⁹⁵



E. F. JOHNSON COMPANY
WASECA, MINNESOTA 56093

1192

CIRCLE NO. 24 ON READER SERVICE CARD



Stereo Scene

By J. Gordon Holt

IN THE LATE 1940's, the recording industry was in the throes of what came to be called the battle of the speeds, with Columbia's LP record and RCA Victor's 45-rpm "donut" disc vying for public acceptance. Now, only pop recordings are released on 45's, while every recording of every kind of music is available at 33½ rpm. The LP didn't kill the 45; it just put it in its place.

Today we are seeing the start of another such engagement, but this time the contenders are tapes, in cartridges or in cassettes. As before, one medium will probably prevail, and the other will take a back seat. But which will be which?

Why did the LP become the leading home-music medium and the 45 a runner-up, limited to the pop field? Certainly, their relative fidelity had nothing to do with it, for the first 45's were clearly superior to the early LP's in this respect. And although it was later proven that most of the distortion that plagued early LP's was more the fault of pickups than of the discs themselves, the LP never did match the sheer cleanness of a good 45.

There must have been other reasons, then, why the buying public showed so unmistakably how it felt that RCA Victor announced after only two years that it was going to produce LP's "for classics." Then, Columbia, just a year later, said that it would release pops on 45's. The reasons

were simple, and really should have been obvious to everyone concerned before the whole petty "battle of the speeds" ever got started. The LP was ideal for long musical works—and really impractical for short works. Also, while a symphony on LP's was a lot more compact than the same work on 78's, the LP could not really be considered a portable music medium—in the sense that a pocket book is portable.

The 45, on the other hand, was no better suited for long musical works than was the 78, no matter how rapidly the cute little record changer went through its change cycle. To a listener of classical music, a pause of a fraction of a second is enough to interrupt the flow of the music; so it was academic that RCA's changer could cut the side-break time from 10 to 5 seconds. But the 45 was ideal for short musical selections, and it was very nearly as portable as a pocket book. In other words, it was a natural for pop records, most of which run less than 3 minutes; and most of whose buyers consider transporting them to friends' homes as part of the fun.

Then There Was the Juke Box. America was juke-box crazy during the 40's and 50's. Practically every place where people gathered, there was a juke box, and all those nickels and dimes added up to a multimillion-dollar business. When juke boxes went microgroove, they went the 45 route, because just about all juke box customers wanted to hear pop; and all pop was short. LP's were nice, but how do you design a juke box that will pick out band 3 on side A in record 24? Columbia's answer to this was the 7-in. LP, with one short piece per side. But this time RCA had the advantage of being there first; the 45 was already established for pop music, and it was better than the small LP in every way in which it wasn't just as good.

The Battle of the Tapes

We enjoy telling you how each aspect of the 12 year basic research program on sound reproduction contributed to the unconventional features found in the Bose 901 and 501 DIRECT/REFLECTING® loudspeakers.* We also take pride in quoting from the unprecedented series of rave reviews because to us they are like awards won for the best design.†

However, it is important to realize that the research and the reviews are of only academic interest unless the speakers really are audibly superior. It is equally important to realize that YOU are in every sense the ultimate judge, for you are the one who lives with the sound you choose.

So—forget the rave reviews and the research and sit in judgement of two fascinating experiments. Take your most exacting records to any franchised BOSE dealer and:

1. Place the BOSE 901's directly on top of any other speakers, regardless of their size or price, and

make an A-B listening test with your records.

2. Place the BOSE 501's beside (with at least 2 feet clearance) any other speaker using woofers, tweeters and crossovers and perform the A-B listening test. (Don't ask the price of the 501 before the test!)

Then, just enjoy your records. When you finish you will know why we get much more satisfaction from our work than could ever be derived from profits alone.

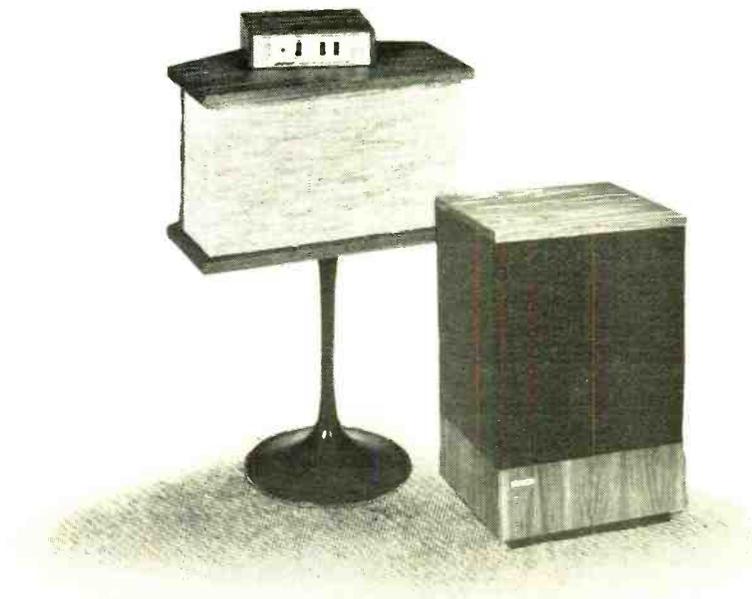
P.S. If you already own expensive speakers, many dealers will lend you a pair of BOSE 901's for an A-B in your living room, where the acoustics are generally far superior to those of the speaker-lined showroom.

* Copies of the Audio Engineering Society paper, 'ON THE DESIGN, MEASUREMENT AND EVALUATION OF LOUDSPEAKERS', by Dr. A. G. Bose, are available from the Bose Corp. for fifty cents.

† For copies of the reviews, circle our number on your reader service card.

You can hear the difference now. **BOSE**®

Unless they're audibly superior it's all academic.



The BOSE 901 and BOSE 501 are covered by patent rights, issued and pending.

CIRCLE NO. 9 ON READER SERVICE CARD

Beware of Stylus Carnivorous, The Vinyl Cannibal.



Stylus Carnivorous can grow under your phonograph cartridge, when you haven't been careful to check the condition of your cartridge and stylus from time to time. He thrives on neglect. The result: your records could suffer.

You can avoid Stylus Carnivorous by taking your cartridge to your high fidelity dealer for a check-up about every six months. Our Pickering dealers will be happy to do this for you—free.

If your cartridge is a Pickering (and it just might be, since more Pickering cartridges are installed on record players than any other cartridge) and if you need a new stylus, you can get the precise Pickering replacement. Ask for the one that matches the stylus originally engineered for your equipment.

So if your stereo has been sounding strange, maybe it's not your stereo. Maybe it's old Stylus Carnivorous. For free brochure, "Questions and Answers About Cartridges and Styli" write Pickering & Co., Inc., Plainview, N.Y. 11803.



"for those who can hear the difference"

All Pickering cartridges are designed for use with all 2 and 4-channel matrix derived compatible systems.

CIRCLE NO. 33 ON READER SERVICE CARD

Although nobody had even begun to think about something called a classical-recording crisis in the late 40's, sales of classics even then were a tiny proportion of total record sales. The pop divisions of the record companies quite literally paid the bills for the classical divisions, and no one thought anything about it. Classics were a prestige line, good for the record company's corporate image—and that was that. It was doubtful, though, that the LP's suitability for a prestigious money loser could have saved it, had it not been for the hi-fi press.

Maybe it was just dumb luck, or maybe someone at Columbia Records had a genius for timing; but the LP record hit the market just as the hi-fi mania was getting off the ground. Perhaps it was also merely fortuitous that practically all record reviewers and the one magazine being published then for the hi-fi fraternity were oriented exclusively to the classics. They saw what the LP could do for classical recordings, and the long uninterrupted playing time alone was enough to send them into fits of unbridled enthusiasm for Columbia's invention.

Initially, the only real advantage of the LP was its extended playing time. But once the die was cast, with 45's being aimed at the pop market and LP's at the hi-fi enthusiast and classics listener, evolution took over and made the schism irreversible. Since juke boxes don't have readily accessible volume controls, and people don't usually bother to adjust volume between sides of a stack on a record changer, the production of 45-rpm records became a contest to see who could ram the highest modulation levels on them. All other considerations, including any pretense of fidelity, took a back seat to volume; and this is still the case today.

The LP (now in its stereo phase), on the other hand, became the medium for improvement, where fidelity-enhancing developments like Dolby mastering, predistortion (to compensate for playback tracing distortion), and improved cutting amplifiers and cutterheads are employed as soon as they become available. Today, most audio perfectionists maintain that a good 33 $\frac{1}{3}$ -rpm stereo disc can provide the highest fidelity obtainable from anything but an original master tape.

Unfortunately, we can't buy master tapes, nor can we obtain direct copies of

NEWS ITEM: New government rules put Cable TV in direct competition with commercial TV in 100 largest cities.

The Cable TV explosion has begun---and CREI is ready with advanced home training to make you part of it.

Most people have one great opportunity in a lifetime. Yours may have come in February of this year when the Federal Communications Commission changed the rules that had been choking the growth of Cable TV.

Experts predict that Cable TV will become a 2-billion dollar industry, giving TV viewers a choice of more than 40 chan-

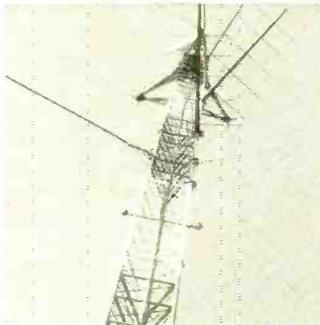


nels of entertainment, news, education . . . and eventually making it possible for them to shop, and even bank, by TV!

This explosive growth has already created many thousands of job opportunities and will create even more in the next few years.

What Does This Mean To You?

Your experience in electronics plus specialized Cable TV training can equip you to take advantage of the serious manpower shortage in the Cable TV field. You can enjoy a well-paying, exciting career designing, manufacturing, in-



stalling or servicing Cable TV systems.

CREI Can Give You The Training You Need

CREI anticipated today's developments in Cable TV. Working with specialists in the field for the past two years, CREI has developed a home study course that will give you just the knowledge you need to make the move into a field that many say will change this country's way of life.

You Can Have Confidence In CREI

CREI has helped thousands of men move ahead in every field of the electronics industry. Leading companies recognize the quality of CREI education; many pay all or part of CREI tuition for their employees.

Study At Home

At your own pace, your own schedule . . . without giving up your present job. Lessons are written to be clearly understood without the presence of a teacher. Many men learn far better through home study than they did in the classroom.

Send For Free Book Today

Use coupon or write: CREI, Dept. E1224C, 3939 Wisconsin Avenue, Washington, D.C. 20016.

Founded 1927

CREI

Accredited Member
of the National
Home Study Council

CREI, A Division of the McGraw-Hill
Continuing Education Company
Dept. E1224C, 3939 Wisconsin Avenue,
Washington, D.C. 20016

Please mail me FREE book describing
today's opportunities in Cable TV and how
CREI can help me take advantage of them.

Name _____ Age _____
Address _____
City _____ State _____ Zip Code _____
Employed by _____
Type of Present Work _____



APPROVED FOR TRAINING UNDER NEW G. I. BILL

FIGHT INFLATION!

Still the greatest value in CB base antenna history...

The Magnum

MODEL M-117 \$32.95
Suggested resale price

- The original omni-gain antenna—3.75 solid dB gain!
- "Hi-Q" phasing transformer, weatherproof construction!
- $\frac{1}{4}$ wave length radials!
- More CBers own Magnums than any other base station antenna!



Be an "antenna specialist!" These great, top-quality jackets available only from your A/S dealer—just \$8.95.

the antenna specialists co.



"Stripes of Quality"

Div. of **allen** Electric & Equipment Co.
12435 Euclid Avenue • Cleveland, Ohio 44106
EXPORT: 220 Shames Drive Westbury, L.I., New York 11690
CANADA: A. C. Simmonds & Sons, Ltd.

CIRCLE NO. 4 ON READER SERVICE CARD

them. But we can go into a store and buy a high-speed-duplicated copy of a copy of the original master on open-reel, cassette, or cartridge.

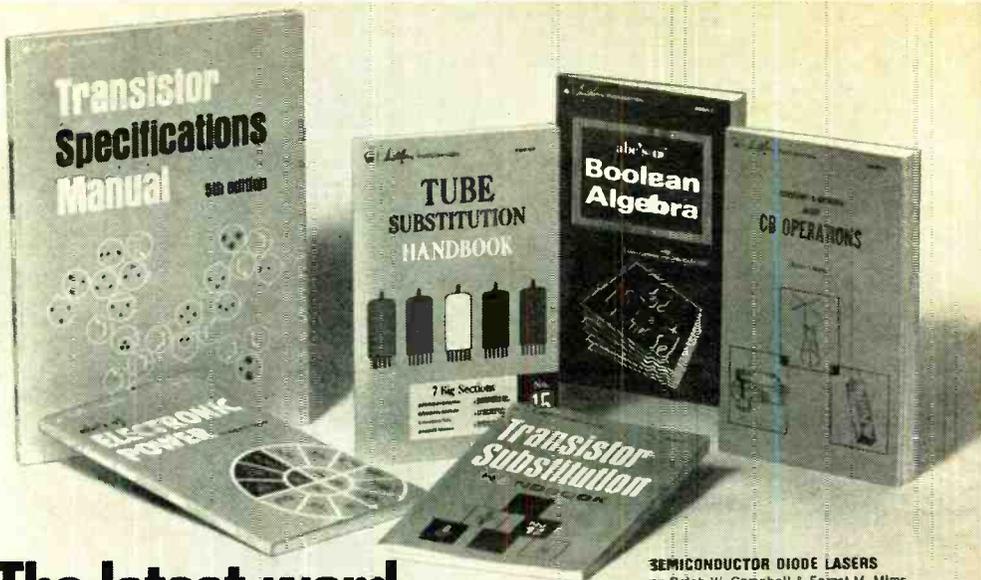
The Tape Formats. Open-reel prerecorded tapes appeared in the late 50's as the first medium for stereophonic sound in the home; but they never became competitive in price with discs. Although they still have an ardent following, mainly among hi-fi enthusiasts, the general public simply couldn't be bothered with threading them. Cartridges would, it was hoped, remove this last objection to tapes in the home.

The whole idea of the cartridge is that anyone can learn to use it and can hardly damage it. Push it in a slot and it plays. Pull it out and it stops, to resume exactly where it left off when it is plugged in again—no complicated threading, no confusing controls like rewind, fast forward, or pause. It was thus ideal for an all-thumbs housewife (or hubby) and perfect for someone who's driving a car or piloting an airplane and would rather not take his eyes off his course to thread an open-reel tape and press the appropriate button to start it running. Along with the idea of utter simplicity went the assumption that the cartridge was to be a playback-only medium, like discs. There were no VU meters on early cartridge machines and no little red button marked RECORD.

Then came the cassette, which was just like the cartridge except that it ran at half speed with half the tape width. It used a length of tape shuttling between two tiny reels (instead of the continuous loop in a cartridge), and it could be moved at fast forward, rewind, and recorded by the user. Then, suddenly, we started seeing cartridge machines with a fast forward control, recording level indicators, and the little red button for RECORD. It was obvious that both formats were aimed at the same market and were going to compete with one another. In other words, another battle of the speeds seemed (and seems) in the offing—if it hasn't already started. So, which will win? Maybe we can hazard an educated guess, based on the facts, and with an eye on what happened last time.

Consider the following points:

- Both formats are eminently portable, with cassettes having a slight edge.
- Both are equally capable of



The latest word on Electronics!

Sams presents 9 brand new or completely revised books
...invaluable working aids for anyone in electronics.

TRANSISTOR SPECIFICATIONS MANUAL 5th Edition

by the Howard W. Sams Engineering Staff
160 fact-packed pages of electrical and physical data for nearly 10,000 transistor types. Lists electrical and physical parameters, essential facts for servicing, and manufacturers of each type. All EIA-registered TO outlines are shown and dimensioned drawings are provided for nonstandard cases.
No. 20883 \$4.50

ABC'S OF ELECTRONIC POWER

by Rulus P. Turner
A clear explanation of electronic power and how to measure it, each point clearly illustrated by worked-out examples. No step in the mathematical solution is omitted. Covers: fundamentals, dc power measurement, ac power measurement, rf power measurement.
No. 20884 \$3.50

TUBE SUBSTITUTION HANDBOOK 15th Edition

by the Howard W. Sams Engineering Staff
The most complete, up-to-date direct tube substitution guide you can use. Includes over 12,000 substitutions for receiving and picture tubes. Easy to use. Sections cover: cross reference of all American receiving tubes, picture tubes and recommended substitutions, cross reference of subminiature tubes, industrial substitutions for receiving tubes, communications and special-purpose tube substitutions, cross reference of American and foreign tubes.
No. 20889 \$1.75

TRANSISTOR SUBSTITUTION HANDBOOK 12th Edition

by the Howard W. Sams Engineering Staff
Here is the answer if you can't get an exact replacement for a failed transistor. Using computers, the Sams Engineering Staff made over a billion comparisons of electrical and physical parameters of all transistors. The over 100,000 substitutions that can be safely and satisfactorily made are listed here in easy-to-find order.
No. 20899 \$2.25

ABC'S OF BOOLEAN ALGEBRA 3rd Edition

by Allan Lytel and Lawrence Buckmaster
A knowledge of Boolean algebra, the algebra of logic, is essential for anyone wishing to understand the logical functions of computer circuitry. This text introduces and explains symbolic logic and shows, with simple block diagrams and examples, the relation between language and switches, and the principles of logical design. It shows how to write logical expressions, expand and simplify them, and how to use relays and switches in circuits.
No. 20867 \$3.50

QUESTIONS AND ANSWERS ABOUT CB OPERATION 2nd Edition

by Leo G. Sands
A quick and handy reference source of information about CB radio; its classes and uses, licensing and FCC rules, operating procedures, selection of CB equipment, and installation of transceivers and antennas in mobile and fixed-station locations. As valuable for anyone who works with CB radio as it is for electronics engineers and technicians.
No. 20893 \$2.95

SEMICONDUCTOR DIODE LASERS

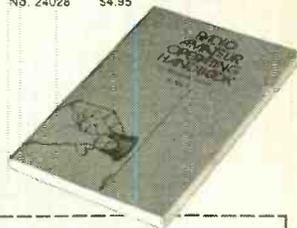
by Ralph W. Campbell & Forrest M. Mims
This introduction to the rapidly expanding use of the injection laser shows how the science progressed from ruby rods to its present compact, highly efficient, and economical form of the semiconductor diode laser. It gives information on construction methods, circuits, conventional and infrared photographs, power requirements, power output, medical uses, and future possibilities.
No. 20887 \$5.95 (tentative)

SOLID STATE SERVICING

by William Sloat
Easy-to-understand, practical service information to aid the service technician in repairing any solid state electronic equipment used in black and white TV, color TV, and radio circuitry. Includes troubleshooting hints and procedures.
No. 20888 \$4.95 (tentative)

RADIO AMATEUR OPERATING HANDBOOK

by Marshall Lincoln, W7DOS
While it is not a technical book on electronics, this book is a practical single-source working guide for hams. It covers all facets of on-the-air operating activities as well as the building, testing, and modifying of equipment. It is particularly intended to improve the ham's operating methods and techniques in radio communication.
No. 24028 \$4.95



HOWARD W. SAMS & CO., INC.

PE 042

20883 20893

Order from your Electronics Parts Distributor, or mail to Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Indiana 46268.

20884 20887

Send books checked at right. \$_____ enclosed. Please

20889 20888

include sales tax where applicable.

20899 24028

Canadian prices slightly higher.

20867

Send Free 1972 Sams Book Catalog.

Name _____

Address _____

City _____

State _____

Zip _____

CIRCLE NO. 37 ON READER SERVICE CARD

accommodating long musical works, of up to 90 minutes duration. However, while the cassette will have a single track change half way through the work, the cartridge must change tracks three times. (Cassettes are available with a running time of 120 minutes but the extremely thin tape is too fragile for many transports.)

- Cartridges, having no definite beginning or end, are not as good for recording compositions—like symphonies—which start here and end there. Specific locations on the tape can be found only by trial and error (in one direction only) or by using a system of signal tones on the tape and a sensing circuit in the transport mechanism. They do, however, play over and over—without rewinding or track switching—a program of 40 minutes or less.

- Cassettes, having a definite start and end, are ideally suited to music with a beginning and end and allow for the use of a resettable digital counter plus rewind and fast-forward facilities for locating specific selections on the tape.

- Neither format is ideally suited for single, short selections. Three minutes in each direction would use so little tape that the housing would constitute a major part of the cost, making the price per minute too high and not competitive with 45-rpm discs. (Would you pay \$2.95 for 6 minutes of music?)

- Since the pop single has been waning as a significant factor in record sales, this field will probably be left to the 45-rpm disc. (Most big-selling releases now are “albums” of several songs per side.) Thus, the prospect of juke boxes loaded with cartridges or cassettes does not appear to be promising.

- Despite the potentially superior fidelity implicit in their higher speed, early 8-track cartridges did not sound substantially better than early cassettes. Since then, cartridge sound has been improving (marginally), while the cassette has been steadily and sometimes dramatically improving in fidelity. Chromium dioxide tape was introduced to the consumer market in cassettes, and the first pre-Dolbyed recordings (for subsequent noise-reducing deprocessing at home) were on cassettes.

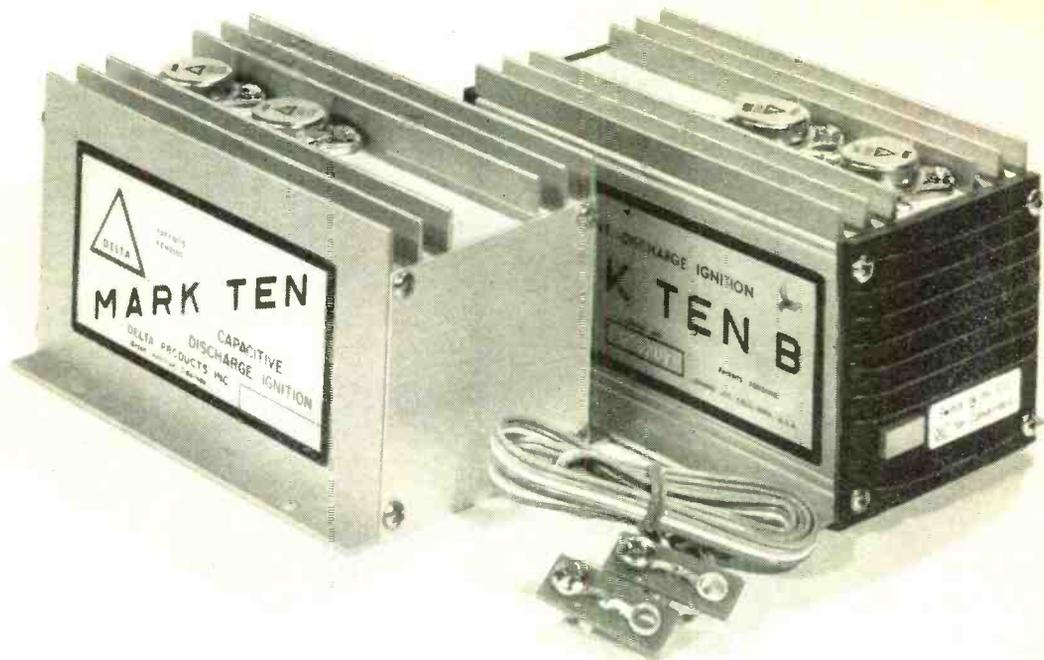
- Matrixing systems, for recording and extracting quadrasonic signals from two channels, are fine for reproducing concert-hall ambiance and the rear half of

antiphonal music; but it is generally agreed that 4 discrete channels do the best job of reproducing sounds from specific rear locations—like a guitar from rear left and a singer from rear right. Both tape formats use recorded tracks of about the same width, and narrower tracks are deemed impractical; so any attempt to record discrete quadrasonic music must halve the tape’s total running time. Since discrete quadrasonic music is likely to find more application in pop music than in other types, it is a happy coincidence that it can be done in cartridges without impairing their compatibility (with 2-channel stereo reproducers). Quadrasonic cassettes will probably be matrixed, thus retaining their full potential running time.

- The useful life of a cartridge is limited by the durability of the lubricant between its tape layers. Cassettes have a life expectancy equal to that of open-reel tape, and are thus obviously better suited to building a music “library.”

In other words, although there are fewer differences between the two tape formats than there were between the competing disc systems, the present situation is not unlike that in the early 50’s. One medium—the cartridge—is ideal for pop music and will probably come to dominate that market. The other medium—the cassette—has more to offer the classics listener, the casual hi-fi buff, and the average person whose taste runs to background music, Broadway shows, and movie sound tracks. And except for its poor suitability for discrete quadrasonic reproduction (whose sales appeal has yet to be determined), the cassette also has as much to offer the pop music buyer as does the cartridge. It is also ideal for portable recording, dictation, and use in autos, boats, and private airplanes.

Thus, while the cartridge undoubtedly has the pop music market pretty well sewed up at present, the cassette has more to offer to a much wider, if temporarily smaller, market. And since wide appeal was apparently what put the LP in the driver’s seat, it could eventually do the same for the cassette. However, I wouldn’t throw away my disc equipment yet. This is still the favored medium for people who collect recordings; and its popularity among them, and among critical hi-fi enthusiasts, shows no sign of waning. ◆



Save money and improve car performance at the same time.

Maintenance costs go down and performance increases when you put a Delta Mark Ten Capacitive Discharge Ignition System on your car.

For eight years we've been telling you about the tremendous advantages of CDI systems. We've promised and delivered better performance for cars, boats and trucks. Hundreds of thousands of satisfied customers testify to that fact. However during these eight years, we've been asked over and over again, "If CDI systems are so great, why doesn't Detroit adopt them?" It's taken a long time, but finally Detroit has recognized the value of the CDI system. Chrysler, long noted for excellence in engineering, is now installing electronic ignitions in new cars. Have you seen their ads? Heard their commercials? They're repeating what we've said for eight years. *Electronic ignition systems not only improve performance, but eliminate the need for most tune-ups.* If you're not buying a new car, but want new car performance, put a Mark Ten or Mark Ten B on your present automobile. If you're purchasing a new car with no CDI system, install a Mark Ten or Mark Ten B and enjoy the benefits of low maintenance and increased performance.

HERE'S WHAT A MARK TEN WILL DO FOR YOU:

Mark Ten and Mark Ten B—up to 20% increase in gasoline mileage Eliminates 3 out of 4 tune-ups Installs in only 10 minutes Spark plugs last 3 to 10 times longer Dramatic increase in performance Promotes more complete combustion Instant starts in all weather.

Mark Ten B—Improves combustion, reducing contaminants Handy switch with redundant contacts for instant return to standard ignition Applicable to ANY 12 volt negative ground engine Eliminates starting and idle problems Longer spark duration during cranking and idling.

Superior Products at Sensible Prices

Mark Ten (Assembled) \$44.95
ppd

Mark Ten (Deltakit) \$29.95
ppd

Kit available in 12 volt only,
positive or negative ground

Mark Ten B \$59.95 ppd
(12 volt negative ground only)

Order today!



Dept. PE
DELTA PRODUCTS, INC.

P.O. Box 1147 / Grand Junction, Colo. 81501
(303) 242-9000

Please send me literature immediately:

Enclosed is \$____ Ship ppd. Ship C.O.D.

Please send:

___ Mark Ten B @ \$59.95

___ Standard Mark Ten (Assembled) @ \$44.95

___ 6 Volt: Neg. Ground Only ___ Positive Ground

___ 12 Volt: Specify ___ Negative Ground

___ Standard Mark Ten (Deltakit®) @ \$29.95
(12 Volt Positive Or Negative Ground Only)

Car Year _____ Make _____

Name _____

Address _____

City/State _____ Zip _____

**CIRCLE NO. 13 ON READER
SERVICE CARD**

**Hunting for
a better job?**

**CIE will
help you get
the license
you need**



A Government FCC License can help you qualify for an exciting, rewarding career in ELECTRONICS, the Science of the Seventies. Read how you can prepare for the license exam at home in your spare time — with a passing grade assured or your money back.

IF YOU'RE OUT TO BAG A BETTER JOB in Electronics, you'd better have a Government FCC License. It will help you track down the choicest, best-paying jobs in the growing field of Electronics.

Demand for people with technical skills is growing twice as fast as any other group, while jobs for the untrained are rapidly disappearing. Right now there are thousands of new openings every year for electronics specialists. And you don't need a college education to qualify!

But you *do* need knowledge, knowledge of electronics fundamentals. And there is only one nationally accepted method of measuring this knowledge... the licensing program of the FCC (Federal Communications Commission).

Why a license is important

An FCC License is a legal requirement if you want to become a Broadcast Engineer, or get into servicing any other kind of transmitting equipment — two-way mobile radios, microwave relay links, radar, etc. And even when it's not legally required, a license proves to the world that you understand the principles involved in *any* electronic device. Thus, an FCC "ticket" can open the doors to thousands of exciting, high-paying jobs in communications, radio and TV broadcasting, the aerospace program, industrial automation, and many other areas.

So why doesn't everyone who wants a good job in Electronics get an FCC License?

The answer: it's not that simple. The government licensing exam is tough. There is one way, however, of getting the kind of preparation that will help you pass the FCC exam. And that is to take one of the FCC license-preparation courses offered by Cleveland Institute of Electronics.

Our training is so effective that better than 9 out of 10 CIE graduates pass the FCC exam. That's why we can offer this famous Money-Back Warranty: when you complete any CIE course which provides FCC License preparation, you'll get your FCC License or a full refund of all tuition paid. This warranty is valid during the entire completion period established for the course selected. You get your FCC License — or your money back.

And with CIE, you learn at home in your spare time. With AUTO-PROGRAMMED* Lessons, you'll pick up the facts, figures and electronics theories you

CIE HAS CAREER COURSES TO FIT YOUR BACKGROUND

ELECTRONICS TECHNOLOGY with LABORATORY... teaches you the fundamentals. With a 161-piece laboratory you apply the principles you learn by analyzing and trouble-shooting electronics equipment.

ELECTRONICS ENGINEERING... A college-level course for men already working in Electronics. Covers steady-state and transient network theory, solid-state physics and circuitry, pulse techniques, computer logic and mathematics through calculus.

may have considered "complicated"... even if you've had trouble studying in the past.

CIE Grads get licenses... better jobs

The value of CIE training has been demonstrated time and again by the achievements of our thousands of successful students and graduates.

An outstanding example is Ed Dulaney of Scottsbluff, Nebraska. He passed his 1st Class FCC License exam soon after completing his CIE course. Today, he owns two companies... one to manufacture and distribute two-way radio equipment, the other to maintain and repair such equipment along with home radio, TV and stereo sets. He says: "In the last three years we sold more than \$1,500,000 worth of equipment through dealers in every state plus Canada, South America and Europe."

Richard Kihn, Anahuac, Texas, worked in the engine room of a tugboat when he started his CIE training. He reports, "Before finishing, I got my FCC License and landed a job as broadcast engineer at KFDM-TV in Beaumont, Texas. I was able to work, complete my CIE course and get two raises... all in the first year of my new career in broadcasting."

Send for FREE book

If you'd like a chance to succeed like these men, send for our FREE 24-page book "How To Get A Commercial FCC License." It tells you all about the FCC License... requirements for getting one... types of licenses available... how the exams are organized and what kinds of questions are asked... where and when the exams are held, and more.

With it you will also receive a second FREE book, "Succeed in Electronics." To get both books without cost or obligation, just mail the attached postpaid card. Or, if the card is missing, just mail the coupon below.

APPROVED UNDER NEW G. I. BILL. All CIE career courses are approved for *full tuition refund* under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now with more than 180 days of active duty, check box on reply card or coupon for G.I. Bill information.

CIE  **Cleveland Institute of Electronics**

1776 East 17th Street, Cleveland, Ohio 44114
Accredited Member National Home Study Council

Cleveland Institute of Electronics
1776 East 17th Street, Cleveland, Ohio 44114

Please send me without cost or obligation:

1. Your book on, "How to Get a Commercial FCC License."
2. Your illustrated book, "Succeed in Electronics."

I am especially interested in:

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

Name _____ (PLEASE PRINT)

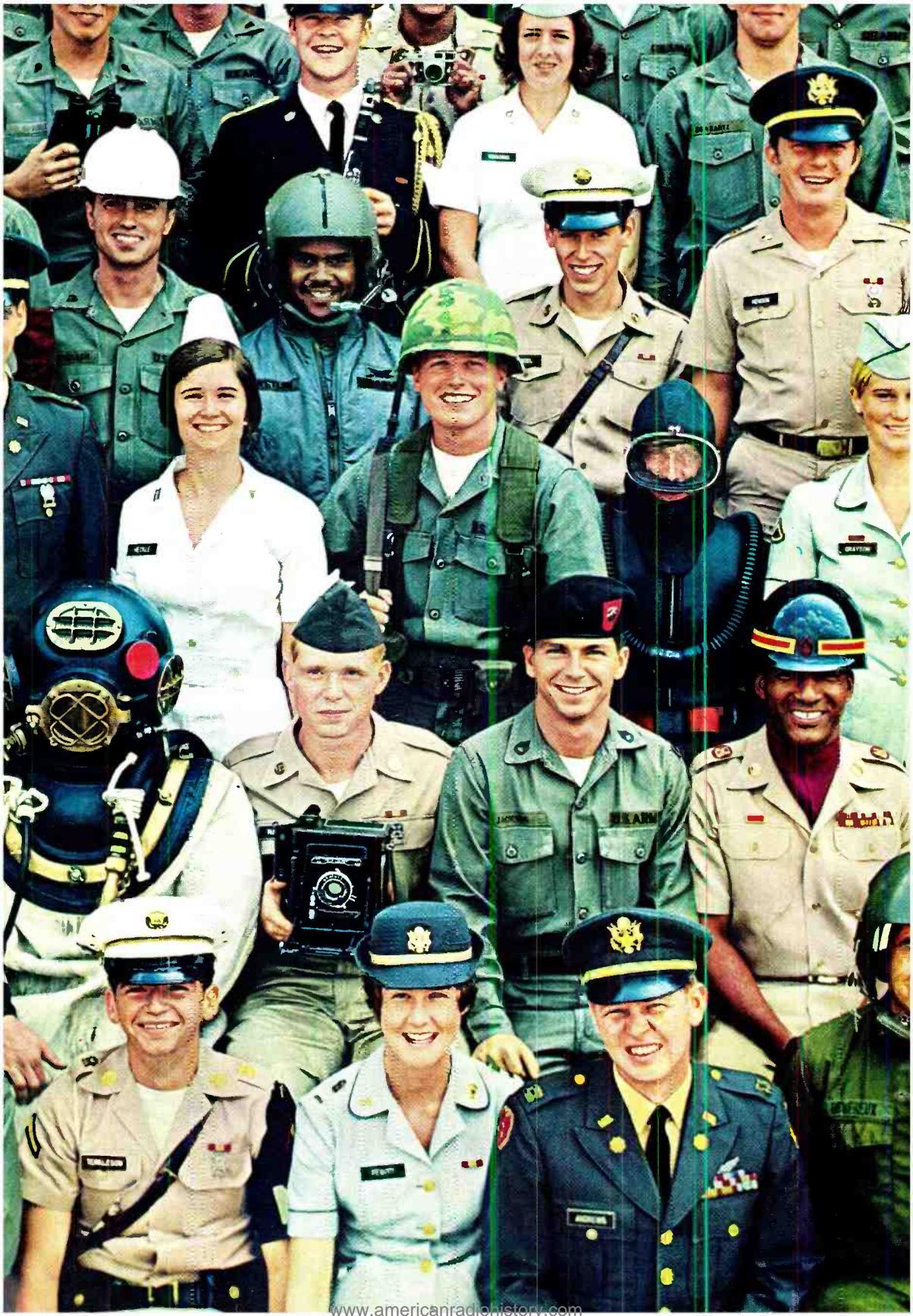
Address _____

City _____

State _____ Zip _____ Age _____

Veterans and Servicemen:
 Check here for G.I. Bill information. **PE-29**

CIRCLE NO. 6 ON READER SERVICE CARD



We've got over 300 good, steady jobs.

Jobs in construction, transportation, communications, computers.

Jobs for photographers, printers, truck drivers, teachers, typists, TV cameramen and repairmen. Cooks, electricians, medical aides, meteorologists. Motor and missile maintenance men.

Jobs for young men. And young women.

Jobs in Europe, Hawaii, Panama, Alaska. And just about any place in the States.

We'll train you to do the jobs. Train you well, in good schools, under excellent instructors, with the best equipment obtainable.

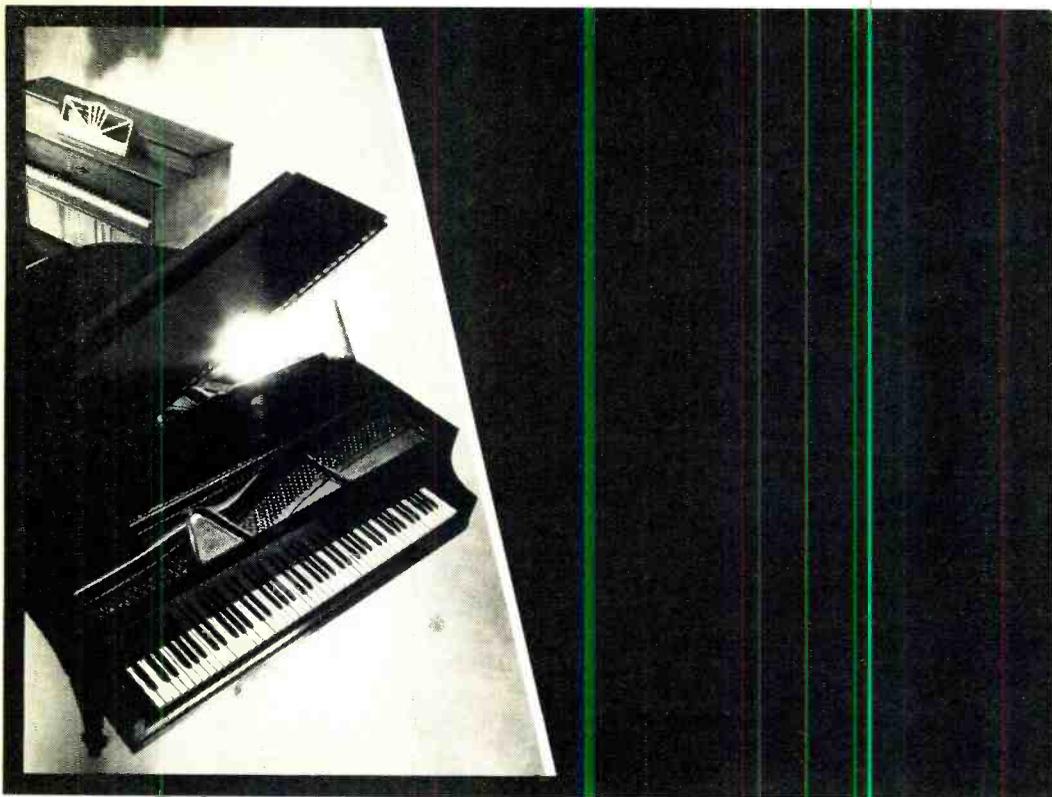
And you get full pay while you train.

You also get unusually good fringe benefits, including a chance to continue your education. In many cases at our expense. In all cases with at least 75% of your tuition paid.

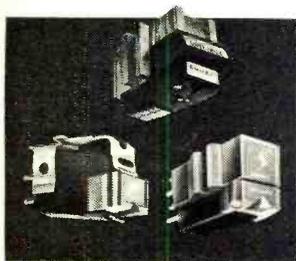
And if you qualify we'll give you your choice of training. We'll put it in writing, before you sign up.

Today's Army wants to join you.

Army Opportunities	Date _____
Dept 200, Hampton, Va 23369	2 PE 4-72
I'd like to know more about the job training and promotion opportunities in today's Army	
Name _____	Date of birth _____
Address _____	
City _____	County _____
State _____	Zip _____
Education _____	



To each his own.



Not everybody needs a concert grand piano, nor does everybody need the best cartridge Shure makes to enjoy his kind of music on his kind of hi-fi system. Eventually, you'll want the renowned *V-15 Type II Improved*, the peerless cartridge for advanced systems and ample budgets. But, if your exchequer is a little tight, consider the *M91E*, widely acclaimed as the *second best* cartridge in the world. With a sharply circumscribed budget, all is *far* from lost. Choose any of the four models in the *M44 Series*, built for optimum performance in the easy-to-take \$18-25 price range. Write for a complete catalog:

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



CIRCLE NO. 40 ON READER SERVICE CARD



News Highlights

Sears to Market Home Video Recorder

At a recent press showing, Sears Roebuck announced plans to market the first integrated videotape cartridge recording-playback unit for the home. The system includes a 25-in. color TV console, which houses the videotape deck, and a lightweight black and white camera. The unit will go on sale in the Chicago area for \$1600. TV programs can be taped in color off the air and prerecorded tape cartridges can be played back in color. Cartridges, either blank or prerecorded, will sell for \$13 to \$40, depending on length and content. The longest tapes offer programs up to 114 minutes. Full-length motion picture tapes can be rented for about \$6 for a single showing (tape cannot be rewound by the user). The tape deck is made for Sears by Avco and uses the company's Cartrivision system. A portable color TV camera is in the works and is expected to sell for around \$400.

Ampex Quitting Consumer Equipment Market

Because of inadequate profits, Ampex is discontinuing operation of its consumer equipment division. The division markets tape recorders for the consumer. The company will continue to sell prerecorded and blank tape and will honor warranties and provide parts for its products. The division represented only about 5 percent of the company's corporate sales last year. About 200 people were with the division; their jobs will be gradually phased out or they will be offered other positions with the company.

Tape Cassette Sales Expected to Rise 18 Percent in 1972

Cassette sales will rise 18 percent to about \$330 million in 1972 according to a prediction by Edward Smulders, manager of Norelco Cassette Dept. The increase will be aided by increased distribution through supermarkets and drug stores. More than 142 million blank and prerecorded cassettes will be sold next year, Mr. Smulders said, compared to an anticipated total for 1971 of 120 million units valued at \$280 million. It is said that there are more than 16 million cassette recorders in the U.S.—one for every four households.

Sperry Rand Takes Over RCA's Computer Customers

Sperry Rand and RCA have signed a final agreement under which Sperry will acquire RCA's customer base in general purpose computers. Under the terms of the agreement, Sperry Rand's Univac Div. will, starting January 1, provide software and hardware maintenance and systems support to RCA's former computer customers in U.S., Canada, and Mexico. These include more than 500 users with more than 1000 computers installed.

Tandy to Sell 36 Allied Radio Stores

The Tandy Corp. has agreed to sell 36 Allied Radio stores it acquired last year when it took over the Allied Radio Corp. A civil antitrust suit was brought against the company last year, and this agreement was contained in a proposed consent judgment filed in the U.S. District Court in Chicago to settle the suit. If approved by the

court, the proposal would become effective within 30 days. Tandy would then sell 36 Allied Radio stores in Illinois, Indiana, Michigan, Minnesota, Missouri, Wisconsin, and Texas. The government had charged that the takeover eliminates competition among electronic parts dealers engaged in retail over-the-counter and mail-order sales to hobbyists.

Electro-Voice and Scheiber Announce Four-Channel Patent

A U.S. patent has been issued to Peter Scheiber of Audiodata Co. covering encoding and decoding matrix techniques for four-channel recording and broadcasting. Scheiber and Electro-Voice had previously agreed to pool their efforts in the protection of patents, licensing, and manufacture of equipment using developments from both firms. E-V's technical director, Howard Durbin, stated that it is the company's belief that the patent is basic and will cover all current or announced matrixing systems. The company is continuing development of their Stereo-4 system (in conjunction with Leonard Feldman and Jon Fixler) which they describe as the first production matrix technique on the market.

Consumer Electronics to Exceed \$5 Billion in 1971

According to preliminary Electronic Industries Association statistics, consumer electronics sales in 1971 will exceed \$5 billion at the manufacturing level including imports, or \$8 billion at retail. This total market includes the sales of television, radio, phonograph, and tape equipment as well as such items as electronic musical instruments, transceivers, hearing aids, and home intercoms. Television, the industry's major product category, will have a record year in both units and dollar volume. Domestic manufacturer sales and foreign imports will exceed 14 million units—7 million in color and 7 million in black and white—for a total estimated sales volume of over \$3 billion. In addition to the 14 million TV sales, radios will reach 45 million units, phonographs 6 million, and tape equipment 15 million units.

Students to Participate in Skylab

Skylab, our manned earth orbital space laboratory to be launched in 1973, will carry some experiments designed by high school students. More than 15,000 applications for participation have been requested of the National Science Teachers Association, which is managing the activity for NASA. Entries consist of proposals by students for experiments, demonstrations, or activities to be performed by the astronauts. Deadline for the proposals to be submitted to the chairmen of one of 12 regions was Feb. 4, 1972. Regional winners will be judged by a national committee and 25 national selectees will be forwarded to NASA. Final selection will be made from the national selectees on the basis of compatibility with Skylab requirements.

Engineering Degrees Show Leveling Off

The number of engineering degrees conferred by the 277 U.S. engineering schools during the year that ended in June 1971 was only slightly more than for the previous year, according to a report released by the Engineering Manpower Commission of the Engineers Joint Council. There were 43,167 bachelor's degrees, only 201 more than last year. At the master's level, where the increase over 1970 was largest, 16,383 degrees were awarded this year compared to 15,548 for the previous 12-month period. Doctor's degrees in engineering, at 3640, barely exceeded last year's 3620. At both advanced degree levels this year's totals were the largest ever recorded. The major field of study, amounting to about a quarter of the total figures, was electrical engineering.

CIRCLE NO. 7 ON READER SERVICE CARD →

new



COBRA 130

Full 15-watt peak envelope power input*.

SIDEBAND! ® T.M.

69 modes to send and receive (equal to 69 channels)! You can always find a clear channel to transmit on. Separate receiver R.F. gain control (gives you absolute control over input signal on SSB operation)!

You've never seen anything like this new Cobra Single Sideband/AM Two-way CB Radio. Really reaches out and penetrates. With a full 15 watts peak envelope power input. And 69 separate communications channels (full range of 23 CB channels *plus* 46 SSB channels). And, frequency synthesizing so you don't need extra crystals. And, integrated circuitry for optimum reliability. And, full power, 12 V DC designed in a mobile unit. In a word, it's sensational!

- Maximum peak output power without overloading.
- Small! (2.55" x 9.0" x 11.38").
- Minimal power drain.
- Average battery current required is far less than with AM because carrier and one side band is suppressed on SSB.
- Series gate noise blanker system.
- Crystal lattice-type filter in sideband generation system.
- Solid state devices include F.E.T.'s and integrated circuit.
- Dynamic microphone and coil cord plugs right in.



A Product of DYNASCAN CORPORATION 1801 W. Belle Plaine Chicago, Illinois 60613

THE SINGLE SIDEBAND UNIT OF THE FUTURE!



COBRA 130: \$349.95

*Maximum power permitted by the F.C.C.

Performance Tests of Cassette Tapes

COMPARATIVE RATINGS OF 20 RAW CASSETTE TAPES WHEN USED ON RECORDERS WITH OPTIMIZED BIAS

BY JULIAN D. HIRSCH
Hirsch-Houck Laboratories

IF YOU want to obtain the best performance from magnetic tapes with respect to frequency response, distortion, and noise, you must have a careful balance among recording bias, recording and playback equalization, and recording level. Although the design of the tape recorder's heads and electronic systems are also vital factors, for any given recorder and tape formulation, the key parameters are the bias and equalization characteristics.

The frequency response of any magnetic tape is far from "flat", and considerable equalization is required at both high and low frequencies to meet audio recording standards. The equalization is divided between the recording and playback amplifiers, but playback frequency response is standardized to permit tapes made on one machine to be played on another. This still leaves the recorder designer considerable latitude in setting bias levels and recording equalization for best results with his heads and available tapes.

The bias is an ultrasonic ac signal (often as high as 100 kHz) superimposed on the audio signal being recorded. It is used to minimize the distortion caused by the inherent nonlinearity of the magnetic tape coating. Bias also affects the recorded level and the frequency response, particularly at high frequencies. The bias, recording equalization, and tape properties are inextricably linked, and in every case require some compromise among level, frequency response, and distortion.

Except in the higher price brackets, most home tape recorders have no adjustments accessible to the user for optimizing performance with any particular tape. They



are generally designed to operate satisfactorily with a variety of tapes, although the manufacturer's specifications may be realized only with a certain recommended tape formulation.

Cassette recorders, which must extract the last bit of performance from the tape in order to meet reasonable high-fidelity standards at their 1½-ips operating speed, are especially critical in their adjustment for the specific tape used. In particular, the bias level is extremely important if a reasonably uniform response in the 8000-Hz to 16,000-Hz octave is to be obtained. Although the user normally has no means of optimizing bias for his tape, the recorder manufacturer often recommends specific tape brands and types which will enable his specifications to be met, and qualified service technicians can adjust almost any machine for use with any tape.

We recently made an extensive study of cassette tapes—some 40 different types—to determine the range of performance one might expect from them with a single recorder whose operating conditions were held constant throughout. Our data suggested that optimizing the machine for each tape could greatly extend the performance. Therefore, we have now evaluated a smaller group of cassette tapes, adjusting the recording bias for flattest overall frequency response with each tape.

The same type of cassette recorder was used in this test (an *Advent* 201), since it is not only representative of the current state of the art in cassette recorders, but is also the only one we know of which provides external access to the recording bias adjustments. We made frequency response measurements with each tape type, adjusting the bias until the flattest response was obtained over the full frequency range of the machine. A calibrated scale allowed us to return to any bias setting at will, and to compare the optimum bias levels for the various tapes. All bias level indications were arbitrary and relative, since any absolute readings would have no significance for any other type of recorder. Whenever possible, a C-60 cassette was evaluated; exceptions are noted in our tabulated data.

Test Procedures. All frequency response

measurements were made at a recorded level of -30 db, relative to the "0 dB" reading of the recorder's meter. This was necessary to avoid tape saturation at high frequencies, which could give erroneous frequency response indications if a higher level were used.

Recordings were made over the full frequency range with each tape. If the playback response in the 10,000-Hz to 15,000-Hz range deviated more than about 2 dB from the mid-range level, the bias was adjusted slightly and the measurement was repeated. Increasing the bias reduced the high frequency response, while less-than-optimum bias resulted in a peaked, or accentuated, high frequency response.

Using the optimum bias setting, we made 1000-Hz recordings at several levels around the 0-dB point, observing the playback distortion for signs of overload. We determined the level (relative to 0 dB) which resulted in 3% distortion (predominantly third harmonic) in playback. The 1000-Hz output from this "3% distortion" level was considered to be the maximum usable output of the recorder with each tape.

We operated the recorder in RECORD mode, with no input signal, and during playback measured the noise level (so-called "bias noise"). This is expressed in decibels below the maximum recording level. The noise measurement was unweighted, but was limited to a 22-kHz bandwidth to eliminate undue influence from inaudible wideband noise.

One of the major weaknesses of cassette tapes is the output fluctuation due to tape coating inhomogeneity ("dropouts") and erratic tape-head contact. The latter is a function of the mechanical design and assembly of the cassette. Unevenness of tape hub friction and tape winding can cause an irregular output amplitude similar to that resulting from actual tape coating defects.

We evaluated each cassette for output uniformity by recording a 10,000-Hz tone for 3 minutes, using the middle of the tape, where best performance can be expected. Many cassettes are somewhat erratic near the ends of the tape. We then recorded the playback output on our graphic level

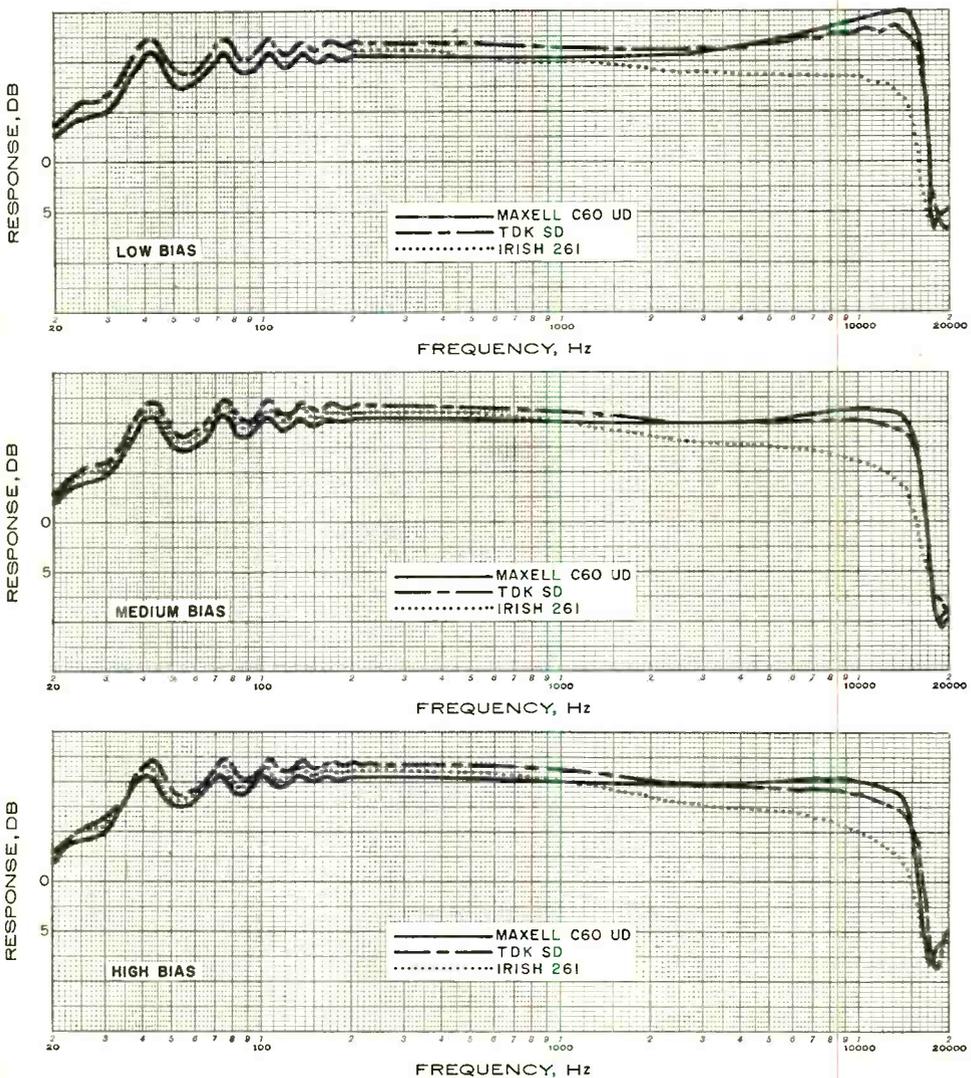
recorder for the full 3 minutes. The degree to which the trace departed from a narrow straight line was an indication of the tape output nonuniformity. Mechanical problems within the cassette could be distinguished from tape dropouts by their periodic occurrence.

Finally, the method of cassette assembly was noted. Some cassettes use screw-assembled (S) cases. If the tape breaks, it is usually possible to open the cassette and retrieve both ends for splicing. On the other hand, the welded (W) case used on most cassettes cannot be opened non-de-

structively, so that a tape breakage means the loss of the cassette.

Two of the cassettes employed unique mechanical features, not found in any of the others. The *BASF C-120 "Chromdioxid"* was packaged in the new *BASF "SM"* design. This refers to an internal construction which places the tape windings under controlled tension to prevent uneven winding. Also an additional pair of slots is included in the back of the cassette, adjacent to the tabs which can be removed to prevent recording over a previously recorded program. These slots will allow automatic se-

Frequency responses of three representative tapes in the low-, medium-, and high-bias categories with recorder supplying (top to bottom) low, medium, and high bias.



CHARACTERISTICS OF TAPES BY BIAS CATEGORY

Tape Type †	Case Type (S or W)	% THD at			Recording Level for 3% THD (dB)	Bias Noise	Output Uniformity	Relative Output (re 3% THD)	Price
		-3 dB	0 dB	+3 dB					
Low Bias									
Capitol	W	2.2	3.3	6.3	-0.5	-50 dB	B	+0.5 dB	\$1.19
Irish 261	W	—	3.0	—	0	-49.5	B	+1.0	1.85
Memorex	W	2.3	2.9	5.8	0	-51	C	+1.7	2.75
TDK LN	S	1.8	2.1	4.0	+2.5	-52	B	+2.0	1.29
Low/Medium Bias									
Soundcraft	W	2.0	2.5	4.3	+1.5	-51.5	B	+3.2	2.65
3 M "High-Energy"	W	2.7	4.0	7.2	-2.0	-51	B	+2.0	3.70
Medium Bias									
Ampex 362	W	1.9	2.7	4.4	+1.0	-51.5	B	+1.0	2.95
Audiopak (Audiotape)	W	2.1	2.8	4.3	+1.5	-50.5	B	+3.2	2.65
Auricord "PRO"	S*	1.9	2.5	4.2	+2.0	-50	B	+2.5	3.95
BASF C60LH	S	1.6	1.9	2.6	+4.0	-54.5	B	+4.0	2.65
Irish 262	W	1.9	2.7	4.2	+1.0	-50	C	+1.0	2.55
TDK SD	S	1.6	1.9	2.4	+4.0	-55	B	+5.3	1.99
Medium/High Bias									
Sony C-90	S	1.7	2.2	3.0	+3.0	-53.5	A	+3.7	1.69
Sony UHF	S	1.6	2.0	3.0	+3.0	-54	B+	+4.5	2.29
High Bias									
Hitachi UDC-90	S	1.9	2.0	3.0	+3.0	-53.5	A	+2.5	4.50
Maxell UD	S	2.0	2.0	3.0	+3.0	-53.5	B+	+3.2	3.75
Chromium-Dioxide									
Ampex 363	W	2.1	2.2	2.7	+3.5	-54	B	+2.0	3.95
BASF C-120	S	1.8	2.3	3.2	+2.5	-52.5	B	+0.9	8.29
Irish 363	W	2.1	2.3	2.9	+3.5	-54.5	B	+1.0	3.75

*Metal cassette.

†C-60 cassette except as noted.

lection of special bias and equalization for CrO₂ tape in future recorder designs, although none of these are yet available. The Auricord "PRO" cassettes are made of cast metal, instead of the usual plastic. This is claimed to provide superior dimensional stability with temperature variations, and to eliminate problems from build-up of static charges during operation.

Test Limitations and Qualifications. As we have stated, several interrelated operating parameters determine the ultimate performance of any cassette tape. By appropriate adjustment of bias and recording equalization it is possible to optimize any cassette in any recorder. However, recording equalization is rarely user-adjustable, and recorder manufacturers are reluctant to encourage any tampering with the internal factory settings.

The only firm conclusions one can draw from our tests relate to the degree of optimized performance obtainable on an *Advent* 201 recorder, with bias as the variable parameter. In a broad sense, our findings should apply to most other cassette recorders. It is always possible, however, that with a different recording equalization char-

acteristic, a different bias level would be required and one might obtain a different signal-to-noise or distortion measurement on any given tape.

We have also found some variation between cassettes of the same make and type, in respect to optimum bias and output uniformity. Since our tests, in most cases, were limited to a single sample, no guarantee can be offered that all samples of the same type will be identical. Doubtless some manufacturers produce a more uniform product than others, but a meaningful evaluation of this factor is beyond our capabilities.

Test Results. We tested 20 different cassettes, from 13 manufacturers. The overall frequency response was largely a function of the recorder design, and differences between tapes were insignificant once the bias had been optimized. The major differences were in the 14,000-Hz to 16,000-Hz range. The output of some tapes fell off rapidly above 14,000 Hz, while others showed a useful output between 15,000 and 16,000 Hz. In practical, audible terms, these distinctions are of little importance.

From the standpoint of optimum bias,

most of the cassettes fell into two categories, which we called "low-bias" and "medium-bias" tapes (purely arbitrary classifications, of course). Within each category, all the tapes gave their best frequency response with the same bias. The so-called "standard" tapes require a "low" bias, and most "extended range" tapes fall into the "medium-bias" category. The only "high-bias" tapes in the group were the *Hitachi* and *Maxell* Ultra-Dynamic cassettes. The *Sony* tapes required a bias intermediate between the "medium" and "high" settings, while the *Soundcraft* and *3M* High Energy tape operated between the "low" and "medium" bias ranges.

The three chromium dioxide tapes were tested with the special bias and equalization settings provided by the CrO₂ switch on the *Advent* 201. No attempt was made to change the CrO₂ bias, which was already optimum for these tapes.

The effect of bias on output and frequency response, for three representative tapes in the "low," "medium," and "high" bias categories, is shown in the graphs. Note that a bias setting giving flat response with a "low-bias" tape results in a rising high end with "high" and "medium-bias" tapes. On the other hand, a recorder biased for a "high-bias" tape will suffer a loss of highs with "medium" or "low-bias" tapes.

The other data is presented in tabular form. Most of the column headings are self-explanatory. The Relative Output referred to 3% THD is the algebraic sum of the recording level giving 3% distortion and the relative playback levels from a 0 dB recording level. Since a tape delivering a very high output from a 0-dB input might distort at a lower level, compared to some tape with less output but the ability to be recorded at a higher level without distortion, this column indicates the actual useful relative outputs of the various tapes, as operated in the *Advent* 201 recorder.

The output uniformity was graded as A, B, or C. The fluctuation in the A and B outputs is periodic, indicating a slightly uneven hub friction or mechanical tape-to-head contact. In the C examples, the trace shows a little more random variations.

Summary and Comments. As the data shows, unless one uses the type of tape for which the recorder is biased, there is little chance of realizing the potentially wide

range, low noise, and low distortion designed into the recorder and the tape. At present, *Advent* is the only manufacturer we know of offering this bias adjustment capability for the technically competent consumer, but qualified service agencies should be able to do the same for most other machines.

Most tapes are very similar in their noise characteristics, with a signal-to-noise ratio of 49 dB to 52 dB in this machine. The premium tapes (*BASF* LH, *TDK* SD, *Sony*, *Hitachi* UD, and *Maxell* UD) average 3 to 5 dB better, as do the chromium dioxide tapes. The chief measurable advantage of the latter is their flatter response at the extreme high frequency end, with generally 3 to 5 dB more output at 15,000 Hz than the best ferric oxide tapes. On the other hand, although they were slightly "flatter" above 10,000 Hz, there was no significant difference between them and the ferric oxide tapes below 13,000 or 14,000 Hz.

Many of the tape brands we tested are also available in C-90 and C-120 cassettes, providing longer playing time. One cannot assume that the performance of a longer playing cassette will equal that of a C-60 of the same brand. The longer playing versions use thinner tapes and have thinner magnetic coatings, as well as potentially greater mechanical problems. However, judging from the few C-90 and C-120 cassettes included in this test, a good brand of tape can deliver excellent performance in any length.

The majority of the tapes had good output uniformity characteristics. We listened carefully to music recordings to judge the audibility of each grade of performance in our uniformity classification. With a B or C tape, an occasional roughness could be heard, but its offensiveness depended strongly on the nature of the program, as well as the sensibilities of the listener. Pop music is relatively tolerant of minor fluctuations, while most classical music is not. The B+ and A tapes were essentially free of audible roughness, and certainly came very close to open reel tape in this respect.

It is noteworthy that one manufacturer's "standard" tape may be better than another's "low noise" tape, and sometimes there is little difference between the "premium" and standard tapes (often called "low noise") of the same manufacturer. A greater difference might be apparent under different test conditions. ♦

Earth Station for Satellite Experiments

GLOBAL TV BECOMING A REALITY

TRUE global television coverage from almost anywhere on the earth may soon be a reality with the development of an air-transportable earth terminal for the ATS (Applications Technology Satellite). Recently demonstrated by the Hughes Aircraft Co., the station is to be used for satellite-relayed TV and voice communications with receive-only ground stations, and for voice and data transmissions to aircraft in flight. These experiments will be started when the new ATS series F and G satellites are orbited in 1973 and 1975.

The mobile station, an outgrowth of small-earth-terminal technology developed at Hughes can be rapidly airlifted anywhere in the world and can be assembled and made ready for use in two hours by a three-man crew.

Among the features of the new terminal are a polar antenna mount that permits rapid and easy alignment of the antenna on a synchronous-orbit satellite 22,300 miles above the earth at the equator and a simplified antenna feed system that eliminates interference with terrestrial communications systems.

Each station is equipped with two parabolic antennas—one a dish 21 feet in diameter for operation in the uhf (835 to 885 MHz) and C band (5925 to 6425 MHz) and a companion 15-foot dish for the S (2050 to 2100 MHz) and L (1500 to 1580 MHz) bands. Both transmission and reception will be available on the C, S, and L bands, while reception only is provided for uhf. Two 30-foot trailer vans provide housing for the station electronics, personnel quarters, and storage for spare parts. The vans are air conditioned for use in tropical areas.

Each dish antenna is formed from fiberglass panels which can be easily handled by one man. The 21-foot dish consists of



The new transportable earth terminal for satellites consists of a 21-foot dish (foreground) and a 15-foot dish with companion electronics in vans.

six segments about an 8-foot center, while the 15-foot dish has four segments around a similar center section.

A similar station equipped with a 30' dish was flown to the West Indies during the Barbados Oceanographic and Meteorological experiment in 1969 for a national scientific study of weather conditions over an area of 90,000 square miles in the Atlantic Ocean. In a previous test, a terminal using a 16-foot dish was flown to South America in 1968 to relay throughout the world live color-TV transmissions of the historic visit of Pope Paul to the Eucharistic Congress in Bogota, Colombia. ♦

COMMUNICATIONS ON A LIGHT BEAM

HOW INVISIBLE LASER BEAMS CAN CARRY TRILLIONS
OF BITS OF INFORMATION EVERY SECOND

THE idea of using a light beam to send messages from one place to another is far from new. In fact, it is probably as old as civilization itself. Since its inception, the basic method of communicating by this medium has been to interrupt the light beam according to a prearranged code system. The principle has not changed much since the first man realized that a light beam could be used to communicate over distances too long for his voice to carry.

Beginning in the 19th century and coming right up to the late 1950's, sporadic attempts were made to perfect light-beam communication equipment that would carry voice messages or high-speed codes over moderately long distances. But, even after pouring all their efforts into the project, scientists failed to perfect light-beam communication. Their designs in this century, when compared with existing radio communication systems, suffered from severely limited operating ranges, low information handling capacities, poor fidelity, and interference from bright ambient light. Little wonder, then, that some of the sincerest of scientific efforts at designing a practical light-beam communicator ended up as toys, construction projects in magazines, science fair projects, and just plain curiosities,

One popular white-light communicator which resulted from scientific efforts employed a microphone or telegraph key to operate a small loudspeaker fitted with a silvered diaphragm. Electrical signals fed through the amplifier made the diaphragm vibrate. A beam of white light focused on the diaphragm reflected out of the transmitter, carrying along the vibration as changes in light intensity. In another simple arrangement, the key merely turned on and off a light bulb, or the output of a microphone amplifier controlled the brightness of the light.

At the receiver end of the communication link, a sensitive photodetector picked up the light beam and translated the light intensity fluctuations into voltage changes. The voltage from the photodetector then drove an amplifier/speaker (or earphone) arrangement, reproducing the vibrations introduced at the transmitter by the sender of the message.

Short operating ranges and poor fidelity notwithstanding, these simple light-beam communicators gave experimenters their first inexpensive walkie-talkies. However, when the Citizens Band came into vogue, light-beam communication was driven into a limbo which lasted until 1969—the year

light-emitting diodes finally became available at low cost.

LED Communicators. Light-emitting diodes, or LED's, are semiconductor diodes which emit relatively pure infrared light when a current is passed through them. Light from an ordinary incandescent lamp contains just about every color in the spectrum. Light energy from an LED, on the other hand, is concentrated in a very narrow band of the light spectrum, making it possible to select a photodetector that responds only to that band. With the photodetector carefully matched to the LED emissions, ambient light has very little effect upon the communication link. Without interference from other light sources, it becomes possible to attain communication ranges of several miles even in broad daylight.

Since the amount of light from an LED varies with the amount of current through the diode, electrical signals from a microphone amplifier or other type of input device can directly modulate the intensity of the beam. Hence, the transmitter is simpler, more reliable, and has better fidelity than is possible with white-light communication systems. (Light-emitting diodes can respond

to frequencies in the megahertz range where no microphone can compete.)

The new LED communication schemes are working out so well that several companies now produce them for industrial and commercial use.

Laser Diode Communicators. While LED's generate a narrow spectrum of infrared light, compared to high-quality laser light, their light is highly contaminated with a number of different phases and wavelengths. Because the intensity of an LED light beam falls off with the square of the distance it travels, telescopic attachments can compensate for some of the losses. But there is a point where the scheme becomes impractical. So, future application of LED communicators will probably be restricted to low-cost portable voice communicators and short-range links.

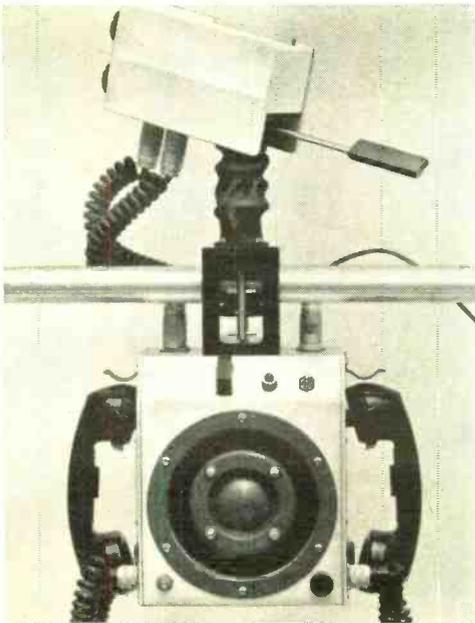
The real future of light-beam communication rests with laser light which is so bright initially that it retains much of its original intensity over longer transmission distances. Just as relatively pure LED light gives light-emitting diode communicators greater range than comparable white-light systems, the coherent nature of laser light multiplies the operating range beyond that feasible with LED's.

Optical communication researchers are now working with three different kinds of laser sources: laser diodes, solid-state lasers, and gas lasers. Of the laser communication systems presently under development, those using laser diodes show the greatest promise for immediate applications.

Laser diodes, properly called injection lasers, operate on the same general principle as LED's. The former, however, are capable of producing much greater output power in addition to generating true coherent laser light. Unfortunately, the tendency for laser diode devices to overheat has still to be overcome. Typically, 10 amperes of current must be pumped through the laser diode to generate one or more useful watts of laser light. Commercially available laser diodes are incapable of withstanding such high currents over long periods of time without overheating. Hence, most laser diode communicators presently in use are operated in pulse mode.

Using trigger circuits similar to those used in strobe lighting systems, a laser diode transmitter fires its diode with large doses of current for about 0.1 μ s at a time.

A laser diode (in the upper unit) voice communicator developed by Holobeam, Inc. for ship-to-ship speech.

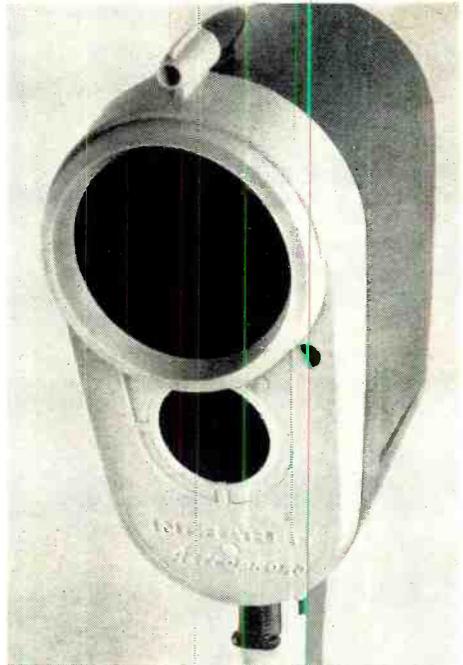
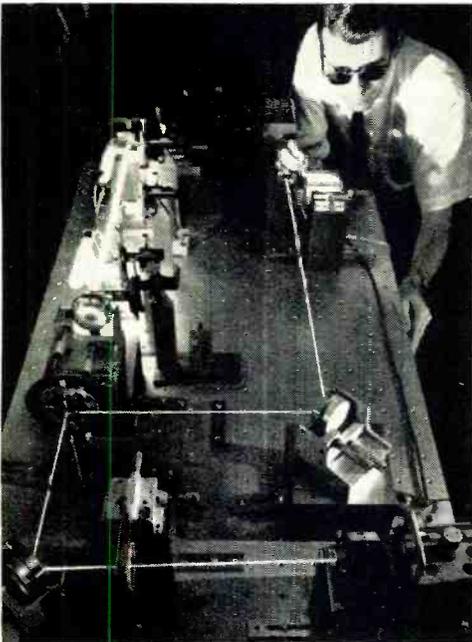


By permitting the diode to cool for about 100 μ s between firings, a pulse operating frequency of about 10,000 Hz can be achieved.

Hughes Aircraft's Santa Barbara Research Center is marketing a portable laser diode voice communicator that uses pulse triggering. It produces 2 watts of peak power, sufficient to establish a communication link over a distance of 6 miles in good weather. This basic equipment range can be considerably extended by adding elaborate telescopic attachments. The trigger pulses for the laser diode are frequency modulated. With a carrier frequency of 6000 Hz, the system can carry a single channel of voice information with frequencies up to 2300 Hz. Although current pulses through the laser diode may reach 40 amperes, the transmitter circuit drains only about 10 mA average current from a 12-volt battery pack.

Another portable laser diode communicator, built by Holobeam for the Navy, also uses short-pulse firing. The carrier is pulse-position modulated; so, voice information fed into the transmitter varies the position of each pulse with respect to some standard "no-signal" position. Conservative military specifications list the maximum operating

A helium-neon gas laser (upper left) provides beam for experimental optical communications setup at Bell Labs.



Simple light-beam communicator such as this one made by Infrared Industries, Inc. used infrared filters over white light source to make the beam invisible and reduce stray light.

range at 1.5 miles, but the transmitter's 8-watt peak output power could easily multiply this figure.

Several major companies, among them Bell Laboratories and Texas Instruments, have under development more efficient laser diodes which are not restricted to the pulse mode. Such diodes promise to combine the high-frequency and continuous-wave characteristics of LEDs with the high power and coherent light of modern laser diodes.

YAG Communicators. Bell Labs is working on a portable laser communicator which uses an yttrium-aluminum-garnet (YAG) solid-state laser source. Closely related to the artificial ruby, the YAG laser has served laser technology almost from the beginning.

Unlike laser diodes, YAG lasers are light amplifiers which convert a flash of light energy into a more powerful beam of laser light. The problem is to find a way to fire the light that excites the YAG crystal.

Researchers at Bell Labs believe that laser diodes make a suitable source of stimulation for a YAG laser. By firing the

YAG crystal with a laser diode flash, they hope to produce a medium-power YAG communicator as portable as laser diode communicators. The YAG devices will operate in a fast pulse mode as do laser diodes, but the former will generate much more high-quality laser light.

Gas Laser Communication Links. All the light-beam communication work using LED's, laser diodes, and YAG lasers is aimed at providing portable short-range communicators capable of carrying only a few channels of information at a time. But the time is coming when the laser links will have to take over where the already overcrowded radio, TV, and telephone channels leave off. A single laser beam will then have to carry millions of bits of information every second from point to point. Most researchers developing long-range, high-capacity laser links agree that gas lasers are the most suitable sources of light for their purposes.

Gas lasers use a mixture of at least two gases. In a helium-neon (He-Ne) laser, for example, passing a current through the tube makes the neon produce ultraviolet radiation which stimulates laser emission from the helium. As long as current flows, the gases continue to do their work.

It is possible to impress information onto a gas laser beam by varying the amount of current through the tube. A far more effective modulation technique uses special external filters which change their planes of polarization in only one direction. Rotating a polarized filter in the beam path changes the amount of light (intensity) passing through. The special voltage-sensitive filters, made of a crystal such as lithium tantalate, rotate the plane of polarization according to an applied signal voltage.

A continuous laser beam can be modulated at frequencies in the GHz range—of which no known electronic circuits can take full advantage. The best electronics technology can do today to take advantage of the bandwidth is to use a number of circuits to drive an equal number of polarization filters. By passing a single light beam through all the filters, all the electronic inputs become impressed on it. It is believed that it is possible to construct such a communication link to carry 200,000,000,000,000 bits of information. Such a system could be capable of handling all voice, TV, facsimile, computer, and commercial radio

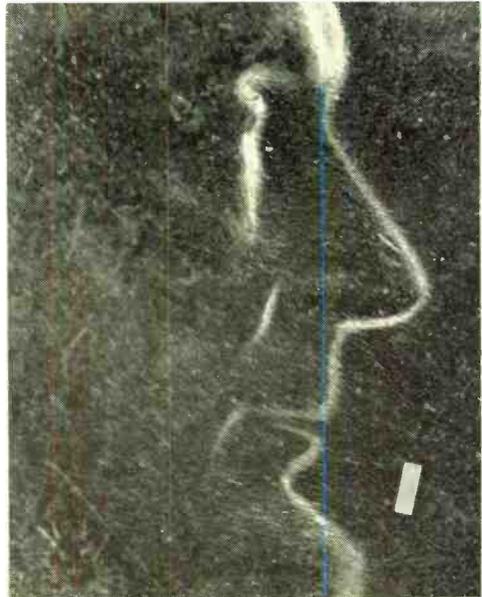
information entering and leaving a city as large as New York.

Laser beams travel in straight lines; so, future long-distance communication systems will have to use a series of mirrors or repeaters to make the beam follow the earth's curvature. Another scheme calls for using mirrors on orbiting satellites to reflect the beam from one point to another thousands of miles apart on the earth's surface.

An entirely different transmission technique will employ fiber optics to get the beam around. A modified version of this will use evacuated pipes, outfitted with reflectors, to carry the beam. These two methods have the special advantages of being immune to atmospheric disturbances.

Gas laser communications is progressing at a rather slow rate compared to the progress being made in LED and laser diode schemes. The reason is that there is presently no real need for communication links which have such staggering information handling capacities. When the time is right, high-performance laser communication systems now operating in experimental labs will be ready to open new communication channels which have virtually no limit with reference to operating range and information-handling capacity. ♦

Laser diode chip from Bell Labs (on a penny) can operate continuously at room temperature and is for possible use in small, low-cost communicators.



“At ComSonics we encourage all our technicians and engineers to enroll with CREI. Know why?”

WARREN BRAUN, *President, ComSonics Inc., Virginia Engineer Of The Year, ASE International Award Winner, CREI Graduate*





"As a CREI graduate myself, I know the advantages of their home-study programs. CREI education has proven an excellent tool of continuing education for our employees and for me. And I strongly believe in CREI's ability to teach a man to learn independently and to use reference materials on his own.

"As President of ComSonics, I see changes taking place in our Electronics business every day. We're in closed circuit TV and acoustical engineering... and pioneered in Cable TV. CREI gives my men the knowledge they need to work in new areas. CREI's new course in Cable TV is an example. The CATV industry is expected to grow 250% in the next three years. I know the opportunities in Cable TV. I designed one of the first CATV systems in 1950. But technical advances are constantly changing the field. And since CREI's experts know most of what's going on in all areas of Electronics, I know that CREI can give my men some of the important, specialized training they'll need to maintain our position in Cable TV and our reputation in Electronics.

"We've interviewed many technicians and engineers for jobs in the past year and had to reject them because their knowledge is archaic and out-of-date. A man is of no value to us if he doesn't keep up-to-date."

Some of the biggest names in electronics buy CREI courses for their own employees. CREI students and graduates prove themselves on the job. They move ahead of the pack by earning promotions and salary increases.

The Future Belongs To You

You've been in Electronics long enough to know that the field is changing more rapidly than ever. New industries, like Cable TV, are born almost overnight. But surveys show that three out of four men now working in Electronics aren't technically qualified to work in these new areas. Clearly, the future will belong to the man who gets the right education *now*.

Start Learning At Home

But what you learn depends on which school you choose. Here's why CREI is among the best.

With the CREI program you study at home. At your own pace. There are no classes to miss, no work to make up. Each lesson is explained in clear, easy-to-read language. That's why many men do far better in home study than they ever did in school...even if they've been out of school for years. And the study habits they learn from CREI are sustained through life.

As a CREI student, you'll be assigned to an experienced instructor who will grade your assignments and offer constructive comments and criticism. If there's a special problem, the instructor will work with you until you understand it fully. You'll receive personal attention from your instructor because he deals with each student individually—as a class of one.

What Will I Learn?

You'll be learning the latest in advanced technology, geared to specific industry programs. Both theory and practical material are presented to meet all phases of job-related training needs.

CREI courses are written for the man who knows basic Electronics, but whose advancement depends on keeping his technical know-how current. You choose what you want to learn. You study subjects which help you grow and advance

in your present job and which relate to your career objectives. CREI offers you the opportunity to continue your education throughout your working life.

Constantly Up-Dated Courses

Because of rapid changes in Electronics, CREI courses are constantly being revised and up-dated by professionals who work in Electronics every day. New developments are included as quickly as they occur. Right now, CREI students are getting the latest up-to-the-minute information on such things as Cable TV, LSI chips, microminiaturization, lasers and masers, telemetry systems, servomechanisms, and data links. If it's new in electronics, CREI—and you—will know about it!

Developed By Top Scientists And Engineers

CREI maintains a full-time advisory faculty of some of the top names in Electronics. Each is a specialist in his own field, an expert who plans and develops CREI lesson material. After each expert submits his course plan, it is carefully reviewed and written by the CREI educational staff. Then each course is broken down into individual lessons. And they make certain each lesson is clear and self-explanatory. Just the right length for easy understanding and effective study.

How Can I Qualify?

If you've read this far, your interest in getting ahead in Electronics is evident. Send for our famous book on how to prepare for tomorrow's jobs in Electronics—the book that has helped thousands of men just like you get ahead. For your free copy, simply mail postpaid card today.



Founded 1927

Accredited Member of the National Home Study Council

Free book tells you all about CREI programs. For your copy, mail coupon, postpaid card or write: CREI, Dept. E1204C, 3939 Wisconsin Avenue, Washington, D.C. 20016

CREI, A Division of the McGraw-Hill Continuing Education Company
Dept. E1204C, 3939 Wisconsin Ave., Washington, D.C. 20016

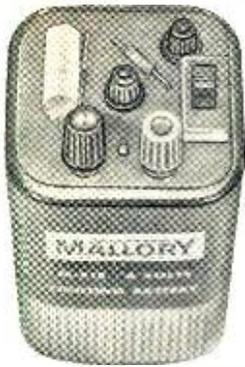
Please mail me free book describing CREI Programs.

I am interested in a College Credits for CREI Study
a Space Electronics b Electronic Engineering Technology
c Computers d Industrial Electronics e Nuclear Engineering
f Technology g Electronics Systems Engineering
h Nontechnical Course in Computer Programming
i CATV Engineering

Name _____ Age _____
Address _____
City _____ State _____ Zip Code _____
Employed by _____
Type of Present Work _____ G.I. Bill _____

APPROVED FOR TRAINING UNDER NEW G.I. BILL





BUILD

3.6-VOLT IC POWER SUPPLY REGULATOR

SIMPLE ADAPTER CONVERTS
6-VOLT LANTERN BATTERY
INTO RTL IC POWER SUPPLY

BY JAMES A. FRED

UNLESS most of your experimenting is done with integrated circuits, investing in a regulated 3.6-volt (only) dc power supply is unrealistic. Yet, on those occasions when you do work with IC's, you can't do without such a power supply. While you could try to find ways of working around the need for IC's or invest in a seldom-used power supply, you would be far better off with a home-built adapter that will provide a stable 3.6-volt dc output when used with a common 6-volt lantern battery.

There are several advantages to building the 3.6-volt power supply regulator described here. First, of course, is economy; aside from the cost of the battery, total cost for parts should not run you more than \$5. Then, since the regulator is line-independent, you are not restricted to using it on your workbench only. Being compact (about 1" thick and roughly the same area as that of the top of the battery), it can be stored almost anywhere—even atop the battery.

Theory of Circuit Design. As shown in Fig. 1, the adapter employs a conventional zener-diode regulator circuit. Light-emitting diode *D1* and its current-limiting resistor *R1* are optional, providing a low-current-drain power indicator feature. (With the 150-ohm value specified for *R1*, *D1* will glow at full brilliance, and the network will draw only 30 mA. If reduced brilliance is desired, *R1*'s value can be increased, and current drain will decrease proportionately.)

Zener diode *D2* is the regulator device in the circuit. It limits the current delivered to the load via *BP1* and *BP2* to 100 mA. The value of *R2* was determined with this limitation in mind. If you plan to use the adapter for one specific application, you can tailor *R2*'s value as required.

For example, if your load circuit draws a maximum of 40 mA, this would leave 60 mA to be dissipated by *D2*. The voltage to be dropped is the difference between the unregulated 6 volts from the battery and the regulated 3.6-volt level, or 2.4 volts. Now, divide 2.4 volts by 0.1 ampere, and the result is 24 ohms. If the load is to be constant, assume a required current of 110 percent of the load current. By Ohm's Law, it can be shown that a 56-ohm value is needed for *R2*. Note, too, the savings in current—only

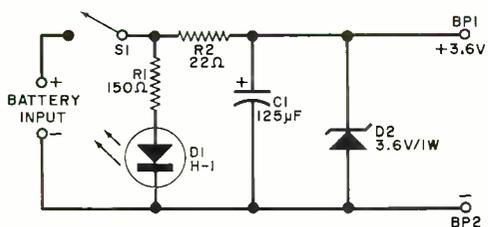


Fig. 1. Simple regulator circuit has *D1/R1* for optional power indication.

PARTS LIST

BP1, BP2—Five-way binding post (one red, one black)

C1—125- μ F, 6-volt electrolytic capacitor
D1—Light-emitting diode (Monsanto type H-1 or similar)
D2—3.6-volt, 1-watt zener diode (Motorola HE-P-102 or similar)
R1—150-ohm, 1/2-watt resistor
R2—22-ohm, 1/2-watt resistor
S1—Spst slide switch (Stackpole type SS-26-1 or similar)

Misc.: Printed circuit board, solder, etc.
Note: The following items are available from J&M Electronics, R 1, Box 28, Cutler, IN 46920: etched circuit board with only pilot holes drilled (No. JM-PC1) for \$1.00; same board with rounded corners and all holes drilled full size for \$2.00. Indiana residents add 2% sales tax.

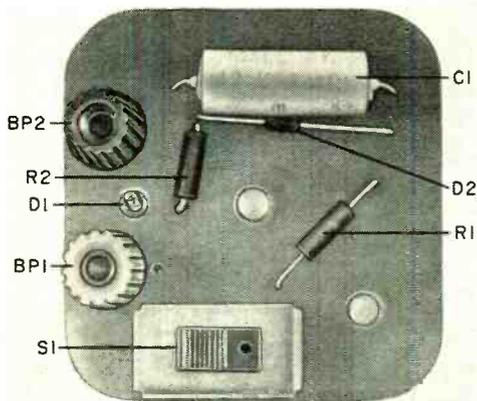


Fig. 2. At the right is actual size printed circuit board etching guide. Component location is in photo above.

44 mA as opposed to 100 mA. The battery would, under these conditions, last 2½ times longer.

When using a zener diode to regulate a voltage, remember that the diode and load are in parallel with each other. The current not used by the load flows through the zener diode to ground; thus, it is advantageous to make *R2*'s value as large as possible.

Capacitor *C1* is in the circuit to maintain a constant voltage across *D2*, even under changing load conditions.

Construction. Building the regulator adapter requires only conventional printed circuit techniques, but a few hints will make the job easier. As with any PC board (see Fig. 2 for actual size etching and drilling guide and components placement photo), avoid overheating when soldering. Also, practice the usual care when soldering *D1* and *D2* into the circuit. Remember, these two components are solid-state devices and are sensitive to heat.

Before soldering the leads of *D1* to the foil pattern, be sure that its tab is toward *BP1*. If it is not properly oriented and the light-emitting diode's leads should be reversed, *D1* will not glow. If *D1*'s glass "lens" is not a press fit in its mechanical mounting hole, dab a bit of fast-drying model cement where the two meet. Note also that *D1*'s leads are routed along the bottom side of the board.

When mounting the binding posts, use lockwashers between the nuts and foil pattern. Fasten the nuts down tightly. Then carefully cut off the screw ends flush with

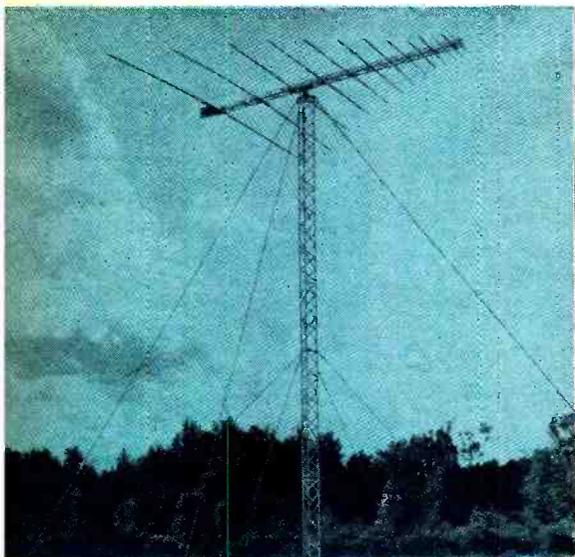
the nuts. Finish the job by soldering the screw ends to the nuts and the nuts to the foil pattern.

When mounting *S1*, it is first necessary to cut away the eyelet ends of the solder lugs, leaving the narrow "necks" that fit nicely into the mounting holes in the board. Carefully bend *S1*'s lugs to mate with the board holes, mount the switch, and solder its lugs to the foil pattern.

A final note on assembly: to assure good electrical contact between battery posts and circuit board, it is a good idea to "tin" the copper foil around the board mounting holes with solder.

Using the Adapter. To use the adapter with any Mallory Type M915 (or similar) battery, first remove the battery's screw lugs from the terminal posts. Position the circuit board over the battery, seating it on the terminal posts. Then fasten the board down by replacing the screw lugs. Switch *S1* to the on position; *D1* should glow and, if you have a meter available, a 3.6-volt potential should be present between *BP1* and *BP2*. If all is well, you are ready to put the battery/regulator into service on your workbench.

You should recheck the output voltage from the regulator periodically since there will inevitably come the day when the battery voltage will be too low for the regulator to operate properly. When the battery becomes depleted, simply unscrew the lugs, remove the adapter, and mount the regulator on a fresh battery to get back into business. ♦



Canada's New Voice on Shortwave

OUR NORTHERN NEIGHBOR IS
TAKING ITS PLACE AMONG THE
MAJOR SHORTWAVE
BROADCAST POWERS

BY RICHARD E. WOOD

THE Canadian Broadcasting Corporation (CBC) is a powerful voice in putting Canada on the world map. Most readers will by now have heard of the new transmitters of CBC's worldwide voice, Radio Canada International (RCI), at Sackville, New Brunswick. Some may even have obtained QSL verification cards when the first of the new 250-kW transmitters went on the air in July 1971, or on the official inauguration day, July 31, at which time programs were beamed only to Europe.

The CBC Sackville project entered a second phase on November 7, 1971, when regular transmissions began over the new transmitters on 9625 kHz to the United States. The U.S. beam is obtained by electrically

reversing the array used earlier in the day by RCI European Service, which ends at 2234 GMT. The 250-kW signal pours into the target zone, overwhelming the competition on 9625 kHz.

The popular English-language transmission beamed to the U.S. is at 2300 GMT—not a convenient listening time for many SWL's, especially west of the Eastern Standard Time belt. However, a solution is in sight.

Since July 1971, the CBC has been beaming to the central and western states a relay of the Deutsche Welle in German from Cologne. Presently on 9745 and 11,856 kHz, the transmissions are during the more reasonable period between 0155 and 0415 GMT. And now the CBC is actively considering their own English transmission, following the German relay, to begin at about 0415 GMT. Plans are not final, but it may go on the air some time this spring. (If you support the idea, write to Radio Canada, Box 6000, Montreal). Then, western and midwestern listeners looking for the CBC during their local evening hours won't have to try tuning in the hard-to-receive Northern Service beamed to the Arctic.

Going beyond North America, CBC's world-wide coverage plans included a series of tests in Japanese, English, and French beamed over the North Pole to Japan in 1971. The tests weren't successful because of interference on the crowded bands and the attenuation and flutter typical of polar circuits. A west coast transmitter station could solve the problem, but CBC is putting its development money into expansion of the Sackville installation.

There's a brighter outlook for the Middle East and Africa. A Voice of Germany relay station is going up on strategically located Malta in the Mediterranean. Just as CBC relays Deutsche Welle for North America, the DW base will pick up and boost Canadian programs in the target areas of the Mid-East and Africa. There is even some talk of an Arab-language service for Radio Canada International when the relay base is completed.

Thanks to an arrangement with the Voice of Germany, Eastern Europe and the Soviet Union are receiving a powerful Canadian Voice. The Russian-language transmissions of the CBC are relayed over Radio Trans-Europe from Sines, Portugal, which is mainly but not exclusively a Deutsche Welle re-

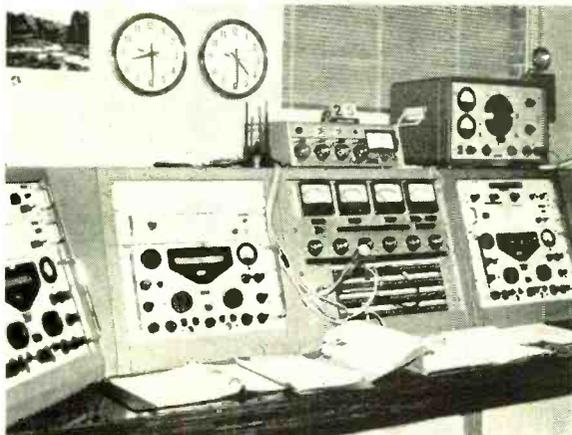
lay base. Likewise, the BBC in London carries CBC relays to Europe and Africa. And there is a local FM relay in Berlin.

The plan for Sackville calls for no less than five 250-kW transmitters in addition to the existing three rated at 50 kW which are going strong after 20 years. The antennas are modestly claimed to be of "conventional" design, but the new transmitters are *unconventional*, representing the state-of-the-art in design at Collins Radio Company. The Collins 821A-2 transmitter system is computer-controlled to provide a high degree of flexibility in prescheduling as many as 100 different programming conditions for a period of 24 hours before the actual time required for them to go on the air.

All of the operations are fed into the computer on punched paper tape. As each instruction is performed, it is erased from the computer's memory, but the punched tape can be saved for a repeat performance at another time.

The transmitters can be automatically retuned in 12 seconds or less to any desired frequency in the 3.95-26.5-MHz continuous range by direct digital control of a frequency synthesizer. The computer also provides continuous control and monitoring of more than 70 analog and 80 digital parameters on each transmitter. Only out-of-tolerance readings are automatically printed out on a teletypewriter; but other readings are available to the operator via teletypewriter request.

Monitoring equipment at the CBC's receiving station near Ottawa, Canada.



Fault reporting is followed by automatic recycling to restore the transmitter to operational status. Should the transmitter fail to operate still, a diagnostic routine is originated by the computer to isolate the cause of the trouble and print out the location of the fault. The direct digital control equipment is also self-monitoring. (Faulty equipment is quickly replaced by plug-in modules, 35 of which—in 16 types—make up each transmitter.)

Upon completion of the Sackville project in the Spring of 1974, there will be four curtain antenna arrays, beamed independently to Europe, the Middle East, Africa, and South America. Each will provide 20 dB of gain, will have reflector curtains, and will be electrically reversible and slewable. RCI shares the Sackville facility with the CBC Northern Service, but the requirements for the Northern Canadian antenna system are different—only 14 dB of gain and a broader beam angle to cover the entire North West Territories and islands of the Canadian Arctic from the Yukon in the west to Labrador in the east.

For the remaining SW stations in Canada, wattage is either elephant power like Sackville's 250 kW or flea power. The CBC's English-language domestic network is relayed on SW by CBC Vancouver on the west coast with 400 watts and CBC St. John's, Newfoundland, with only 300 watts. Identification is complicated by the fact that both stations operate on the same frequency of 6160 kHz in the 49-meter band where all Canadian mini-powered SW stations are confined. Positive identification is therefore necessary. CKZN St. John's has its major newscasts on the half-hour as opposed to the on-the-hour newscasts from CKZU Vancouver, which is one way to tell the stations apart.

Not all Canadian shortwave broadcasting is operated by CBC. Six lively commercial stations, with low-powered (ranging from 1 kW to a tiny 10 W) SW relays on 49 meters, give overseas SWL's a glimpse of North American domestic commercial radio. Best heard in the U.S. is CFRX on 6070 kHz out of Toronto, relaying CFCF.

In the West, CFVP Calgary on 6030 kHz relays CFCN on 1060 kHz. These and three others—also widely heard in spite of their low power—round out the scene in Canada where shortwave broadcasting is still very much alive. Have you heard them yet? ♦



Smallest set seen is Panasonic's 4½-inch model.

WHAT'S DIFFERENT ABOUT JAPANESE COLOR TV?

Some imported sets have features not found in domestic models

BY FOREST H. BELT

THE WORD is around that Japan faces a problem: inadequate research and development. If the rumor is true, it has yet to show much effect on color TV sets from that country. Some incorporate features not found in U.S. receivers.

An outstanding example is Sony's Trinitron picture tube. U.S. companies fiddled for several years with a color tube that would be simpler to use than the three-color triad-dot shadow-mask CRT. None of the early one-gun tubes ever reached feasibility. General Electric did build, and still uses, a small color tube with phosphor dots in rows instead of in triangles.

Then came Sony with the Trinitron. First models had 9- and 12-inch screens. Sony recently introduced a 17-inch size, and a larger version is imminent.

The Trinitron differs from a conventional color tube. Both are tricolor, but the electron guns that drive the colors are situated differently in the glass neck. Guns in a conventional color CRT are in a triangle, with blue on top. Trinitron guns are side by side.

The phosphor screens on the faces of the tubes bear no resemblance except for colors. The Trinitron phosphor is deposited in

stripes instead of dots. The insides of each kind of tube are structured to take advantage of the gun and phosphor arrangements.

The Trinitron requires less complicated circuitry. Beam convergence on the screen is simpler, less critical, and needs adjustment less often. So far, no U.S. company has acquired the rights to use the Trinitron.

Television in Miniature. Imported color receivers outdo many American brands in portability and small screen sizes. One company claims a 2-inch (sizes are in viewable diagonal inches) color set, but hasn't displayed it.

The smallest we've seen working is Panasonic's 4½-inch shown at left. This model takes a prize for portability too. It weighs only 18 lb. A low-power picture tube reduces power drain to a mere 15 watts, whether from the internal battery, a car or boat electrical system, or household ac.

The Hitachi CWU-210 operates from batteries. It is the only color set we know of that does (and that you can buy). This 12-inch portable draws considerable current, but a boat or car battery can run it several hours without recharge.

Small size is distinctive of Japanese color TV. A 7-inch model was built but never got here. Sales today consist mainly of 9-, 11-, 12-, 14-, and 15-inch portables. Larger sizes (16, 17, 18, and 19 inches) usually are in table and console cabinets. Newest of these are the 17-inch and the 19-inch, both square cornered (S), and a 17-inch Trinitron. By brand, here are CRT screen sizes:

Hitachi	12, 14, 16, 18
JVC	17(S), 18, 19(S)
Micotron	12, 15, 18, 19(S)
MGA	12, 14, 16, 19(S)
Panasonic	9, 12, 16, 18
Sanyo	12, 15, 18, 19(S)
Sharp	12, 15, 16, 18, 19(S)
Sony	9, 12, 17 (all Trinitrons)
Toshiba	11, 15, 18, 19

Notice the lack of a large-screen import. One company, the MGA division of Mitsubishi, sells a 25-inch receiver with plug-in modules. But the chassis is not imported. That makes MGA the only foreign-brand color set built in the U.S. so far. (It's common to find the opposite—domestic brand labels on imported sets.) Sony won't tell the size of the larger-screen Trinitron promised for next year.

Solid Technology. American manufacturers are strong on transistors, integrated circuits, and other solid-state components. Imports have them too, although surprisingly few IC's show up in Japanese brands.

The irony is that a foreign brand almost won the race to all-transistor color. Sony's first Trinitron receiver was solid-state. The company demonstrated it in 1966. But before it was available, Motorola came out with the first "Quasar"—and this you could buy.

Color imports today continue the total-transistor trend. All Hitachi models are solid-state. One JVC chassis uses only transistors and IC's. In some models of MGA, Panasonic, and Sanyo, the CRT is the only tube. Sony has kept the Trinitron chassis solid state.

You find transistors, and even integrated circuits, in other import brands and models, but in limited numbers. More tubes than transistors fill their sockets, just as with most U.S. brands.

Easy Fixing. Few American set-makers took seriously the matter of building a TV set easy to service; that is, until recently. Naturally, neither did their offshore counterparts, the Japanese manufacturers—also until recently.

Some U.S. sets have been redesigned to make servicing less difficult. The concession to repairs began here about four years ago. Now, finally, similar attempts appear in a few Japanese sets.

JVC helps with plug-in interconnections between PC boards and chassis. MGA, in its all-solid-state 19-inch, exposes all circuitry by slide-out, fold-out boards (Fig. 1). Both sides are accessible for testing or parts replacement. Most interconnections terminate in plugs.

Circuit boards in the newest Hitachi chassis snap loose and some have plug interconnects. The boards are also interchangeable from model to model. Printed boards in these and many other brands now have connection and parts markings on both sides to ease circuit tracing.

Tuner "Equality." Beginning this July 1, 40% of the TV sets sold in this country by any manufacturer must have a uhf tuner that is as simple as a vhf tuner. Already, 10% of a manufacturer's line must reflect this tuner equality. Detented uhf positions fulfill this requirement, although

not ideally. Anyway, that accounts for the 8-position uhf tuner in top models of several 1972 Japanese lines.

More consequential, perhaps, is the 25-position detent uhf tuner Mitsubishi put into its all-transistor receiver.

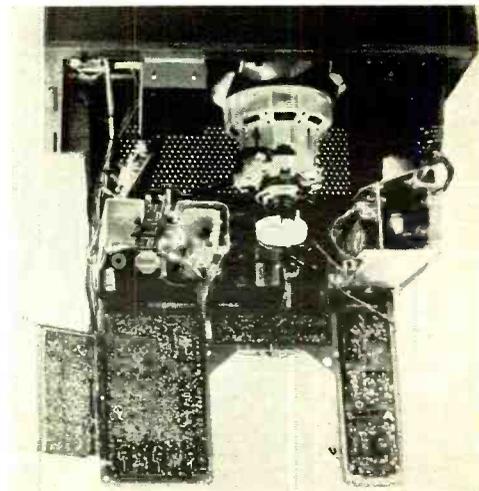
The tuner itself is tiny. The 25 positions derive from a mechanical contrivance that drives the tuning capacitors inside the little tuner. Each mechanical position allows a spread of three uhf channels. The owner pushes in and turns the center knob to fine-tune the active channel. Mechanical accuracy and stability don't suffice at uhf, so aft (and a variable capacitance diode in the tuner) takes over and holds the station solid.

Automatic? Well—Maybe. Color television brought a host of customer problems for dealers and technicians. Owners had trouble with tuning, so manufacturers added automatic fine tuning or aft. Color is stronger in some telecasts than in others; so—automatic color control or acc.

A serious shortcoming has been tint or hue. Faces come on green or purple when programs change. To alleviate that, some color sets now include automatic tint control of one kind or another. The most common atc system alters the color demodulator, making it less sensitive to variations in the signals that form flesh colors.

The temptation to use that word "auto-

Fig. 1. Only recently have Japanese sets become easy to service. MGA set has sliding chassis, fold-out boards.



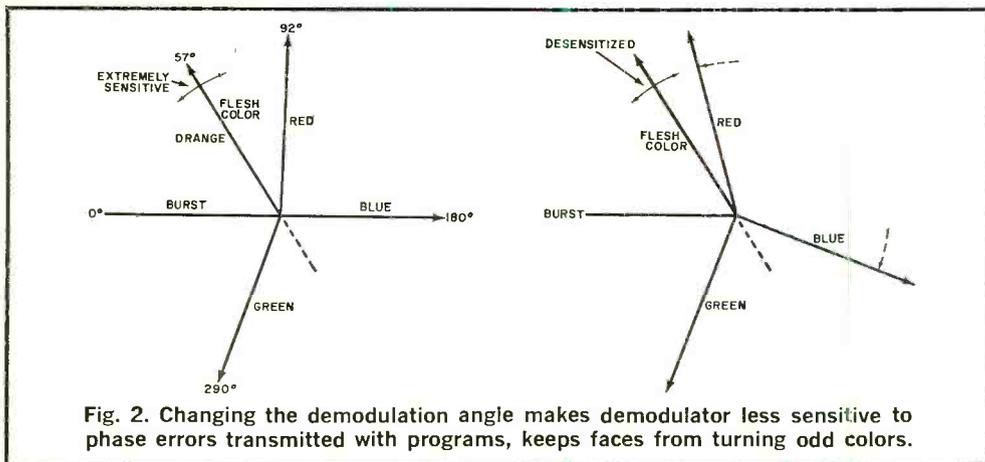


Fig. 2. Changing the demodulation angle makes demodulator less sensitive to phase errors transmitted with programs, keeps faces from turning odd colors.

matic" is great. You'll find several imported color sets advertised as having automatic tint, color, brightness, and contrast. Most of those chassis actually contain only an extra set of potentiometers. A technician pre-sets them to suit the viewer's favorite programs. A switch connects these internal controls and disables the front-panel equivalents. When color, hue, and video values in a program don't suit the pre-set pots, pushing the switch "off" reverts operation to the manual control knobs or sliders.

However, at least two Japanese brands have atc like that in American sets. Sanyo calls the circuit "Automatic Tint/Sensor." Toshiba atc is part of its abc system, which stands for "Automatic Balanced Color."

A typical atc, whether imported or domestic, depends to some extent on eye colorimetry. You see variances in red and yellow-orange shades easier than in blue or near-green shades. Widening certain angles at which a color demodulator works renders it less sensitive to flesh-tone variations. Fig. 2 shows the effect graphically. Reducing sensitivity to flesh-color alterations aggravates any changes in shade between blue and green. But the eye doesn't notice those changes as readily.

Selling Alphabetically. If calling a circuit "automatic" helps sales, so do catch-names and official-sounding acronyms. Another page from the book of U.S. set-sellers? Perhaps. Whatever the reason, the sales pitch for Japanese color sets has become alphabet-filled.

The old familiar age, acc, afc, aft, and

so on have been joined by a multitude of look-alikes. Try these new ones for meaning: aps, act, pse, abc, another abc, ats, arc. You'll find them all among imports.

Aps stands for Hitachi's *automatic picture setting*, another name for pre-set brightness, contrast, tint, and color pots. Act is Sharp's *automatic color tint*, which is just a pre-set hue control. Psc is a step toward accurate labeling: *pre-set color* (meaning hue), in sets sold by JVC America.

The two abc's bear little likeness. One stands for *automatic brightness control*, but not the kind that years ago kept TV screens adjusted for room light. This one is—you probably guessed—a pre-set brightness control activated by a pushbutton.

The other abc is *automatic balanced color*, a multi-function system in some Toshiba chassis. The abc switch activates a real atc (yes . . . automatic tint). It also connects up "Unicolor," a contrast circuit that doesn't upset color proportions. And finally, just so nothing is omitted, the abc switch puts pre-set color and tint controls into operation.

Ats, for *automatic tuning system*, is a Sanyo idea. It combines ordinary aft with a pre-set tint control. And arc is Sanyo's too. It means *automatic resolution control*, and is another name for brightness limiting—keeping the raster lines from blooming at bright whites.

Color sets from abroad have plenty you don't find in American sets. Some features are real, some just for sales promotion. But then, that characteristic fits U.S. sets too. ♦

LASER HOLOGRAMS SPEED COMPUTER PARTS ANALYSIS

ENGINEERS and scientists have used 3-dimensional photography to significantly speed up testing and analyzing computer parts at the IBM General Systems Division development laboratory in Rochester, Minnesota. The laboratory technique, an accepted standard of industrial testing using laser photography (otherwise known as holography), was successfully used to test several parts for experimental machines.

Quick and accurate parts analysis is the most important aspect of this technique. A recent analysis involved a part for a new card reader. Within two hours, the shortcomings of the part and how to prevent similar problems were known. As Dr. LeRoy D. Dickson of the Opto-Electric area of IBM points out: "Without holography, it could have taken us as long as two weeks to analyze this part."

The optical facility used interferometric equipment, including a small laser, various mirrors and lenses, a variety of part holders, a photographic plate holder, and a stable table as basic equipment for the test setup. To make the holograms, the intense coherent light from the laser is enlarged and split into two beams through a series of lenses and mirrors. One beam is directed at the test part; the other at the glass photographic plate. Light reflected from the test

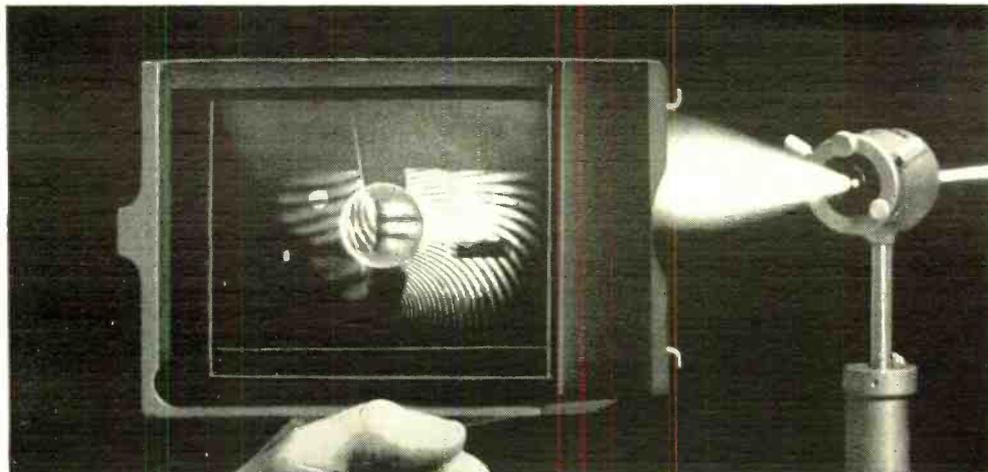
part combines with the light in the second beam to produce the holographic exposure on the photographic plate.

The hologram is completed by making a second exposure of the part on top of the first exposure. Before making the second exposure, however, a load equal to that which the part would receive in normal use is applied to the test part. Following the second exposure, the plate is developed. After this is done, it is necessary to remount the plate in its holder and focus onto it the laser beam, to make the image visible for viewing.

Through the double-exposure technique, part deformation between the two exposures shows up as fingerprint-like patterns of lines over the image (see photo). A visual study of the line pattern shape and spacing yields a great deal of information concerning the forces on the test part.

"Although this technique is one of many that are vital laboratory analytical tools, its speed and non-destructive elements made it particularly valuable to us," concludes Dr. Dickson. ♦

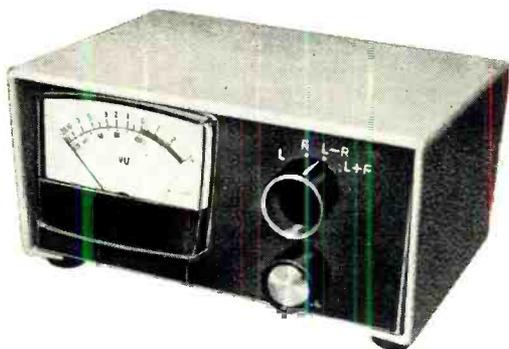
The large fingerprint-like patterns on double-exposed hologram images show the precise areas of stress during actual operation of the parts.



BUILD A SIGNAL DIFFERENCE STEREO BALANCE METER

EXACTLY BALANCES
OUTPUTS OF BOTH CHANNELS
FOR PERFECT STEREO
SOUND REPRODUCTION

BY J. R. LAUGHLIN



MOST audiophiles invest considerable effort and money into building their home stereo systems. Often, however, they are so concerned with wide frequency response, minimum distortion, and good channel separation, that proper amplitude balance of stereo channels is overlooked.

The "Signal Difference Stereo Balance Meter" described here, when connected to the stereo system's amplifier outputs, provides a means of quickly and accurately balancing stereo channels and gives a continuous readout of the various functions of the stereo signal. The Balance Meter is passive and requires no power supply.

The meter used here is a standard type commonly found in the broadcasting and recording industries. The face of the meter has two scales: one reading VU (volume units) from -20 to $+3$; other showing voltage percentages from 0 to 100, with 100% voltage coinciding with the 0 point on the VU scale. (An internal rectifier drives the dc meter movement.) The normal level for volume units is at 0 VU.

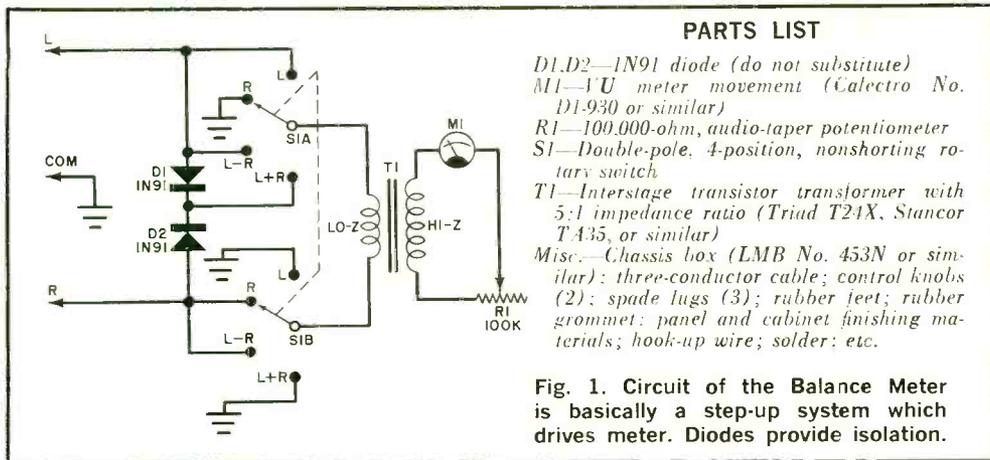
Volume units are numerically equal to the number of decibels above the reference level of 1 mW of power into a 600-ohm load. The use of an uncalibrated level control and the omission of special circuits to compensate for loads other than 600 ohms great-

ly simplifies the hardware requirements of the Balance Meter. Of course, absolute power measurements are impossible without the aid of special calibration procedures; but, for any setting of the level control, accurate relative variations in audio amplitude will be displayed in dB on the meter scale.

Theory of Circuit Design. As shown in Fig. 1, $T1$ is a stepup transformer that boosts the input from the amplifier to provide a driving signal for $M1$. This gives the Balance Meter great sensitivity, even at low volume levels, without the need for active amplifiers. Level control $R1$, in series with $M1$, permits on-scale readings over a wide range of volume levels.

Function switch $S1$ connects the primary of $T1$ to the input circuit in the appropriate manner to provide four signal configurations for driving the meter movement. In the L and the R positions, the primary is simply connected to the input selected, while grounding the unwanted input.

The $L-R$ is obtained by connecting the primary of $T1$ to both "hot" lead outputs from the amplifier, without completing the circuit to ground. If the channels contain identical signals, there is no indication on $M1$. On the other hand, with a stereo



PARTS LIST

- D1, D2—1N91 diode (do not substitute)
- M1—1V meter movement (Calctro No. D1-930 or similar)
- R1—100,000-ohm, audio-taper potentiometer
- S1—Double-pole, 4-position, nonshorting rotary switch
- T1—Interstage transistor transformer with 5:1 impedance ratio (Triad T24X, Stancor T435, or similar)
- Misc.—Chassis box (LMB No. 453N or similar); three-conductor cable; control knobs (2); spade lugs (3); rubber feet; rubber grommet; panel and cabinet finishing materials; hook-up wire; solder; etc.

Fig. 1. Circuit of the Balance Meter is basically a step-up system which drives meter. Diodes provide isolation.

signal, current will flow through *T1* in proportion to the *difference* signal.

The *L + R* function is derived by connecting the primary of *T1* to the "hot" outputs of both amplifier channels and completing a circuit to ground through *D1* and *D2*. Thus, the meter reads a *sum* signal.

Construction. Since the circuit (Fig. 1) of the Balance Meter is very simple, a circuit board and complicated wiring techniques are not needed.

Begin construction by machining the front panel of the cabinet to be used so that it will accommodate the meter movement, function switch, and level control. Then carefully finish the panel with a coat of paint or with adhesive-backed vinyl to complement your present system. This done, use a dry-transfer lettering kit to apply the legends for *S1* and *R1*; use black letters on light backgrounds and white letters on dark backgrounds. Then, to protect the lettering during use, spray a *thin* coat of clear Krylon over the entire front panel; allow to dry. Follow up with another coat or two of the Krylon. Note: Do *not* apply one heavy coat of the Krylon and let it go at that. A heavy coat will simply dissolve the lettering.

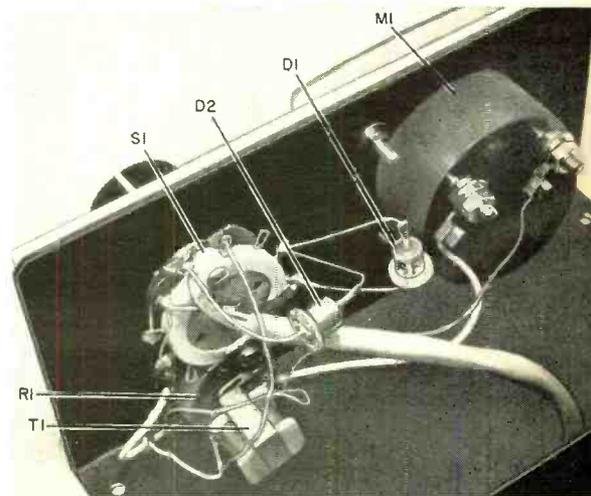
Now mount the meter movement, switch, and potentiometer in their respective cut-outs on the front panel. Referring to both Fig. 1 and Fig. 2, wire together all components and cables. When wiring *T1* into place, remember that the high-impedance side goes to the meter circuit. The polarities of *D1* and *D2* are not important as long as they are connected together either in an

anode-to-anode or a cathode-to-cathode configuration. Wiring up *S1* can be a bit tricky; so, be careful when working on the switch.

After passing the input cable through a rubber-grommet-lined hole in the rear panel of the chassis and connecting it at one end to the appropriate lugs on *S1*, connect and solder spade lugs to the free ends. The spade lugs facilitate easy and dependable connections to the amplifier.

As with the front panel, pains should also be taken to make the cover of the Balance Meter blend with the rest of your equipment. You can use contact cement to apply a cloth-backed vinyl upholstery material to the cover. Then finish up by assembling the cabinet and attaching rubber feet to the bottom of the chassis.

Fig. 2. Components are mounted on lugs of switch, potentiometer and meter.



Setup and Use. Preliminary checkout is best accomplished with the aid of an audio generator. But if a generator is not available, you can use one channel of your stereo system for the tests.

First, place *SI* in the *L* position and connect the *L* and *COM* input leads to the generator's hot and ground outputs, respectively. With the generator turned on, the *VU* meter's pointer should deflect, and the deflection should change as you change the setting of the level control.

With *RI* fully clockwise, the most sensitive position, the signal level required for full-scale deflection of the meter pointer should be less than 0.4 volts rms. This signal should also be read on the *VU* meter with *SI* set to *L + R*. (It may be slightly less due to the drop across *DI*.)

Repeat the above procedure with the Balance Meter's *R* and *COM* inputs connected to the generator's hot and ground outputs and *SI* set to *R*. Check also to see that the signal is read in the *L + R* position of *SI*. Here, again, a slight reduction may be noticed as a result of the voltage drop across *D2*.

To check out the *L - R* function, place *SI* in the *L - R* position and ground the *R* input lead to *COM*. A reading should be obtained with the generator connected between the *L* and *COM* input leads. Likewise, the same reading should be obtained with the *L* input lead grounded to *COM* and the generator connected between the *R* and *COM* input leads. Now, tie the *L* and *R* input leads together, connect them to the

hot output of the generator, and connect the ground of the generator to the *COM* lead. If a zero reading is obtained on *MI* with this test and all previous checks are correct, the Balance Meter is ready to use.

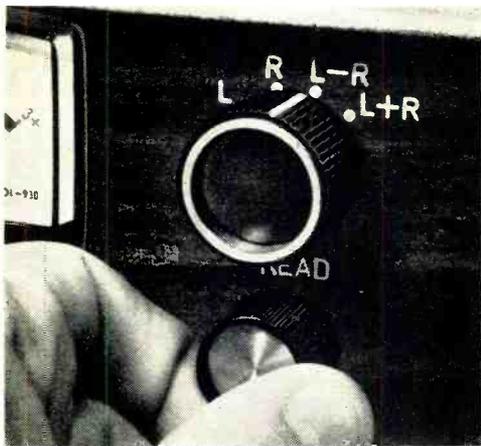
Locate the Balance Meter close to the amplifier with which it is to be used and in a position where it can easily be observed. Then connect the input cable to the appropriate output terminals on the amplifier. (Note: In some amplifiers, especially those which provide speaker phase switching for one of the channels, use of the Balance Meter is not recommended. To determine whether or not it is safe to use the Balance Meter with your amplifier, study the amplifier's schematic diagram; if the outputs share a common reference line—and *only* if they do—it is safe to use this instrument.)

With the Balance Meter properly installed, readings should be obtained on *MI* with the function switch in the *L*, *R*, and *L + R* positions. A stereo signal will provide readings in the *L - R* position. To exactly balance the amplifier, switch to the mono mode so that identical program material is fed into each channel. Rotate the balance control on the amplifier to a position where the *VU* meter nulls to the left index of the scale.

Now, adjust *RI* fully clockwise to obtain maximum sensitivity. At maximum sensitivity, it might be difficult to obtain a perfect null, especially if the volume level is fairly high. Differences in bass or treble response in each channel will cause small deflections of *MI*. Some amplifiers incorporate separate clutched controls for bass and treble adjustments. In these amplifiers, adjust the controls to obtain the best possible null. If your amplifier has a switch to take the controls out of the system to provide a flat response, put the switch in the flat position.

When using a tape playback deck or record player with the amplifier, precise balance of the entire system can be obtained by use of a full-track prerecorded test tape or a test record that produces equal output amplitude on each channel. As the tape or record is being played, first switch the amplifier to mono and balance it as outlined above. Then switch to the stereo mode and adjust the tape recorder balance control for best possible null. This will balance the system from the tape heads or pickup cartridge forward. ♦

Mark *SI* positions to agree with circuit wiring. Finish front panel to coordinate with other system components.





175-MHz PRESCALER

BY DANIEL MEYER

EXTEND YOUR 20-MHz DIGITAL FREQUENCY
COUNTER TO WORK AT 175 MHz

DIGITAL readout frequency meters capable of indicating to about 20 MHz are now becoming widely available at reasonable prices. There are a few that can reach 50 MHz, but if you have to go higher than that, the price really starts to climb.

However, by taking advantage of the latest developments in IC's, it is very easy to build a new divide-by-ten front end for less than \$35. This will permit the use of limited-range counters at frequencies up to 175 MHz.

The new type of IC uses what is called emitter-coupled logic (ECL), which operates considerably faster than the TTL types now used in most counters. The high operating speed is obtained by never letting the internal transistors be driven into saturation. This eliminates the storage time delays that slow down TTL and DTL types. There are flip-flops available that can be used for counting speeds over 500 MHz. Although the Fairchild ECL-9528 dual flip-flop used here is specified for 160 MHz, in testing the Prescaler circuit, no samples were found that would not operate to 175 MHz.

Theory of Circuit Design. A schematic of the Prescaler circuit is shown in Fig. 1. The input high-frequency signal is suitably attenuated in *R1* and applied to the first IC through *C1* and *R2*, which provide

dc isolation and overload protection for the IC. Resistors *R3*, *R4*, and *R5* are used to bias the input gate to the mid-point of its switching levels and to provide an input impedance approximating 50 ohms—the optimum value.

Diodes *D6* and *D7* clip any signal that goes positive or exceeds the supply voltage in amplitude. The first flip-flop (half of *IC1*) simply divides by two and passes the signal to the next three flip-flops (second half of *IC1* and both halves of *IC2*) which are connected to form a synchronous divide-by-five circuit. The output signal is amplified by *Q1* to provide sufficient drive for almost any type of counter.

Construction. It is best to assemble the Prescaler on a printed circuit board having the foil pattern shown in Fig. 2. Be sure to observe the terminal markings on the semi-conductors and use a low-power soldering iron and fine solder to avoid thermal damage. The input and output connectors, transformer *T1* and filter capacitor *C4* are mounted on the metal chassis as shown in the photographs. The circuit board is mounted on four spacers.

Testing, Adjustment, and Use. Apply a signal with frequency over 20 MHz and a level between 0.5 and 2 volts rms to the in-

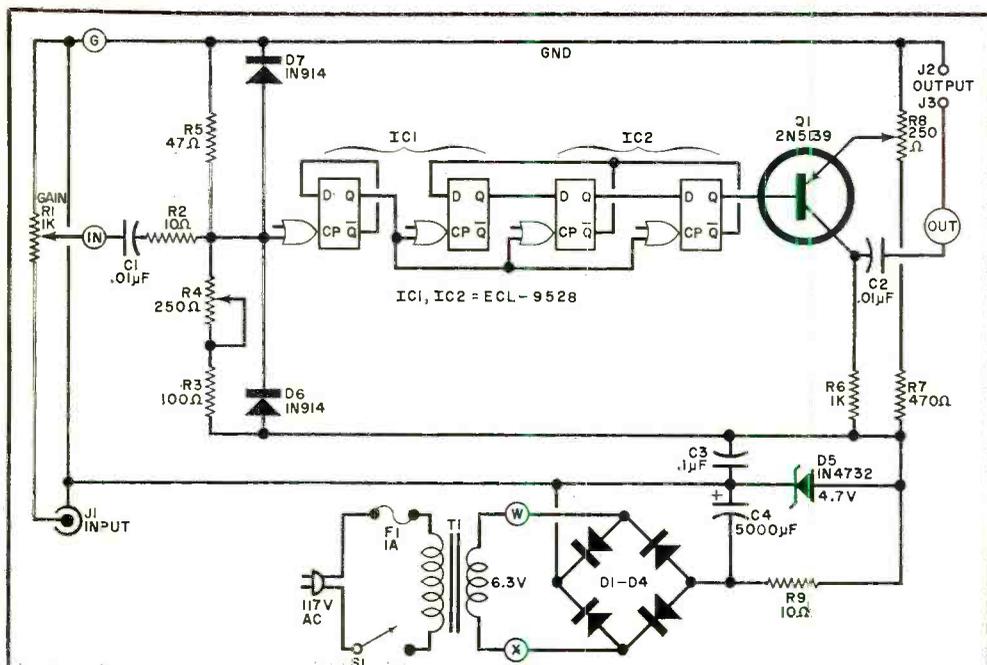


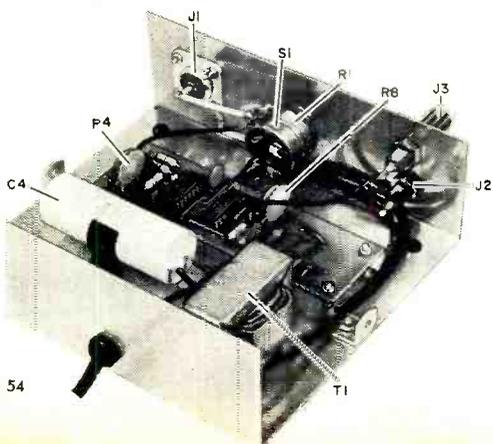
Fig. 1. The Prescaler is essentially a high-frequency divide-by-ten circuit that enables a 17.5-MHz frequency counter to indicate to 175 MHz.

PARTS LIST

- C1,C2—0.01- μ F disc ceramic capacitor
- C3—0.1- μ F disc ceramic capacitor
- C4—5000- μ F, 10-volt electrolytic capacitor
- D1-D4—1A silicon rectifier diode
- D5—4.7-volt zener diode (1N4732 or similar)
- D6,D7—1N914 diode
- F1—1A fuse and holder
- IC1,IC2—Dual flip-flop (Fairchild ECL-9528)
- J1—BNC connector
- J2,J3—Five-way binding post (one red, one black)
- Q1—2N5139 transistor
- R1—1000-ohm potentiometer with S1 attached
- R2—10-ohm, $\frac{1}{2}$ -watt resistor
- R3—100-ohm, $\frac{1}{2}$ -watt resistor

- R4,R8—250-ohm PC potentiometer
 - R5—47-ohm, $\frac{1}{2}$ -watt resistor
 - R6—1000-ohm, $\frac{1}{2}$ -watt resistor
 - R7—470-ohm, $\frac{1}{2}$ -watt resistor
 - R9—10-ohm, 1-watt resistor
 - S1—Spst switch on R1
 - T1—Transformer; secondary: 6.3V, 600mA
 - Misc.—Suitable two-piece chassis, line cord, grommet, knob, board spacers, mounting hardware, capacitor clamp, etc.
- Note—The following are available from Southwest Technical Products Corp., Box 32040, San Antonio, TX 78216: drilled and etched PC board #177 at \$2.37, postpaid; complete kit of all parts including punched chassis at \$33.75, plus postage and insurance for 2 lb.

This photo shows how prototype Prescaler was assembled in small chassis.



put. Connect the output to an oscilloscope. Turn on the Prescaler (via S1 on R1) and adjust R1 until a pulse waveform is displayed on the scope. If it is not possible to do this, leave R1 at maximum and adjust R4 and R8 to obtain the desired display. Then adjust R1 to reduce the input level and set the two controls on the board to produce an output with as low an input signal as possible. It is best to adjust these controls with an input signal of about 100 MHz since the adjustments are slightly frequency dependent. The adjustments may be broad at low frequencies, becoming more critical as the frequency is increased.

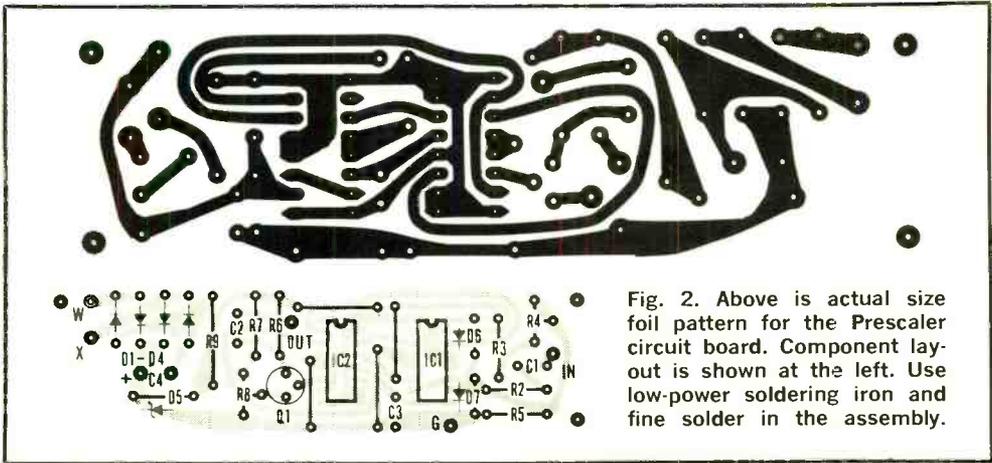


Fig. 2. Above is actual size foil pattern for the Prescaler circuit board. Component layout is shown at the left. Use low-power soldering iron and fine solder in the assembly.

In using the Prescaler and connecting an external signal to the input, always set *R1* for the minimum useful signal. Even with the protective diodes, a very large voltage level at the input could destroy the IC's.

When connecting the Prescaler output to a counter, note that *J2* is the ground connector. Set the frequency counter to the kHz position and remember that, with

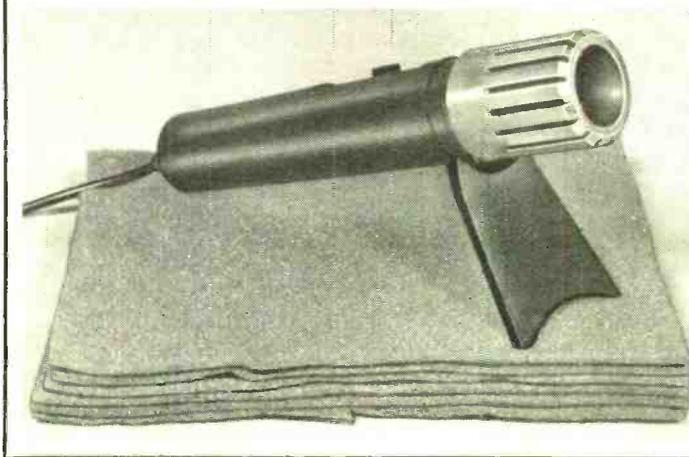
the Prescaler added, all values will indicate one digit to the right. That is, with an input of 15 MHz, a conventional five-digit counter will indicate 15000 kHz. With the Prescaler added, the indication will be 01500 kHz. An input frequency of 175 MHz will show up as 17500 on the kHz range. If your frequency counter has a MHz range, it may be used, but you must still keep track of the decimal point mentally. ♦

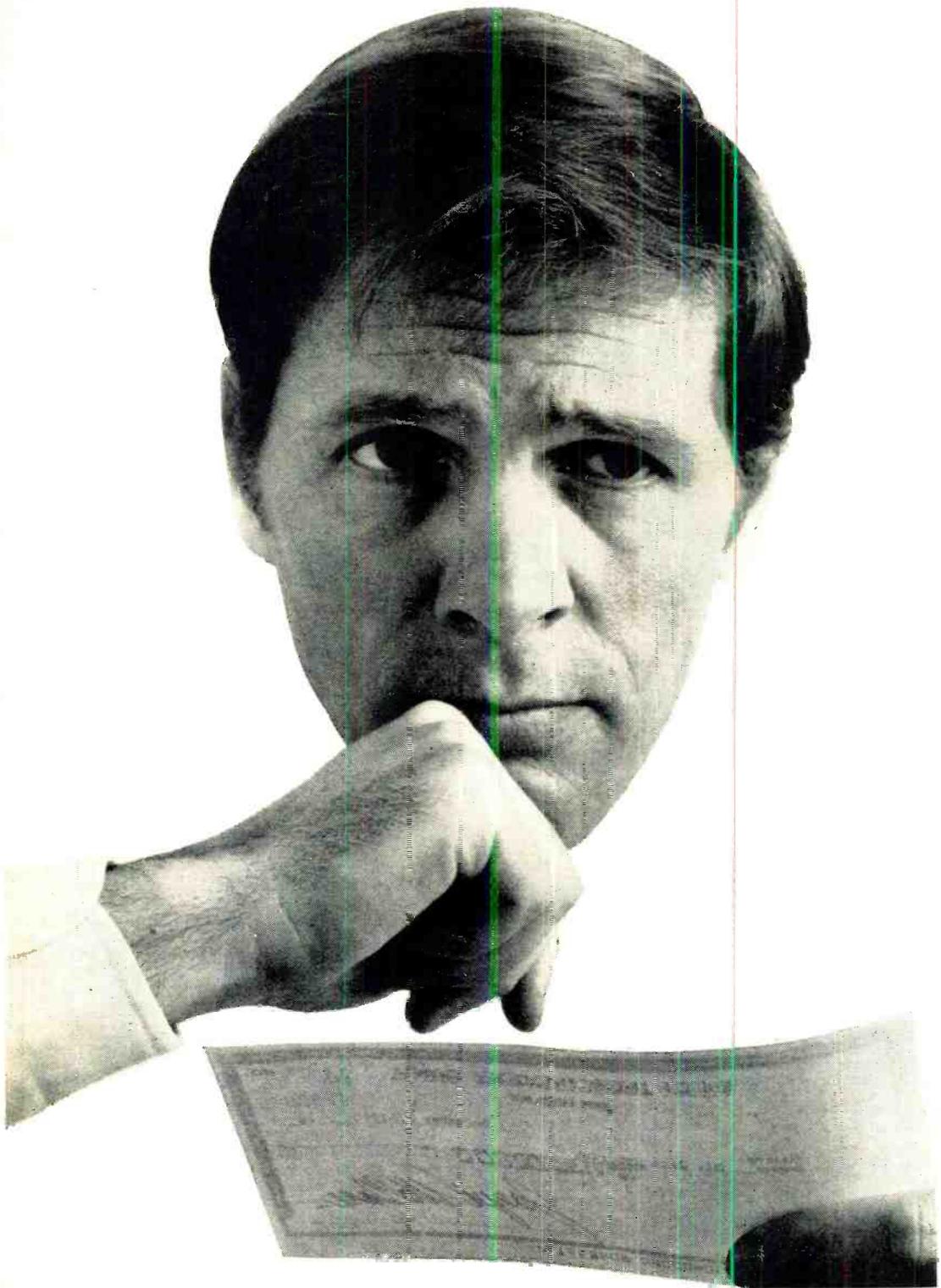
SIMPLE THUMP AND RUMBLE FILTER

IF YOU do a lot of home or on-location tape recording using a microphone, you know how annoying and amateurish your tapes can be when the sound played back is loaded with "thumps" and rumbling noises. Even one thump or short rumble roll can be a downright nuisance. However,

there is a simple method of practically eliminating any of these noises. All you need is a square of soft foam plastic (not the rigid kind used for arranging floral decorations or the type used in many kitchen sponges that turn rock hard when dry). Cut the foam plastic to about 6" x 6". For best results, the foam plastic should be $\frac{1}{4}$ " to $\frac{3}{8}$ " thick. Just set the plastic foam pad on a solid surface, and place the recording microphone on the pad. You're ready for your next taping session. You'll be pleasantly surprised at how little background noise the mike picks up.

—Frank H. Tooker





Your paycheck says a lot about you

It tells you more than how much you make. It tells you how far you've come. And if your paycheck looks very much the same as it did last year, or the year before, it simply means that *you* look very much the same as *you* did last year and the year before.

But times change, and you should be changing with them. Old dull jobs are disappearing. New exciting ones are being created. There are challenging new fields that need electronics technicians...new careers such as computers, automation, television, space electronics where the work is interesting and the earnings are greater.

RCA Institutes has one of the nation's largest and most respected home study schools devoted to electronics. They can get you started even if you've had no previous training or experience. RCA Institutes has developed a faster, easier way for you to gain the skills and the knowledge you need for a fascinating, rewarding electronics career. And you don't have to quit work and go back to school. With RCA Institutes Home Study Plan you can do

both. You set your *own* pace depending on *your* schedule.

Check over these RCA benefits:

- You get Hands-On Training—over 250 experiments and as many as 22 kits with some programs.
- You get RCA's unique "Autotext" method of learning—individual programmed instruction, the easy, faster, simplified way to learn!
- You get the widest choice of electronics courses and programs—everything from Electronics Fundamentals right up to Solid State Technology and Communications Electronics.
- You get a selection of low-cost tuition plans!

Sounds great, and it is! For complete information, without obligation, send in the attached postage paid card...or return the coupon below. That will say a lot about you.

Veterans: Train under new GI Bill. Accredited Member National Home Study Council. Licensed by N.Y. State—courses of study and instructional facilities approved by the State Education Department.

RCA Institutes

Home Study Dept. 694-204-0
320 West 31st Street, New York, N. Y. 10001

Please rush me FREE illustrated catalog.
I understand that I am under no obligation.

Name _____ Age _____
(please print)

Address _____

City _____ State _____ Zip _____

Veterans: Check here

If reply card is detached—send this coupon today



Meter Accuracy Specifications

By John T. Frye, W9EGV, KHD4167

BARNEY, a little late for work this sunny April morning, had his hands cupped tightly together as he shouldered his way through the front door of the service shop.

"Guess!" he commanded Matilda, the office girl, as he stopped in front of her desk.

"Knowing you," she retorted, shrinking back in her chair, "it's probably a mouse."

Gently Barney took away one hand and held out the other, with a beautiful gold-flecked purple crocus nestling in the palm.

"Barney, how gorgeous!" she exclaimed. "Let me get a glass of water."

"Thought you might like it," Barney said gruffly as he tenderly deposited the little flower on the surface of the water. "Where's the boss?"

"Back in the service department," Matilda answered absently, still spellbound by the sight of the velvety petals floating in the glass.

Mac was sitting crosslegged on the service bench reading several stapled-together mimeographed sheets.

"Hi, my ten-o'clock-scholar," he said, glancing up. "Have a hard night?"

"Nope, just spring fever," Barney answered and then went on rapidly, "but let's not talk about me; let's talk about you. What are you reading?"

"A paper sent me by a young friend attending the British Columbia Vocational School in Burnaby, B.C. It's a study prepared by H.F.R. Adams, the Chief Electronics Instructor for the school, and it's entitled *The Meaning of Accuracy Descriptions of Measuring Instruments*. My young friend says the instructor's lectures remind him of me, which I consider very flattering, considering the impressive credentials possessed by this man."

"Anything in there I should know?"

Pointer-Type Meters. "Yes, so let's review it. Mr. Adams points out that pointer-type meter accuracies quoted by manufacturers reflect several sources of error inherent in the instrument as part of its manufacturing and calibration process: the balance, alignment, and resistance of the moving coil; friction in bearings or taut-band suspension; shunt and multiplier resistance values; magnetic strength, shunting, and shielding; and the effect of temperature on all of these. In addition, the technician often introduces additional errors because of parallax, pointer width, scale misreading, and improper interpolation of sub-divisions of the scale.

"Manufacturers have different ways of describing the accuracy of their products. One may advertise '±1% of Full Scale' while another may claim '±1% of Reading.' Suppose we compare these descriptions for a voltmeter with a full-scale reading of 100 volts. Obviously the permissible error of the meter with a claimed accuracy of ±1% of full scale will be 1 volt over the entire scale. At the top of the scale, the percentage of error will be 1/100 or 1%. At the 50-volt mid-scale point, this changes to 1/50 or 2% of the reading. At 33 1/3 volts it becomes 1/33.3 or 3% of the reading, and at the bottom of the scale, at 1 volt, the possible error can be 1/1 or 100% of the reading."

"A guy would be wise to stay away from the bottom end of the scale on that meter when accuracy is important," Barney observed.

"Right. If the reading falls in the upper two-thirds of the scale on such a meter, you can depend on the reading to be off no more than 3% of the true value. That's why a multimeter with many scales affords

better accuracy than does one with only a few scales. With the former, you can always select a scale so the reading will fall in the upper two-thirds of the scale."

"How about meters in which the accuracy is rated as $\pm 1\%$ of the reading?"

"Here the maximum percentage of reading error is constant clear across the scale, but the permissible voltage error increases with the reading to reach a maximum at full scale. In our example, this would be 1 volt at 100 volts. It would only be 0.5 volt at 50 volts and 0.1 volt at 10 volts. This might mislead you into thinking the meter was more accurate at lower readings, but of course the permissible error, 'percentage-wise,' is exactly the same at 1 volt or 100 volts. But note the maximum percentage of reading error can never exceed 1% and the maximum voltage error, in our example, can never be more than 1 volt. At full scale, the anticipated accuracy of both meters would be the same; but the reliability of the readings on the meter rated at $\pm 1\%$ of full scale would decrease as the pointer moved down-scale, while the percentage-of-reading accuracy of the other would stay the same."

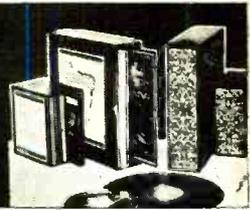
"Some manufacturers have done their best to decrease 'cockpit trouble,' or operator error," Barney pointed out. "A mirror beneath the pointer lets the operator avoid parallax errors by moving his head until the pointer is directly over its reflection before taking a reading. Some multimeters shift a different appropriate scale into position with each setting of the range knob, or they illuminate the proper scale. But how about the new digital voltmeters? Does Mr. Adams say anything about those?"

Digital Voltmeters. "Yes, and I have a few thoughts of my own to add. He points out that DVM's eliminate reading errors. Viewing angle does not affect accuracy of readings; and, in most models, placement of the decimal (selection of the most sensitive range) and indication of the proper polarity are all automatic. However, DVM's do have other internal sources of error. Noise riding on the voltage being measured must be filtered out to avoid errors with high speed DVM's. Amplifier zero drift and offset voltages arising from switch positions can contribute to error according to Mr. Adams. Finally, a DVM has a built-in ambiguity error of ± 1 digit.

"To understand why, you must realize

DELUXE RECORD AND TAPE CASES

with gold embossed
EXCLUSIVE
STEREO REVIEW DESIGN



Decorative and sturdy cases constructed of reinforced fiberboard—covered in rich leatherette to keep your records and tapes from getting damaged. Available in choice of five decorator colors. Record and Tape Cases lend themselves handsomely to the decor of any room. Padded back (in your color choice) is gold tooled in an exclusive design. Sides in standard black leatherette to keep them looking new after constant use.

Cases are available in three sizes for 7", 10" and 12" records. Center divider separates records for easy accessibility, holds an average of 20 records in their original jackets. Tape case holds 6 tapes in original boxes.

Ziff-Davis Pub. Co. • Dept. 23 • 1 Park Ave. • N.Y., N.Y. 10016

My remittance in the amount of \$

Quantity is enclosed for the Cases indicated below.

Tape Cases at \$4.50 ea., 3 for \$12, 6 for \$23.

7" Record Case at \$4.50 ea., 3 for \$12, 6 for \$23.

10" Record Case at \$4.95 ea., 3 for \$13, 6 for \$25.

12" Record Case at \$4.95 ea., 3 for \$13, 6 for \$25.

Add \$1.00 PER ORDER for POSTAGE and HANDLING. Outside U.S.A. add \$1.00 PER CASE ORDERED.

Check color choice for back of case (sides in black only):

Midnight Blue Red Spice Brown

Pine Green Black PE-472

Name _____

Address _____

City _____

State _____

Zip _____

PAYMENT MUST BE ENCLOSED WITH ORDER



not by a long shot it isn't !!

There's certainly nothing top secret about Popular Electronics' classified pages. They're wide open to every buyer in the market for the product or service he knows can be found in Electronics Market Place.

More than 375,000 buyers of Popular Electronics, largest readership of any electronics magazine in the world, guarantee that your ad is being read by people constantly looking for and buying electronics products. It is these people to whom you MUST direct YOUR advertising as do the many key advertisers appearing in this issue and in each issue throughout the year.

No doubt about it—there's a vast market of buyers searching the classified advertising pages of Popular Electronics and it's important that your ad be exposed to them. Prove to yourself that the leading electronics magazine MUST ALSO be the leader in sales responses to the many classified ads presently enhancing its pages—it makes a great deal of sense—give it a try.

See classified section for rate information or write to
HAL CYMES, Classified Advertising Manager
ZIFF-DAVIS PUBLISHING COMPANY
One Park Avenue, New York, N. Y. 10016

that, in a DVM, the measured voltage is balanced by an internal voltage in a bridge circuit. The internal voltage is applied lightning-fast in counted and displayed identical increments until the bridge is balanced as nearly as possible. By that I mean we reach a point where the bridge is almost nulled on the low side; yet the addition of one more increment of voltage makes it just slightly unbalanced on the high side. The displayed count can stop on either side of the true null, with the unbalance not being sufficient to cause the addition and subtraction of another unit of voltage and consequent change in the right-hand, least significant digit of the displayed voltage.

"DVM's usually specify accuracy as a percent of reading plus a percent of full scale. Sometimes the latter half is given as a number of digits. A 5-digit DVM accuracy may be specified as either $\pm(0.005\%$ of reading plus 0.001% F. S.) or $\pm(0.005\%$ of reading plus 1 digit.) Both are the same. As in the case of the pointer type meter, the *percent of reading error* is fixed, but as the reading increases, the number of digits error increases. On the other hand, the *percent of full scale* determines the greater portion of the permissible error on the lower portion of the scale. This can be an important factor in selecting a DVM for a particular purpose. For example, a DVM with a specified accuracy of $\pm(0.01\%$ of reading plus 1 digit) will be more accurate over the lower 80% of the range than will one with a claimed accuracy of $\pm(0.005\%$ of reading plus 0.005% F. S.)"

"I guess the accuracy of a DVM depends on the number of digits displayed. Is that right?"

"Probably it's better to say the 'resolution' of a DVM depends on the number of digits. Resolution is the amount of change in the voltage being read required to produce a 1-digit change in the reading. As the number of digits in the display goes up, the value of this voltage goes down. You might lump all these factors together and say that, in general, if you need 0.01% accuracy over most of the range, it's advisable to buy a 5-digit DVM; if 0.1% accuracy is sufficient, a 4-digit instrument will do; but only if 1% accuracy over most of the range is good enough should you buy a 3-digit DVM. However, if your needs are centered around a particular voltage,

computing the accuracy at or near that voltage, according to published specs, is the best way to select an instrument. If this voltage falls near the full scale reading of any range, you can expect 0.1% accuracy and resolution from a 3-digit DVM, 0.01% accuracy and resolution from a 4-digit, and 0.003% accuracy and 0.001% resolution from a 5-digit instrument."

"DVM's have better accuracy and sensitivity than pointer-type meters, don't they?"

"Yes, because they lack the mechanical friction and inertia of moving coil meters, they can respond more quickly and to much smaller changes in voltage than can pointer-type meters. While DVM's are not designed to perform as laboratory standards or to replace laboratory potentiometers, they have brought near-laboratory accuracy into the field and into the production line."

"Do you think radio and TV service technicians should use DVM's in their work?"

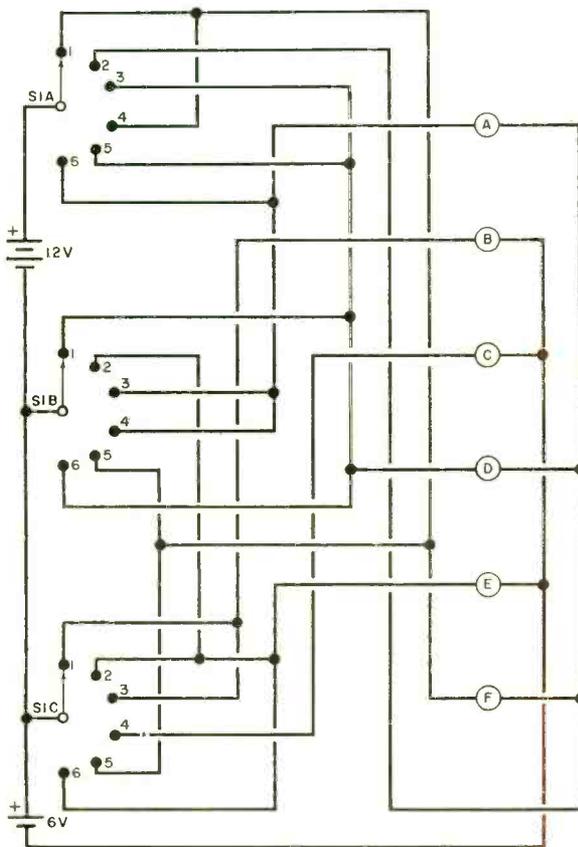
"If you mean do I think we should replace our pointer-type meters with DVM's the answer is no. We do not need anywhere near the accuracy of even a 3-digit DVM. Remember most resistors in radio and TV sets have a 10% tolerance and most voltages listed on schematics are within $\pm 20\%$. Using a DVM to perform routine voltage checks in our work would be about as logical as mounting a high-powered telescope sight on a shotgun. However, I'm thinking of buying at least a 4-digit DVM for use as a reference in checking and calibrating our other meters and for use in those few cases where critical voltage measurement is necessary. I have a hunch the quick response of the DVM might also be useful in some intermittent cases."

"I guess no matter what instrument a fellow uses, he ought to know what to expect from it." Barney observed.

"That's right. When you are using any tool, you cannot use it to the fullest extent and with confidence unless you know two things: what it is capable of doing, and what its limitations are. The latter is just as important as the former, for it avoids trying to do something of which the tool is incapable. When you know the accuracy limitations of a meter, you keep these in mind when taking a reading; furthermore, when the accuracy is not uniform across the scale, you are in a position to take advantage of this fact in selecting the range that provides maximum accuracy." ♦

Ganged Switching Quiz

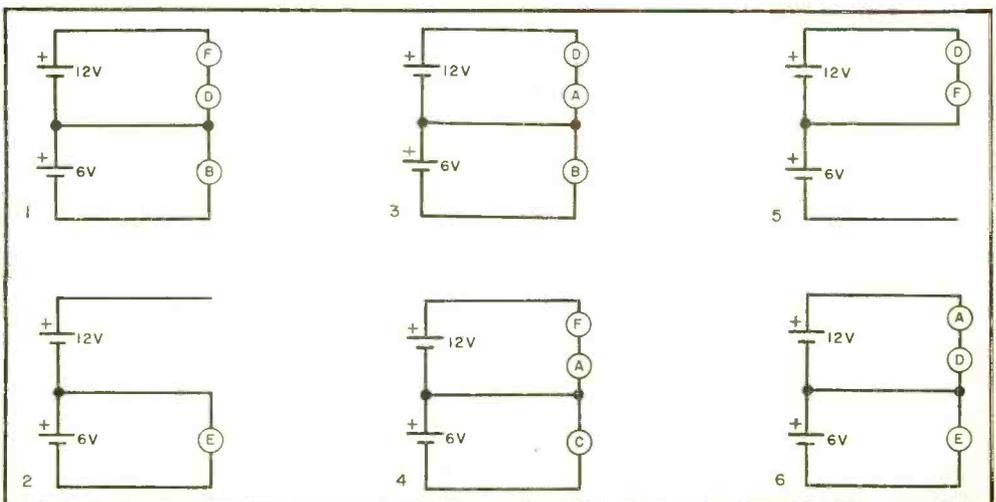
BY ROBERT P. BALIN



ELECTRONICS hobbyists, especially troubleshooters, can always use some practice in tracing out circuits that include ganged switches. Unless you are careful and systematic, it is easy to get confused, lose your way or overlook a component. Here's a chance to practice this important skill.

The schematic at left contains a 6-position, 3-pole switch, six 6-volt lamps and 6- and 12-volt batteries. As the switch is rotated, determine what combinations of lamps will light—each to full brightness. The answers are below so cover them up while you work out the circuit.

Note that although the switching function which this circuit performs can be done by a much simpler circuit (a single 6-volt battery can do the job) such a circuit would be too simple to be challenging and only unnecessary schematic zig-zagging could make it look more complicated. Since this quiz is intended to be a training problem, practical considerations have been ignored.





Product Test Reports

AMPEX MODEL AX-300 TAPE RECORDER DECK (A Hirsch-Houck Lab Report)



The Ampex Corporation's Model AX-300 differs, both in appearance and function, from previous tape decks in the company's line. The deluxe three-motor, six-head machine which can record and play back in both directions with off-the-tape monitoring is manufactured in Japan to Ampex specifications. Its transport mechanism is solenoid-controlled through light pressure on "piano-key" levers. All transport controls are duplicated in an optional remote control unit which is fitted with a 15-foot cable.

The AX-300 has a foolproof tape-handling system which defied our attempts to outwit it. No matter how rapidly the controls are operated, or in what sequence, the recorder mechanism comes to a complete stop and pauses for a second or two before going from a fast speed to a normal speed. Its electromechanical brakes are failsafe, halting the tape without spillage in the event of a power interruption.

This is a three-speed tape deck, providing

operation at 1½ ips, 3½ ips, and 7½ ips with a single control to change both speed and equalization. Recording levels are set by four slider controls. A line source can be mixed with microphone inputs or with another high-level source to provide a variety of operating modes. Playback levels are fixed. And the two large VU meters can be used to monitor either source or tape playback levels.

Special effects are possible with a Function Programmer switch; no external patching is required. Programs can be recorded in stereo or quarter-track mono formats, transferred from one track to another with added material for sound-on-sound, rerecorded with a time delay for an echo effect, or recorded on one channel while listening with the other for sound-with-sound.

The tape direction can be reversed at any time by operating a control lever or automatically by a 20-Hz tone recorded on the tape. Commercially recorded tapes produced by Ampex already have this tone on them. However, by pressing a lever on the AX-300, the user can add the tone to his own home-recorded tapes.

The PAUSE control stops and starts tape motion instantly. Each of the six tape heads has a cueing/editing mark for simplified pinpointing of any specific instant of time on the tape.

The microphone inputs and headphone output jack are located on the front panel; all other inputs and outputs are located on the rear apron of the recorder. A recess on the left side of the deck contains four separate bias adjustment controls for the two channels in both directions of tape movement so that the recorder can be optimized for any tape formulation. As shipped from the factory, the AX-300 is set

up for BASF LP-35-LH tape, the same type we used in our tests.

A novel feature of this new tape deck is the continuously variable 12-dB/octave low-pass filter in the playback outputs. The cut-off frequency can be set for less than 3000 Hz to beyond 16,000 Hz. The Ampex philosophy in supplying this filter is that limiting the bandwidth to that needed for the program provides optimum signal-to-noise ratios.

Laboratory Measurements. In our laboratory measurements, the record/playback frequency response in both tape motion directions within a ± 2 dB range was 33-18,500 Hz at $7\frac{1}{2}$ ips, 40-11,500 at $3\frac{3}{4}$ ips, and 38-6000 at $1\frac{1}{4}$ ips. Playback response, with Ampex full-track tapes, was ± 1 dB from 150 Hz to 15,000 Hz at $7\frac{1}{2}$ ips, rising to +5.5 dB at 50 Hz. The low-frequency rise was partially due to "fringing" effects which occur when playing a full-track tape with quarter-track heads. But with a quarter-track test tape, the output at 50 Hz was still up 4 dB. At $3\frac{3}{4}$ ips, the full-track response was flat out to 7500 Hz and up 3 dB at 50 Hz.

The filter had ideal 12-dB/octave slopes with a sharp "knee." At its minimum setting, cut-off was at 2000 Hz. The calibration markings at 3, 6, 10, and 16 kHz were accurate. The response in the OFF position on the control was the same as in the 16-kHz position.

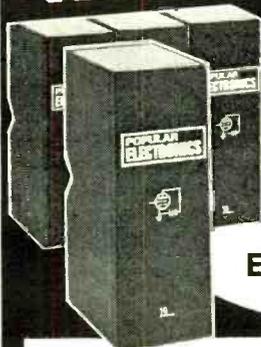
A line input of 98 millivolts or a microphone input of 0.82 millivolts produced a 0-VU recording level. The corresponding playback level was 0.83 volt. Distortion was a low 1.0 percent at 0-VU, reaching the standard 3.0 percent level at +6 VU, far off-scale. The signal-to-noise ratio measured out at 55 dB referred to 0 VU, or 61 dB referred to the 3.0-percent distortion level, which makes the AX-300 one of the quietest recorders we have ever tested.

Wow was unmeasurably low, reading the residual level of our Ampex test tapes (0.01-0.02 percent). Flutter was 0.08 percent at $7\frac{1}{2}$ ips, 0.09 percent at $3\frac{3}{4}$ ips, and 0.175 percent at $1\frac{1}{4}$ ips. Tape speeds were exact, and the fast speeds moved 1800 feet of tape, end to end, in about 70 seconds.

User Comments. The mechanical operation of the AX-300 was outstandingly

DELUXE

MAGAZINE CASES



Designed Exclusively for
POPULAR ELECTRONICS

● It's the new look in Magazine Cases! The ideal way to save your valuable copies, keep them well protected and make it easy for you to refer to any issue at any time. This bold new design is both decorative and attractive enough to enhance the decor of any room—and each case is specially designed to hold a full year's copies.

Constructed of reinforced fiberboard to guard your magazines against soiling and tearing, these tough and durable cases are covered in a rich textured, leather-like fabric. They're available in either all black or attractive maroon back with black sides. The gold embossed back adds to its elegance and makes each case a welcome addition to your bookshelf, end table, desk—or for that matter, anywhere in your home or office.

In addition to Popular Electronics, cases are available for any of your favorite magazines. They're only \$3.95 each, 3 for \$11.00, 6 for \$21.00, in any combination of titles ordered. Add 50¢ per order for postage and handling. Outside U.S.A. add \$1.00 per case ordered.

Ziff-Davis Pub. Co., Dept. 23, 1 Park Ave., N.Y., N.Y. 10016
PE-4-72

Enclosed is \$_____ Please send Magazine Cases for the titles indicated below @ \$3.95 each, 3 for \$11.00, 6 for \$21.00. Add 50¢ per order for postage and handling. Outside U.S.A. add \$1.00 per case ordered.

TITLE	QUANTITY
POPULAR ELECTRONICS	_____
_____	_____
_____	_____

Check One: All Black Maroon Back • Black Sides

Name _____

Address _____

City _____

State _____ Zip _____

PAYMENT MUST ACCOMPANY ORDER

smooth and faultless. The control levers required only about 1/16" travel with a feather-light touch to activate. This contrasts sharply with recorders using purely mechanical control linkages.

When we recorded FM broadcasts, we were not able to distinguish any difference in the playback at 7½ ips, only rarely at 3% ips. Using wide-range phonograph records for source material, we occasionally detected minute changes in the highest frequencies associated with bells and wire brushes. However, speakers with exceptional high-frequency response were needed to reveal these effects.

The frequency response at 1% ips limits that speed to background music and voice recordings. The audio filter worked well, but in view of the recorder's low noise and distortion, the AX-300 could have done just as well without it.

The Ampex AX-300 is housed in a walnut base which measures 16½" x 15½" x 8". The combined weight of the deck and base is 45 pounds. It should be mentioned that the AX-300 is designed to be used horizontally or vertically.

The suggested retail price of the AX-300 tape recording deck is \$649.95. The optional remote control, Model RC-204, sells for \$39.95.

Editor's Note: We understand that Ampex is discontinuing their line of tape recorders for the consumer. At this time we do not know what the disposition of the line will be. However, since the recorders and decks may still be available, we have presented the above report.

UTAH STUDIO 4 FOUR-CHANNEL ADAPTER (A Hirsch-Houck Lab Report)

The Utah Electronics "Studio 4" Ambience Regenerator is a passive device designed for extracting "ambience" or reverberant sound from 2-channel stereo recordings and broadcasts, reproducing four channels of sound with an additional pair of speaker systems located at the rear of the listening room. In some ways, the Studio 4 resembles other matrix devices for "decoding" specially processed 4-channel material. However, it is not offered as a 4-channel decoder or synthesizer. Rather, it is advertised as a means for enhancing listening pleasure by reproducing some of the sounds not normally heard through a 2-channel stereo system.

The simplified schematic of the Studio 4 shows how this is accomplished. The Ambience Regenerator is connected to the amplifier's left and right speaker outputs, and cables go from it to four speaker systems, two of which are in the traditional front left and right locations and one each in the rear left and rear right. The only special requirement for the amplifier is that its speaker output grounds be internally tied together, which is no real problem since most amplifiers are so constructed.

The common, or ground, lead from the two front speakers returns to the amplifier's common connection through an 8-ohm L-pad, shown in the schematic diagram as



a simple potentiometer. This potentiometer, identified on the front panel of the Studio 4 as RIGHT REAR, controls the level of a *sum* signal ($L + R$) used to drive the right rear speaker. The left rear speaker, with its level controlled by the LEFT REAR L-pad, is connected across two "hot" amplifier outputs and, thus, receives a *difference* signal ($L - R$).

Off hand, it is not easy to imagine the spatial distribution produced by the Studio 4. The left rear difference signal can be expected to supply ambience sounds, as it does with other matrix systems (including the original system proposed by Dynaco some time ago). But the purpose of the sum signal in the right rear is not quite as clearly understood.

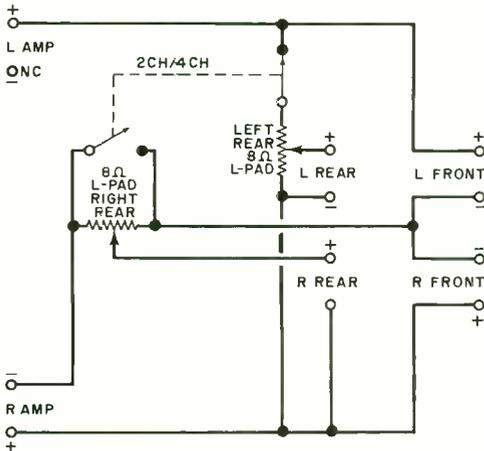
Listening Tests. It was a pleasant surprise

to find that the Utah Studio 4 produced a very listenable and pleasant pseudo-4-channel effect with most stereo program material. At most points in the listening room, one senses a distinctly different sound character from each of the four corners of the room. As an Ambience Regenerator, it must be considered a success, quite

comparable in its subjective qualities to the other matrix decoders we have used on ordinary 2-channel stereo programs.

One could hardly expect the Studio 4 to decode records cut for a specific matrix parameter (such as those used by Dyna, Electro-Voice, Sansui and the like) with any faithfulness to the original intent. We played a number of these records through the Studio 4, and although there was at times a vague sense of directionality, it was random and difficult to define. Certainly, it was not equivalent to the results one obtains with the appropriate decoder. However, the records sounded fine, exhibiting a strong sense of spaciousness, even if directionality was lacking.

One mildly annoying side effect of the Studio 4 was the difference in noise level from the two rear speakers. A large percentage of hiss, hum, rumble, and other unwanted sounds on records and on FM broadcasts seems to be out-of-phase information. It appears to emit from the left rear speaker, often at audible levels. On the other hand, little or no noise comes from the right rear speaker system. Fortunately, the rear speaker systems are normally operated at rather low levels,



Simplified diagram of Utah Ambience Regenerator shows speaker hookup.



It's the BSR McDonald 310/X, and it's the best buy in automatic turntables. Anywhere.

This is no "little brother" turntable, either. It's got a full-size platter, cue and pause control, low mass tone arm system and a visible stylus pressure indicator.

And because it's a famous BSR Total Turntable, it comes complete with a tinted dust cover, custom molded base and a Shure M-75 magnetic cartridge—all factory-installed and balanced and included in the low price.

The BSR McDonald 310/X. It's perfect for people who want the best, no matter how little it costs.

Send for free full color catalog on all our automatic turntables. BSR (USA) Ltd., Blauvelt, N.Y. 10913

**The does-it-all turntable
at a do-it-yourself price.**

BSR
McDONALD

CIRCLE NO. 8 ON READER SERVICE CARD

preventing this effect from becoming a serious problem.

The Studio 4, besides its rear speaker level controls, has two rocker switches on its front panel. One switch converts the adapter to conventional straight-through stereo operation, a very effective way to convince the user that the Studio 4 is really doing its job. As Utah states, one is unlikely to use this switch much after the initial period of use.

Circle No. 76 on Reader Service Card

The second switch reconnects the speakers to produce a sound null when the amplifier output levels are perfectly balanced. This output level balancing is a necessity for proper operation of the system (a similar function is part of the Dynaco "Quadaptor" and other units).

Utah's Studio 4 Ambience Regenerator is housed in a 9 $\frac{1}{2}$ " x 4 $\frac{1}{2}$ " x 4" attractive walnut-finished wood cabinet. Its retail price is listed at \$39.95.

TRAM TITAN III AM/SSB CB TRANSCEIVER

The Tram Corporation's Titan III is a solid-state Citizens Band transceiver capable of operating on all 23 channels in both AM and SSB, the latter on either the upper or the lower sideband. Designed for base-station use—requiring a 117-volt ac power source—this transceiver is an impressive looking piece of equipment. It is housed in a large cabinet with a wood-grain finished bottom and side panels and a scuff-proof vinyl-clad top. A host of controls make the Titan III a "dial twiddler's" delight.

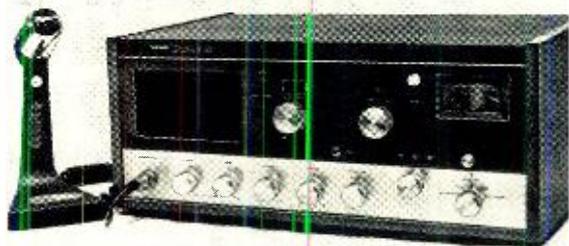
The size of the transceiver is 18 $\frac{1}{2}$ " x 11 $\frac{1}{2}$ " x 8 $\frac{1}{2}$ ". Weight is 22 $\frac{1}{2}$ pounds. It is a high-quality product made in the U.S. and is available for \$598 with an Electro-Voice Model 719 microphone or for \$614 with an Astatic Model D104 microphone.

Operating Controls. There are two channel selector switches, one for transmit and the other for receive. In contrast to gear with a single selector, this permits convenient split-channel operation.

An r-f gain control, not usually found on CB units, is provided to allow the user to minimize overload and distortion on strong nearby signals. The power switch and a-f gain are combined on one control. There is also a squelch control which can be adjusted for threshold sensitivities between 0.2 and 10,000 μ V on either AM or SSB.

Another control switches an automatic noise limiter in and out to allow the user to set the degree of limiting action. This optimizes the effectiveness with minimum distortion. A fine-tune control varies the receiver over a range of \pm 1000 Hz; this is a must for SSB operation.

A three-position selector permits selection of SSB on the lower sideband (LSB),



SSB on the upper sideband (USB), or AM operation. A large meter is coupled with another rotary switch and a potentiometer control. The meter can be switched to indicate receiver S units, actual r-f output power, SWR calibration (in conjunction with the pot control located just above the selector switch), or SWR. A fifth position of the switch transfers the transmitter's output from the antenna to an internal 50-ohm dummy load at which time the meter also indicates the r-f power. This position facilitates transmitter tests and adjustments without putting a signal on the air and, thus, eliminates unnecessary interference.

Technical Details. Dual conversion is employed on receive with a first i-f of 4.4 MHz and a second i-f of 455 kHz. Selectivity is obtained using a mechanical filter which has a rated bandpass of 6 kHz at 6 dB and 20 kHz at 75 dB. An adjacent-channel rejection of 70 dB is obtained on AM, and for SSB, unwanted sideband suppression at 1 kHz is 25 dB.

An excellent sensitivity of 0.1 μ V with 10 dB S+N/N on SSB and 0.35 μ V on AM, plus good signal-handling capabilities, are made possible with two FET's in a cascaded r-f stage, followed by FET's

at the two conversion mixers. A better-than-usual image rejection of 80 dB and an i-f signal rejection of 75 dB are realized.

A crystal-controlled oscillator is used for heterodyning at the first mixer, while a self-excited tunable oscillator is engaged at the second mixer. This oscillator functions in the 4.3-MHz range where excellent frequency stability can be obtained, thus eliminating the need for crystal control on receive. Individual detectors are switched in for AM and SSB. Optimized noise suppression for each mode is realized with individual series-gate type noise limiters.

The a-f system ends with four transistors in a push-pull Darlington amplifier to produce a 1-watt, 2-percent distortion or a 2-watt, 2.5-percent distortion power output at 1000 Hz. The speaker is front-facing. There is also a jack for an external speaker. An amplified agc system holds the a-f output change to within 10 dB, with 100 dB (1-100,000 μ V) signal input change.

For transmitting, an initial carrier is generated in the 6.2-MHz region with an SSB signal obtained from a four-diode balanced modulator and a 6.255-MHz crystal-lattice filter where an unwanted sideband suppression of 50 dB at 1000 Hz is realized. A carrier suppression of 35 dB is obtained at the balanced modulator. For AM, the modulator is unbalanced and the initial carrier is slightly shifted to produce a carrier through the filter.

The SSB signal or the AM carrier is then heterodyned with a crystal-controlled signal of a frequency which produces an output on the desired 27-MHz channel. An overall frequency tolerance of 0.0015 percent is maintained. Two 27-MHz drivers precede the power amplifier where the bias is thermistor-stabilized to guard against thermal runaway.

For AM, the second driver and the power amplifier are collector-modulated by the receiver's a-f power amplifier. A pi network at the output is designed for operation into loads of 30-70 ohms.

Operation is at the maximum legal power input levels of 5 watts on AM and 15 watts PEP on SSB. Power outputs are 3 watts carrier and 8 watts PEP in the respective modes. Distortion products with a two-tone test on SSB were at least 23 dB down.

An FET, functioning as a shunt limiter

TUNER SERVICE

VHF, UHF, FM or IF Modules . . .

Fast **8** hr. Service!

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 573 • Bloomington, Ind. 17401 • 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 6881 • Jacksonville, Fla. 32203 • Tel. 904. 386-9952
EAST—
Box 3180 • Springfield, Mass. 01103 • Tel. 413. 734-2737
MOUNTAIN—
Box 4245 • Denver, Colo. 80201 • Tel. 303. 244-2818

CIRCLE NO. 35 ON READER SERVICE CARD

ANOTHER SUPERB VALUE
from **Olson**

Electronics
ONLY

\$10⁹⁸

DELUXE BATTERY TESTER



Compact precision tester checks all types of batteries from radio to industrial. 12 position switch selects most popular ranges from 1.5 volts to 240 volts. 1.5v to 15v ranges are tested under load. Complete with test leads and instructions.

Olson Electronics, Dept. 14, 260 S. Forge St.,
Akron, Ohio 44308

- I enclose \$10.98 plus \$1 for postage and handling. Send me the TE-237 Battery Tester.
- Send me the next seven issues of the Olson Catalog, without cost or obligation. **FREE**

Name _____
Address _____
City _____
State _____ Zip _____

CIRCLE NO. 32 ON READER SERVICE CARD

at the speech amplifier, provides compression which maintains a high modulating level with wide variations in voice intensity. The user can back off from the microphone or come close up to it without any significant level changes. This, coupled with adequate a-f filtering, introduces much less distortion than is possible with conventional clipping systems.

Operationally, it takes a bit of getting used to the two-dial method of channel selection. Selection is done in the conventional lock-in-place control for the transmitting channels. But the receive channel selector employs a continuously tunable system. The tuning control must be rotated to the channel identification numeral and then "rocked" slightly for peaking to obtain maximum signal. The correct spot falls close to the dot at the related numeral. On SSB, however, proper tuning with a fine-tuning control must be made for natural voice quality. This occurs a bit to either side of this spot, depending on which sideband is in use.

In some cases, it might not be quite clear just to which channel the receiver is tuned. But this can be easily ascertained by depressing a "frequency-spotting" button and rotating the transmitter selector until a signal from the transmitter's crystal oscillator is heard on the receiver. Reference to the channel number on the transmitter selector then identifies the channel to which the receiver is set.

Since the tuning spot is slightly different for each sideband when SSB is involved, the receiver's dial must be accordingly reset when sidebands are switched by another station. This can be an inconvenience where an instant change is desired at the receiver. It also might be noted that only the receiver frequency is varied by the fine tuning, whereas in some SSB gear the fine tuning simultaneously adjusts both the transmitter and receiver to exactly the same frequency.

All performance figures given above were essentially the same as those specifications supplied by the manufacturer.

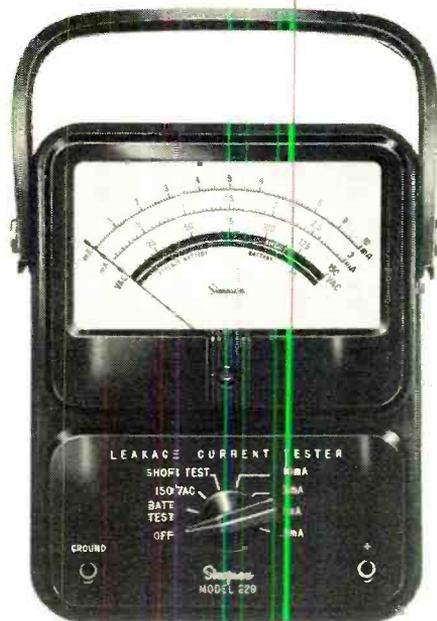
Circle No. 77 on Reader Service Card

SIMPSON MODEL 229 AC CURRENT LEAKAGE TESTER

Although many of us think nothing of fearlessly shoving a voltmeter probe into a "hot" circuit, sober thought is always given to working on an ac power-line operated appliance that has no transformer because there is always the possibility that the chassis may be hot with respect to ground.

One important question is, how hot is "hot"? Legally, it is spelled out in the U.S. Standards Committee Proposed Specification No. C101.1 for ac current leakage tests. This proposes a maximum leakage current of 0.5 mA measured through a 1500-ohm resistor shunted by a 0.15- μ F capacitor. Note that this is *current* leakage NOT voltage. This is because it is current that does the damage, and the amount of current is a function of the applied voltage and the resistance of the body parts in the conducting path. (See "How Much Current Is Fatal?" on page 31, in our issue of January 1972, for more detailed information.)

A mean value of 1.067 mA at 60 Hz was determined as the threshold of perception in some recent tests having to do with ac leakage currents. Obviously, then, the lower the leakage current, the safer



the device. Above a couple of milliamperes or so, there is a dangerous threat to life.

The Simpson Electric Company's new Model 229 AC Current Leakage Tester

follows the Specification to within 1 dB and can measure leakage currents as low as 5 μ A. The complete full-scale ranges for this instrument are 0.3, 1, 3, and 10 mA. The 229 also has the capability of measuring ac voltages to 150 volts, which effectively doubles the instrument's usefulness.

The input impedance to the Model 229 is 1500 ohms, shunted by a shaping network on all current ranges, and 500,000 ohms on the ac voltage function and ranges. The instrument is fully protected to 150 volts ac on all ranges. Full-scale accuracy is within 2 percent.

The large, easy-to-read meter movement not only indicates the voltages and currents being measured, but it also indicates the condition of the internal battery. Another scale is used to indicate short circuits and near-short circuits.

User Tests. In use, the Simpson Model 290 is connected between the metal frame of the electrical appliance under test (washer, dryer, toaster, ac-dc radio receiver, etc.) and a good earth ground such as a cold water pipe. It is best to connect the ground lead first, then the hot probe. The range/function switch is then set to the SHORT-TEST position; if the meter pointer rises into the red area on the meter scale, the current leakage

is in the danger zone and is greater than 10 mA. Conversely, if the meter pointer stays in the green area, the amount of current leakage can be measured by setting the switch to the appropriate range/function position.

We had occasion to try out the Model 229 on some typical home appliances which have been in daily use for years. It came as quite a shock to see the amount of leakage in the washer-dryer area in our basement utility room and how close the lady of the house has literally been to danger. Our readings convinced us that we should immediately remove the elderly two-wire electrical system and replace it with a three-wire system with a safety ground lead. After doing this, we removed several years accumulation of lint, oily dust, and other sundry items from around the electrical connections. The connections were then coated with a nonconducting plastic spray, after which we again used the leakage tester to see what improvements, if any, had been made. It was nice to see the leakage drop to well within the safe limits for operating home electrical appliances.

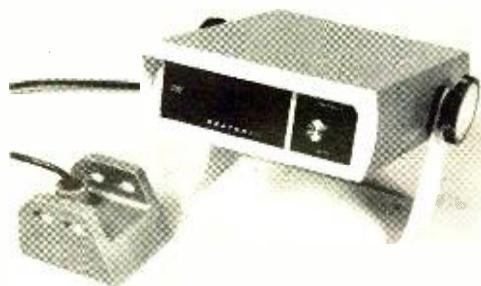
The Simpson Electric Co. Model 229 AC Current Leakage Tester sells for \$90. An optional leather carrying case, No. 00805, is also available for \$13 more.

Circle No. 78 on Reader Service Card

HEATHKIT MODEL MI-101 DIGITAL DEPTH SOUNDER

For the past couple of years, this reviewer has been dashing around the waters off the East Coast using a Heathkit Model MI-29 Depth Indicator and Fish Spotter. The primary use of the device was to keep tabs on where the bottom was with respect to the fragile hull of our staunch craft, rather than to locate fish. However, we did locate many a school of bass and blues when they were running.

During this time, we were very pleased with the performance of the fish spotter, finding it to be the equal of many more expensive spotters. Therefore, we jumped at the chance to build and try out the new Heathkit Model MI-101 Digital Depth Sounder which sells in kit form for \$139.95. The MI-101 is quite a step forward in depth sounders. It displays water depth through 2½ decades of



seven-segment incandescent readouts along with a very useful "under-10-feet" indicator lamp. The complete range of the sounder is 2.5-19.9 feet, with automatic switchover to 20-199 feet. But if desired, the minimum depth indication can be modified to one foot of water.

The display is updated once a second.

AT LAST! PROFESSIONAL HOME PROTECTION EVERYONE CAN INSTALL AND AFFORD.

Model FC-100
WIRED \$59.95

- 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. 14 ON READER SERVICE CARD

Technical excellence in electronics

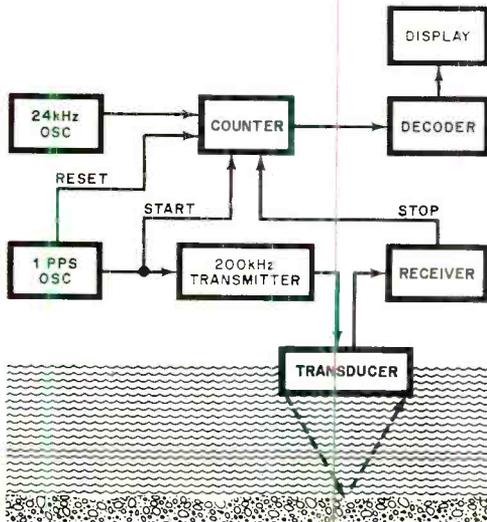
On our small, friendly campus the emphasis is on Living as well as Learning. Extra-curricular social activities, student clubs, a student operated radio station, student government, new dormitory and a full sports program help provide a world of your own in which to prepare for tomorrow. Associate Degree in Engineering Electronics. B.S. obtainable. G.I. approved.



VALPARAISO TECHNICAL INSTITUTE

Dept. PE, Yellowstone Trail, Valparaiso, Indiana 46383

CIRCLE NO. 47 ON READER SERVICE CARD



Logic diagram shows how depth indicator functions like frequency counter.

The readout brightness can be controlled from a low light level for use on those dark nights when you don't want bright panel lights disturbing your night vision, to a very bright display which can be easily read in sunlight.

Operated from a conventional 12-volt automotive-type battery—the same one used to power the radio, lights, and electric starters on most boats—the MI-101 draws only 300 to 500 mA of current, depending on readout brightness.

The instrument comes in a smart-looking blue molded plastic case which measures 8 1/2" x 6 3/4" x 2 1/4". The readout/electronic package is designed for use with a screw-down gimbal bracket (supplied) which permits the user to adjust the sounder for almost any convenient viewing angle of the readout display.

The MI-101 is available in two models, depending on the type of transducer mounting desired. The MI-101-1 has a through-the-hull transducer, while the MI-101-2 has a transom-mounted transducer.

Easy Assembly. Using the first-class Heathkit assembly and operating manual, assembly time for the MI-101 worked out to about eight hours.

The assembled MI-101 employs seven integrated circuits, for which sockets are provided, thus virtually eliminating the possibility of heat damage to the IC's during the soldering operations. The metal-

work, plastic housing, and electronic components are all of top quality. With a little care, the kit builder will have a depth sounder to be proud of.

Operation of this new sounder is quite different from the earlier spinning-wheel type which just displayed two red blips, one at zero and the other at a position on the scale which corresponded to the depth of the water. At first glance at the logic diagram, the MI-101 appears to be just another digital frequency counter (which, in a way, it is). A one-pulse-per-second master oscillator causes the 200-kHz transmitter to emit the "main bang" into the water and simultaneously turns on a frequency counter. The counter follows either a 2400-Hz or 24-kHz pulse train, automatically selected by the water's depth, and when the receiver picks up the echo pulse from the bottom or a nice-sized fish or school of fish, the counter stops and displays its last count. A blanking circuit keeps the display on until the next cycle occurs, eliminating the blurring display common to unblanked counters. The display remains on, changing the digits only when the water depth beneath the boat changes. Also, a built-in noise suppression circuit greatly reduces interference from engine ignition noise (the assembly/operating manual which accompanies the kit details how to reduce engine noise).

User Results. We used the MI-101-2 version of the depth sounder, the one with the transom-mounted transducer. After mounting everything in place in our boat, we took off. Knowing we were in shallow water, it was reassuring to see the under-10-foot lamp signalling its warning. Once out into the deeper waters of a bay, the lamp extinguished and the digital display kept us posted on just how deep was the water.

With the earlier depth sounder, too long a time was required to read the depth as the red blips were often dimmed out by ambient light, necessitating the directing of our attention to the display instead of the water ahead of our boat. This can be a little bothersome in unfamiliar waters where shoals can materialize as if by magic. With the MI-101, however, all we needed was a fast glance at the display panel to get an instant reading.

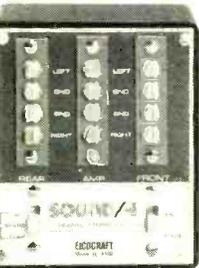
Circle No. 79 on Reader Service Card

ADD A FOURTH DIMENSION TO YOUR STEREO SYSTEM.

Enjoy 4-dimensional sound hidden in standard stereo records, tapes and FM broadcasts.

Just add the SOUND/4™ adaptor and two speaker systems — No additional amplifiers required.

EC-4700 KIT \$9.95



WIRED \$19.95

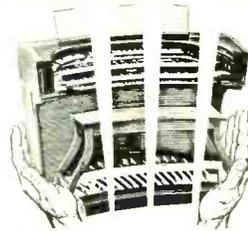
FREE 1972 EICO CATALOG

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. EICO, 283 Malta Street, Brooklyn, N.Y. 11207.

SOUND/4
BY EICOCRAFT

CIRCLE NO. 15 ON READER SERVICE CARD

IT'S EASY TO ASSEMBLE A SCHOBER ORGAN



THEATRE ORGAN
*\$1730

*Includes finished walnut console. Amplifier speaker system, optional accessories extra. Only \$1256 if you build your own console.

You couldn't touch an organ like this in a store for less than \$3500—and there hasn't been a musical instrument with this vast variety of genuine Theatre Organ voices since the days of the silent movies! If you've dreamed of the grandeur of authentic big-organ sound in your own home, you won't find a more satisfying instrument anywhere—kit or no kit.

You can learn to play it. And you can build it, from Schober Kits, world famous for ease of assembly without the slightest knowledge of electronics or music. Highest praise from musicians everywhere.

Send right now for your copy of the full-color Schober catalog, containing specifications of the five Schober Organ models, beginning at \$499.50.

The Schober Organ Corp., Dept. PE-42
43 West 61st Street, New York, N.Y. 10023

- Please send me Schober Organ Catalog and free 7-inch "sampler" record.
- Enclosed please find \$1.00 for 12-inch L.P. record of Schober Organ music.

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

CIRCLE NO. 38 ON READER SERVICE CARD



**Train on this
315 sq. in.
picture
color TV
and get the
skills that
mean a
high-paying
career!**

For a solid future...

NTS Home Training makes tomorrow's electronics happen—today!

Now included in two exciting NTS color TV courses, this set is the largest, most advanced color television made. Guided by the NTS "Lab-Project Method" of combining professional kits and easy-to-follow lessons, you build this color TV step by step — learning TV Servicing as you go! NTS has successfully trained thousands of men at home for rewarding careers as electronics technicians. Prepare for the great opportunity fields of TV-Radio Servicing, Computers, Communications, and Automation.

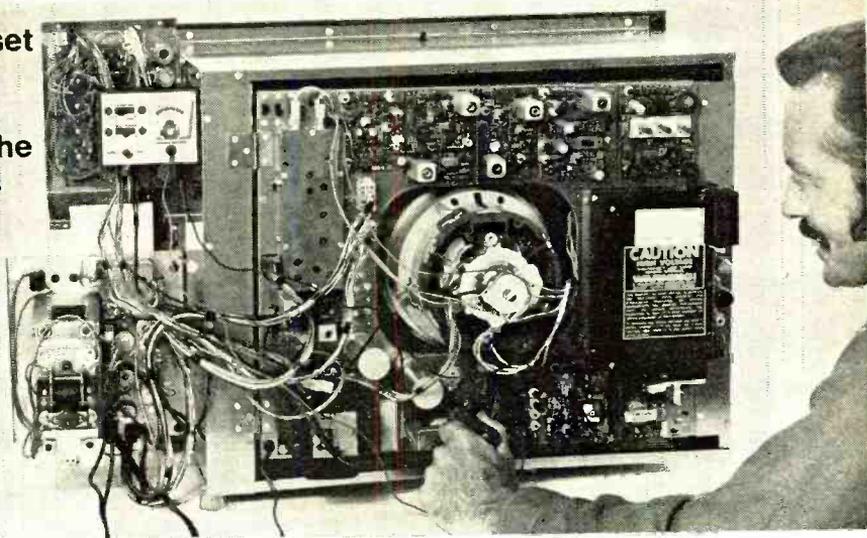
This solid-state color set contains: 45 transistors, 55 diodes, 2 silicon controlled rectifiers, and 4 advanced Integrated Circuits representing an addi-

tional 46 transistors and 21 diodes. The first solid-state color TV this large — yours to keep! It features Automatic Fine Tuning; "Instant On"; an Ultra-Rectangular Screen (25 in. diagonal measurement) that lets you see the complete transmitted image for the first time — a full 315 square inches; exclusive built-in Self Servicing features which eliminate the need to buy costly test equipment; exclusive design Solid-State VHF Tuner with an MOS Field Effect Transistor; 3-stage Solid-State IF; Automatic Chroma Control; Adjustable Noise Limiting and Gate Automatic Gain Control; High Resolution Circuitry; Matrix Picture Tube; and a specially formulated Etched Face Plate that eliminates unwanted glare, and heightens contrast. Colors are more vivid,

fresh tones more natural, and the picture is sharper than ever before. By training on this unique color TV, you'll gain the most up-to-date skills possible in TV Servicing!

Other valuable equipment you build and keep includes an AM SW Radio, Solid-State Radio, FET Volt-Ohmmeter, and Electronic-Tube Tester. All included in your tuition. You learn troubleshooting, hi-fi, multiplex systems, stereo, and color TV servicing. Step right into a technician's job at top pay or open a business of your own! For complete details on *all* NTS electronics courses, mail the coupon today for the full-color NTS Catalog. No obligation. No salesman will call.

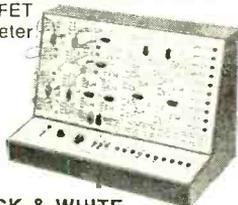
Build this set and learn solid-state circuitry—the electronics of today!



train on solid-state

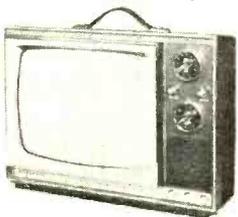
NTS ELECTRONICS & COMPUTER TECHNOLOGY

Build this exclusive NTS Computer Trainer! Loaded with integrated circuits, it shows you the how, what, and why of computers. Learn this exciting field faster, more thoroughly. You also assemble and learn to operate an FET Volt-Ohmmeter and 5" wide band Oscilloscope.



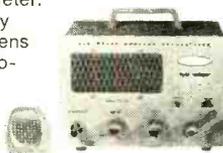
NTS BLACK & WHITE TV AND RADIO SERVICING

Learn all phases of television, radio, stereo, and hi-fi. You receive this 74 sq. in. picture Solid-State B&W TV, Lo-Silho "Superhet" Radio, FET Volt-Ohmmeter, Solid-State Radio, Electronic Tube Checker, and Signal Generator. Start earning extra money even before you complete the course!



NTS ELECTRONICS COMMUNICATIONS & F.C.C.

Gain the security and prestige 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 14 kits, including a 5 watt AM Transceiver, 6 Transistor Pocket Radio, and FET Volt-Ohmmeter. Learn 2-way radio, Citizens Band, micro-waves and radar.



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" wide band Oscilloscope. And you perform experiments that involve regulating motor speeds, temperature, pressure, liquid level, and much more.



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.

APPROVED FOR VETERANS

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

NATIONAL TECHNICAL SCHOOLS

WORLD-WIDE TRAINING SINCE 1905
4000 South Figueroa Street, Los Angeles, Calif. 90037

Please rush Free Color Catalog and Sample Lesson, plus information on course checked below. No obligation. No salesman will call.



National Technical Schools

- 4000 S. Figueroa St.
Los Angeles, Calif. 90037
- Master Course in Color TV Servicing
 - Color TV Servicing (For Advanced Technicians)
 - Master Course in B&W TV & Radio Servicing
 - Master Course in Electronic Communication
 - Practical Radio Servicing
 - FCC License Course
 - Master Course in Electronics Technology
 - Industrial and Automation Electronics
 - Computer Electronics
 - Basic Electronics
 - High School at Home Dept. 205-042

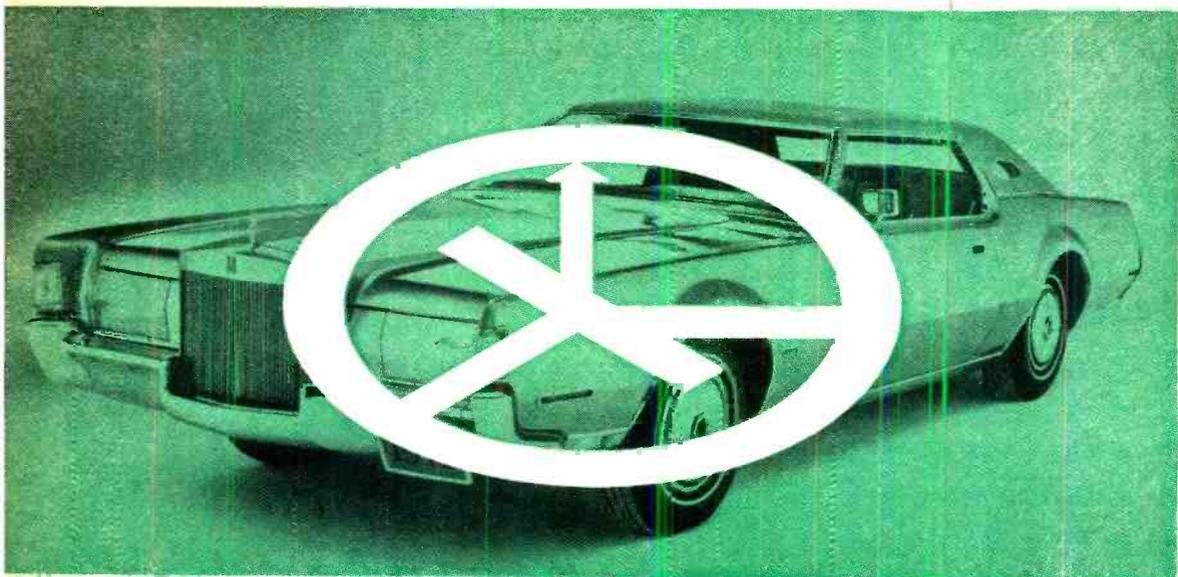
Name _____ Age _____

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.



More Solid-State Electronics for the New Cars

PART 2

CHANCES are that the first car you drive with an on-board minicomputer that starts the engine, optimizes ignition and air/fuel mix, sets safety mechanisms, and gets ready to shift transmission, will come from Japan or Germany. The reason such a car is not likely to come from Detroit is that foreign car firms and electronics companies are cooperating with each other to develop and deliver sophisticated system packages. The picture on the domestic front is quite different; a lack of good communications has put the auto men and electronics men at odds with each other.

There is certainly no lack of expertise or ambition in the U.S. The missing ingredients are cooperation and understanding. But with no clear, enthusiastic agreement, solid-state electronics in American-made automobiles has only inched along.

It is obvious that any little "blackbox"

WHAT FORD AND
CHRYSLER
ARE OFFERING IN
THEIR 1972 LINES

BY JOHN D. DRUMMOND

electronic package integrated into an automobile must be able to outfox and outlast the hostile environments created by rough roads, snow, ice, mud, extreme heat, and extreme cold. Otherwise, the highly practical automobile engineer wants no part of it, according to Charles T. Mulcahy, a Ford Motor Co. Engineer. He goes on to say, "If the engine won't start, the car won't go; if the engine starts and the car is inoperative, the car won't move."

But consider this: the little black box has guided man to the moon and back in spectacular form. Solid-state devices contain no inherent wear-out mechanisms. In fact, thanks to their proven reliability, solid-state devices and systems are perhaps the only practical and economical way to realize safety, environmental cleanliness, and the convenience required for tomorrow's automobile.

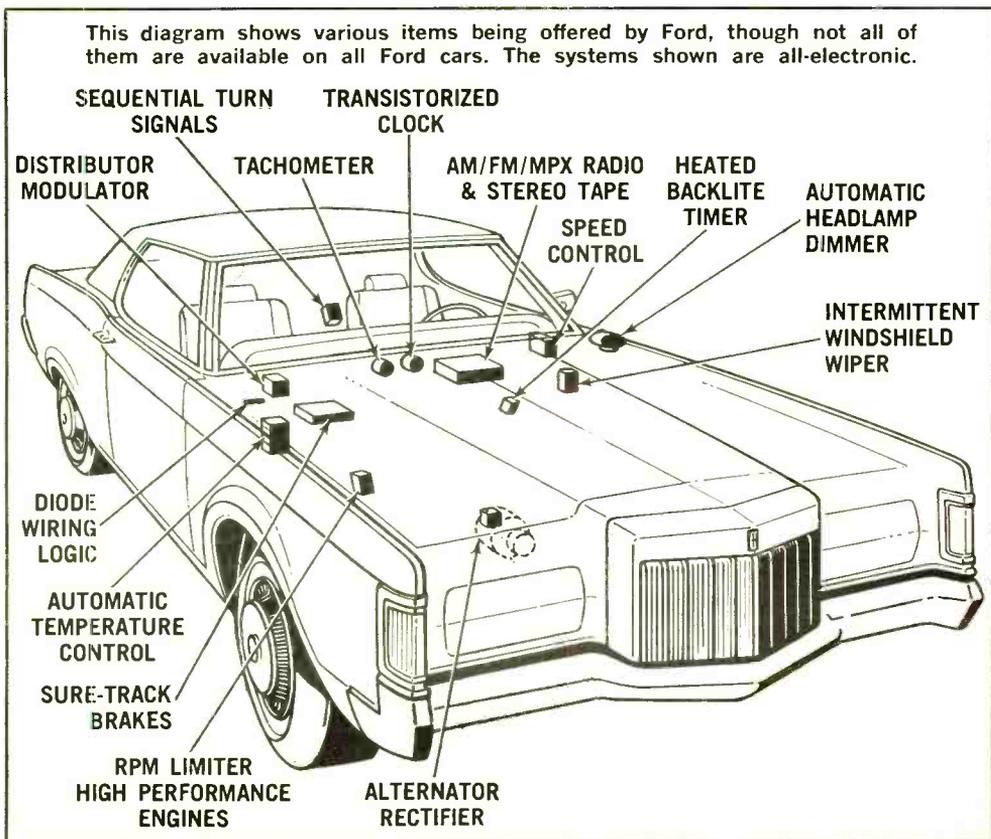
The Pressure is On. With enforcers breathing down their necks, the auto makers are necessarily devoting most of their efforts to solving the problem of reducing exhaust emissions and developing passive-restraint devices to comply with Federal regulations. So, Detroit has had to lay aside, at least for the present, development and implementation of such exotic things as a single-wire multiplexed system that replaces the maze-like electrical network wiring harness; radar-based anticollision and braking systems; central processor to control antiskid braking; electronic fuel injection; and speed and transmission controls.

The auto men are furious over this stringent Federal legislation. Ernest S. Starkman, a General Motors vice president, explains that considerable progress has already been made toward reducing air pollution from automobiles. But pressure for further reductions is a consequence of impatience with the progress being made in the state of the air in our urban environments.

Whatever the impetus, the electronics industry has a golden opportunity to work with Detroit in meeting Federal pollution standards. The electronics men feel that solving both the pollution and passive-restraint problems are within their bailiwick. Presently, however, the auto men are more preoccupied with grappling with the pollution problem. But some electronic devices are showing up in Detroit's new cars.

Ford's Better Ideas. Typical of what is being marketed are the electronic controls in Ford's 1972 line. Not all of the items (see illustration below) are available in any one model. But they are available in various combinations on all Ford-built cars.

Among the offerings are safety braking for skid control to prevent the wheels from locking up and skidding should the driver attempt a panic stop on wet, slippery or icy roads. The system utilizes an electronic computer that goes to work only during an emergency situation that could cause the wheels to lock. The computer receives



POSSIBLE APPLICATIONS FOR SOLID STATE IN AUTOMOBILES

	Signal Devices	Power Devices	Hybrid Subassemblies	Applications for IC's	Transducers and Sensors
Safety	Speed limit warning Obstacle warning	Automatic braking Automatic headway control Air bag trigger	Automatic headlight dimmer Obstacle detection	Anti-skid braking Failure monitor Drunk driver spotter	Passive restraint sensor Tire pressure monitor Manifold pressure sensor Engine temperature sensor
Propulsion	Ignition trigger	Breakerless ignition Chopper for battery-powered cars	Voltage regulators Electronic fuel injection	Triggers for power devices	Torque measurement Ignition timing Compression measurement
Comfort and convenience	Air conditioner control Headlight time-delayed action	Remote control for radio or tape equipment Cruise control	Transistorized clock Automatic temperature control Electronic speedometer	Automatic vehicle control	Temperature control devices (thermistors)
Entertainment	Radio and tape player	Electronic tuning	Speed regulator for tape player drives	AM/FM/MPX radio Tape players	
Economy of operation		Electric propulsion	Sequential turn signals	Coolant temperature indicators Electric fuel pump	Fuel flow measurement and control Electric fuel pump
Control	Fuel and coolant gauges Temperature indication Electronic tachometer	Voltage regulator Shaft and rotor position control	Interval windshield wiper control	Voltage regulator	Liquid gauges Temperature control Braking control
Lighting	Automatic headlamp dimmer	Instrument lighting	Headlight and domelight delay	Triggers for flashers	Instrumentation
Maintenance	Brake fluid level warning Tire pressure warning	Ignition	Trouble indicators Multiplexed power distribution	Engine performance analyzer Voltage regulator	Failure sensors

speed information from a wheel sensor through a digital-to-analog (D-A) converter that translates it to a dc voltage before it is fed to a differentiator and data analyzer. The differentiator output is compared with a reference signal representing the coefficient of friction of the road surface from the data analyzer. The comparator output is fed to a logic circuit which determines the amount of braking required and simultaneously activates a power stage which controls braking.

Automatic speed control is another offering. Using an electronic memory, this system automatically maintains a constant speed in response to the driver's command. When the car reaches cruising speed, the driver presses a button. The desired speed is then "memorized" and maintained up- and downhill and on the straightaway without the driver having to touch the accelerator. When the brakes are applied, the speed control is automatically deactivated.

A number of safety features have been put into the system to meet the industry's standards. For example, a redundant brake-disable feature is available to protect against a defective or poorly adjusted brake switch. Hence, if no disabling signal is received when the brake pedal is depressed, the speed control will automatically disable when the car's speed drops to about 8 miles below the speed that was set into the computer.

A distributor modulator is a third offering. Designed primarily as an exhaust control device, the modulator precisely controls spark advance at speeds in the 25-32-mph range, assuring more complete fuel combustion.

There is also an rpm limiter available. It is used primarily in Ford cars equipped with high-performance engines and manual transmissions. This overspeed limiter keeps the engine from exceeding a safe maximum rpm limit.

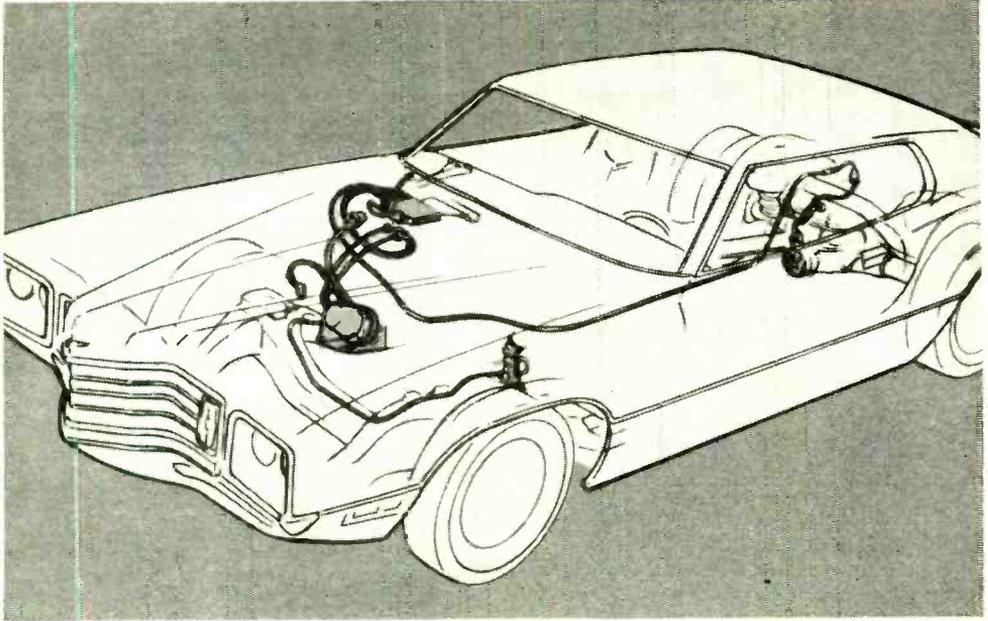


Diagram of Ford's new anti-skid braking system installation. Computer is located behind glove compartment. (Photo courtesy of Ford Motor Company.)

Chrysler's Coming Through. Keeping up with their Detroit rivals, the Chrysler people are pushing electronics in their ignition systems, a safety braking system, and automatic temperature control.

The electronic ignition, which eliminates breaker points, looks pretty much like a conventional system except for a control unit between the distributor and the ignition coil and the addition of a dual ballast resistor. The electronic circuitry is activated by a pickup coil and is used to control a switching transistor that opens and closes the primary circuit of the ignition coil.

The great advantage of the breakerless system is lower tune-up cost. A by-product of the electronic circuitry, claims Chrysler, is that ignition timing and dwell angle are more accurately controlled than would be possible with conventional breaker points. The end result is better exhaust emission control.

Like the systems employed by GM and Ford, Chrysler's safety brake relies on a logic computer to activate a pressure modulator to decrease the amount of hydraulic pressure being applied to the brake at the wheel which is about to lock up or skid. Where it differs from the competition is that the Chrysler system prevents front or rear wheel lockup for shorter straight-line stopping distances. It is claimed that the

four-wheel safety braking system makes any driver better than an expert driving a standard-equipped car in straight-ahead braking applications. However, as Chrysler engineers are quick to point out, it cannot correct for skids initiated by bad driving, such as when entering a curve too fast.

The 1972 Chrysler and Imperial model autos are equipped with a second-generation automatic-temperature control which uses an all-electronic solid-state amplifier to totally control the system's performance. In prior systems, Chrysler employed a combination of vacu-electronic components to automatically adjust temperature. This marks the first time that Chrysler Corp. has used a totally solid-state system employing IC's, transistors, and diodes to control a major system.

The Coming Tide. It is obvious from the foregoing that, in spite of foot-dragging and lack of cooperation, some inroads are being made by the electronics industry in Car City. What is also obvious is that, if and when a team effort is finally made, great things are in store for the average American-made automobile. Let us hope that the animosity gap existing between the car makers and the electronics industry narrows soon and creates the friendly conditions needed to bring about cooperation. ♦

Amazing New Bonding Liquid

ZIPBOND

one tiny drop

gives you weld like bond in 60 seconds



New bonding liquid joins materials in 60 seconds. No mixing, heating, solvents or catalysts necessary!

Zipbond joins ferrous and non-ferrous metals, plastics, glass, rubber, wood, porcelain and "exotic" metals with a lasting, colorless and transparent bond.

Write for
more information

Dept. 4-33

INSTRUMENT DIVISION

2600 Niagara Lane No., Mpls., Minn. 55441



CIRCLE NO. 45 ON READER SERVICE CARD

SOLDERING + DESOLDERING + RESOLDERING =

SOLDERABILITY

ELEMENTARY TO ELITE

WORLD'S MOST PRACTICAL SOLDER HANDLING TOOLS

meets industries demands.....

with a COMPLETELY PORTABLE SOLDERING/DESOLDERING/RESOLDERING SYSTEM



EDSYN
15954 ARMINA STREET
VAN NUYS, CALIFORNIA 91406
PHONE (213) 989-2324
TELEX NO. 65-1469 EDSYMX VAN

Ads in EEM, MAS, EBG,
AE, TR, and EPAC Catalogs

Send for our FREE 16 page
SOLDERABILITY
manual.

CIRCLE NO. 17 ON READER SERVICE CARD

ANALOG LOGIC

IT TAKES MORE
THAN FLIP-FLOPS
TO MAKE A CALCULATOR

BY JAMES HANNAS

HAVE YOU ever wondered how some complex calculators can do so many operations at such high speed and accuracy? The answer is in the use of linear and non-linear integrated circuits that are basically quite simple in theory. Most of the circuits involve an operational amplifier—a very high-gain linear amplifier that inverts the input signal.

When input and feedback resistors are connected to the op amp as shown in Fig. 1, the amplifier tries to maintain its input as close to zero as possible. The higher the gain, the lower the offset or error voltage. To do this, the amplifier must cause a current through the feedback and input so that the voltage drop across the input resistor is equal to the input voltage. The input swing is equal to the input voltage times R_f/R_i . A graphical analogy of the amplifier is shown in Fig. 2.

Using the same circuit, but with additional input resistors, the amplifier can be made into an adder. The sum of the voltages can also be multiplied by a constant by adjusting the input resistors.

Nonlinear functions, such as squaring, can be performed by the diode shunt matrix shown in Fig. 3. By adjusting the feedback resistors, any type of curve with increasing magnitude can be formed. A logarithmic, or decreasing, curve will result when the diode matrix is used as a feedback instead of a shunt matrix.

The most common squaring circuit is shown in Fig. 4. The numbers on the op amps indicate the multiplier constants. By adding one quarter of the sums of A-B and A+B, the result is the product of A and B.

Division is shown in Fig. 5. Here an op amp is supplied feedback by a multiplier circuit which is controlled by B. As B increases, the output decreases.

FIG. 1

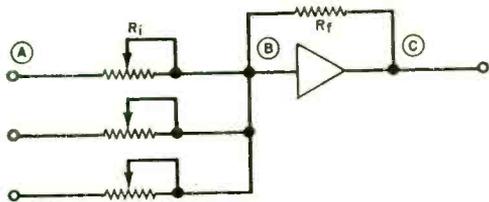


FIG. 2

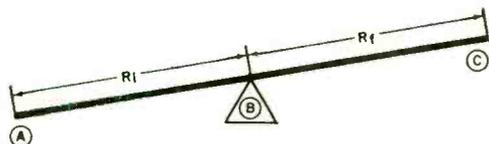


FIG. 3

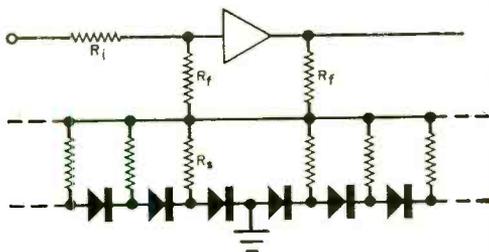


FIG. 4

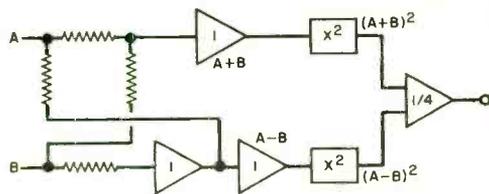
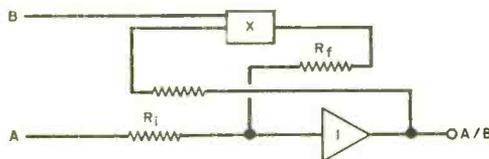


FIG. 5



There are also operational amplifiers and multipliers which are binary-to-analog and analog-to-binary converters. These are basically resistor networks and amplifiers. By combining analog circuits with binary bit storage, switching and readouts, a compact calculator can be designed. ♦

RUBBER

MICROPHONE EXTENSION AND REPLACEMENT CORDS

ONLY MANUFACTURED RUBBER MICROPHONE CORDS AVAILABLE ANYWHERE

EXTENSION CORDS:

MEC-25, MEC-50, MEC-100 WITH MALE AND FEMALE CONNECTORS ATTACHED

REPLACEMENT CORD:

MER-50 WITH FEMALE CONNECTORS ATTACHED ON BOTH ENDS

CABLE: BELDEN 8412

CONNECTORS: ITT CANNON XLR-3-11C, XLR-3-12C

OR

SWITCHCRAFT A3F, A3M

Please Specify

SESCOM, INC.

P. O. BOX 4155
INGLEWOOD, CA 90309
(213) 678-4841

Export:
Meridian/International
P. O. Box 64302
Los Angeles,
CA 90064, USA

CIRCLE NO. 39 ON READER SERVICE CARD

LAFAYETTE® 1972 CATALOG 720

- 4-Channel Stereo Equipment
- Cartridge and Tape Players
- CB Gear
- PA Systems
- Tools
- Cameras
- Auto Accessories
- Books
- Musical Instruments and Amplifiers

Lafayette Radio Electronics Dept. 35042
P.O. Box 10, Syosset, L.I., N.Y. 11791

Send Me the Free 1972 Catalog 720 35042

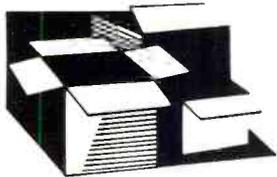
Name

Address

City

State Zip

CIRCLE NO. 26 ON READER SERVICE CARD



New Products

JOHNSON MOBILE CB TRANSCEIVER

Dual Receive Capability (DRC) introduced by *E.F. Johnson Co.* recently in their Messenger 124-M base station is now available in a mobile CB transceiver, the Messenger 323-M. DRC allows the operator to use any of the 23 chan-



nels normally while simultaneously monitoring any other channel. Separate squelch controls are provided for the primary receiver and the monitoring function, permitting the user to squelch down the monitored channel so that only local callers will activate the DRC circuitry. The main channel selector covers 23 channels, and all crystals are supplied.

Circle No. 60 on Reader Service Card

SENCORE TUBE TESTER

A new solid-state "Mighty Mite VII" tube tester featuring ten pin-elimination switches that permit testing more tubes than ever before is currently being marketed by *Sencore, Inc.* The pin-elimination switches can be used to isolate from test up to ten pins simply by setting the switches for the pins to be isolated. The switches are simple slide types, grouped together for maximum user convenience. They can be set and reset individually or all at once by pressing a reset slide. The new tester retains the full-load cathode emission, 100-megohm grid leakage, and stethoscopic shorts tests of the six previous Mighty Mites.

Circle No. 61 on Reader Service Card

ONKYO LINEAR SUSPENSION SPEAKER SYSTEM

A 3-way "Linear Suspension" speaker system featuring a 14" woofer, 2" hemispheric dome midrange driver, and a 1" hemispheric dome tweeter is being marketed by *Mitsubishi International Corp.* as the Onkyo Model 25. The system has a ported cone cap woofer, linear suspension enclosure design, and a unique integrated crossover network with exclusive

filter circuits to help produce smooth transitions at the 700-Hz and 7000-Hz crossover frequencies. Frequency range is 30-20,000 Hz, maximum power handling capacity is 60 watts, minimum power required is 10 watts rms, and impedance rating is 8 ohms.

Circle No. 62 on Reader Service Card

TV TUNER CLEANER/LUBRICANT FROM GE

A specially blended compound of methyl alkyl silicones and transport fluids are formulated into a new type of *General Electric Co.* silicone chemistry for polishing and lubricating tuner contacts in both color and monochrome TV receivers. Developed for the professional serviceman, GE Silicone TV Tuner Cleaner/Lubricant is safe for all plastics, driftless, nonflammable, and immune to evaporation and running. It resists temperature extremes as well. An extension spray nozzle included with the aerosol can provides an accurate means of getting at tuner contacts.

Circle No. 63 on Reader Service Card

PIONEER AM/STEREO FM TUNER

U.S. Pioneer Electronics Corp. now has a medium-priced AM/stereo FM tuner, their Model TX-600, with performance specifications and advanced engineering design that put it into the professional class. The tuner section includes a FET to increase sensitivity and safeguard against cross-modulation. The i-f sec-



tion is equipped with IC's and ceramic filters for improved selectivity. Multiplex separation of the two channels of stereo FM programs is better than 40 dB at 1000 Hz, while there is more than 35 dB subcarrier rejection. Technical specifications demonstrate that the TX-600 is indeed a professional-quality tuner.

Circle No. 64 on Reader Service Card

CENTRALAB SERVICE KITS

Assortments of the most popular and widely used *Centralab* electronic components are offered in eight new service kits. The kits are designed to provide instant access to well-balanced supplies of components. Kits include: KIT-10F with Fastach II controls, KIT-20V with miniature wirewound controls, KIT-50A with axial-lead electrolytic capacitors, KIT-55P with 2C-lead electrolytics, KIT-60D with general-pur-

MCR-1211... the tonal truth, and nothing but the truth.

Our trim, new true-fidelity cassette tape recorder. What a beautiful way to break the big-sound/small-package barrier.

With built-in uniform sound-level control, full-range dynamic speaker, new automatic shut-off that prevents electrical or mechanical damage to tape and machine... many other high-value features.

All compactly designed into a lightweight 5½" x 2¾" x 10¼" case. Complete with easy-carry handle, microphone, earphone, Duratape® cassette, four Duracell® batteries... ready to play.

The MCR-1211 joins our other two solid-state models for go-anywhere, great-everywhere cassette recording. Try 'em all. See your nearby Mallory Distributor, soon.

MCR-1232
Recorder and superb AM/FM radio. Total entertainment in sound. Batteries/a-c plug-in.



MCR-1204
Neat, easy-to-use, battery-operated recorder.

MCR-1211
The perfect gift. Simple, push-button operation. Batteries/a-c plug-in.

MALLORY

MALLORY DISTRIBUTOR PRODUCTS COMPANY

a division of P. H. MALLORY & CO. INC.
1000 Cambridge, U.S.A. 06208

Batteries • Capacitors • Controls • CRIME ALERT® • DL RATAPE® Recorders • Resistors • Semiconductors • SONALERT® • Switches • Timers

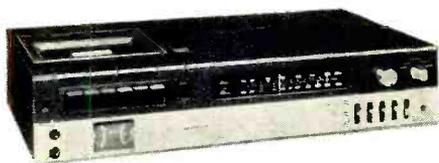
CIRCLE NO. 30 ON READER SERVICE CARD

pose capacitors, KIT-70H with high-voltage capacitors, and KIT-100P with packaged electronic circuits (P.E.C.'s). Each is housed in a steel-frame cabinet with 15 plastic drawers.

Circle No. 65 on Reader Service Card

LAFAYETTE STEREO RECEIVER/RECORDER

The Model LRK-900 is the newest combination AM/stereo FM receiver and cassette tape deck with built-in 4-channel composer and adapter available from Lafayette Radio Electronics Corp. The cassette deck features standard and chromium-dioxide tape bias equalization, dual record meters, sound-with-sound mixing, automatic mechanical/electrical shutoff, and jacks to suit most input needs. Output power is 20 watts total, FM sensitivity is 3.5 μ V IHF, stereo



separation is 35 dB at 400 Hz, signal-to-noise ratio is 48 dB, and frequency range is 50-10,000 Hz. The built-in 4-channel composer produces 4-channel stereo from 2-channel stereo signal sources. The sensitive FM tuner utilizes "Acrifone" for instant center station tuning.

Circle No. 66 on Reader Service Card

TRI-STAR CD IGNITION

A capacitive-discharge ignition system Simpli-Kit, called the "Tiger SST" CD Module by Tri-Star Corp., can be built and installed in any car in less than 90 minutes. It is said to be the most reliable, powerful, and efficient ignition system on the market. The circuitry is so unique that improper construction or installation will not damage the unit or the vehicle. The Tiger SST can be added to any engine that employs a 12-volt negative ground

generator/alternator ignition system. No rewiring is necessary.

Circle No. 67 on Reader Service Card

SONY/SUPERSCOPE QUADRADIAL TAPE DECK

The introduction of the lowest priced 4-channel reel-to-reel tape recorder now on the market was recently announced by Superscope, Inc., as the Sony Model 277-4. The deck is designed to provide complete 4-channel record and playback, plus 4-1/2-channel formats with a record selector switch which makes it possible to either record or play back 2-channel stereo or the new Quadradial tapes. Features include illuminated VU meters, independent channel level controls, record equalization selector, triple-function headphone switch, reel locks, automatic shut-off, and 7 $\frac{1}{2}$ ", 3 $\frac{3}{4}$ ", and 1 $\frac{1}{8}$ " ips tape speeds.

Circle No. 68 on Reader Service Card

KNIGHT-KIT SPEAKER SYSTEM KITS

Do-it-yourselfers can now assemble their own hi-fi speaker systems with one of three new Knight-Kits from Radio Shack. The Model KG-5120 kit is an acoustic suspension system that employs an 8" dual-cone woofer and a 3 $\frac{1}{2}$ " cone tweeter with an overall range of 45-18,000 Hz and input power handling capability of 24 watts peak. Model KG-5121 is a 3-way system with a bass reflex enclosure, 10" woofer, 6" midrange driver and 3 $\frac{1}{2}$ " tweeter; response is 40-18,000 and power capacity is 40 watts peak. Top-of-the-line Model KG-5122 features acoustic suspension design with 12" woofer, 3 $\frac{1}{2}$ " x 8" compression midrange driver, and horn-loaded dome tweeter; it has midrange and tweeter level controls, 30-20,000 Hz range, and 60-watt peak power capacity.

Circle No. 69 on Reader Service Card

DATRON PICTURE TUBE RESTORER

An electronic device that restores brilliance to weak, faded monochrome and color TV picture tubes can be obtained from Electronic Specialty Division of Datron Systems, Inc. The patented Picture Tube Restorer is not a booster,

Sonar SENTRY VHF MONITOR RECEIVERS WITH ADJUSTABLE SQUELCH

With Battery, Earphone, & Crystals \$5.00 ea.

\$49.95

SOLID STATE
WITH ADJUSTABLE SQUELCH
POCKET SIZE
3 CHANNELS

FR-103SA (150-175 MHz) | FR-106SA (IN FOUR 30-50 MHz FREQ.)

LISTEN TO: POLICE, FIRE, & WEATHER REPORTS!

for Industrial, Commercial, Utility & Govt. Use
3 CHANNELS • BROADCAST BAND • CRYSTAL CONTROLLED
Designed and engineered for simplicity of operation, compact enough to fit a shirt pocket yet powerful enough to deliver a clear clean signal—it's dependable • Operates on three crystal controlled VHF channels plus broadcast band • Adjustable squelch • Completely solid state for long life use • Visible battery indicator to show battery condition at all times • Built in antenna • 5 $\frac{1}{8}$ " H x 2 $\frac{1}{2}$ " W x 1 $\frac{1}{4}$ " D, Wt. 11 oz.

SONAR RADIO CORP., 73 Wortman Ave., Bklyn, N.Y. 11207
Please send information on VHF Monitor Receivers.

Name _____ Dept. 461
Address _____
City _____ State _____ Zip _____

CIRCLE NO. 43 ON READER SERVICE CARD

POPULAR ELECTRONICS Including Electronics World

nor will it have any favorable effect on tubes which have been on a booster for an extended period of time. What it does is test the quality of the picture tube, then provide a "cleansing" voltage that removes the cause of many picture tube failures. No special training is needed to use the Restorer. Its low-voltage output makes it safe for use even by the most untutored individuals. It is said that the Restorer can extend the life of a picture tube up to 3 years.

Circle No. 70 on Reader Service Card

SUPEREX ELECTROSTATIC STEREOPHONES

An electrostatic stereophone system from *Superex Electronics Corp.* has a virtually flat response with negligible distortion over the entire audio range. The Model PEP-77C phones



feature a dual-polarization capability for self-energization and 117-volt ac operation. With the phones comes a control console which accommodates two sets of Superex electrostatic stereophones. Frequency range is 10-22,000 Hz, and nominal impedance is 4-16 ohms. Individual separate grounds, one per channel, are provided as are individual channel volume controls.

Circle No. 71 on Reader Service Card

RUSSOUND IMPEDANCE CONVERTING AMP

The *Russound/FMP, Inc.* Model IMP-1 "Impedaverter" is a solid-state device for impedance matching high inputs to low outputs in microphone and instrument lines. This impedance converting amplifier allows cables up to 500 ft long to be used without altering audio response or picking up hum or noise. The input and output characteristics allow bridging lines without loading and the output to be split to feed two amplifiers simultaneously. Standard phone and phono jacks are paralleled at both the input and output for maximum convenience. Gain and phase switching are provided.

Circle No. 72 on Reader Service Card

A true bargain by Post



The famous PA 263

plus heatsink/pc board for \$5.80

The PA263 monolithic audio power amp provides 3.5W rms, 10W peak, to a 16 ohm load. Ideal for mono or stereo players, tape, disc or intercom amplifiers, AM receivers, Op. Amp. boosters etc.

Now we supply it complete with a specially designed heavy duty pc board ready drilled for PA263 and up to 12 other components all ready for soldering. No other heatsink is necessary. ONLY \$5.80 COMPLETE including delivery by return FREE 4-PAGE PA263 DATA SHEET PLUS DESIGN INFORMATION WITH ALL ORDERS.

Send Check/Money order payable Bordeaux Industries Inc. to Jermyn 712, Montgomery Street, San Francisco, California 94111.

JERMYN

CIRCLE NO. 23 ON READER SERVICE CARD

AR guarantees its published specifications

At Acoustic Research we believe that the publication of complete performance data on our high fidelity components is obligatory. Otherwise, our guarantee would have little meaning.

Find out just what AR guarantees that its products will do. Mail the coupon below, and detailed technical literature will be sent to you free of charge.



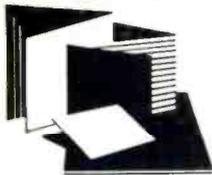
Acoustic Research, Inc.
24 Thorndike Street
Cambridge, Mass. 02141
Dept. PE-4

Please send measured performance data on AR products to

Name _____

Address _____

CIRCLE NO. 1 ON READER SERVICE CARD



New Literature

INTERNATIONAL RECTIFIER DATA HANDBOOK

The Winter Edition of International Rectifier's "Semiconductor Cross Reference and Transistor Data Book" is now available. The 64-page book has been fully revised, including listings for more than 4000 new transistors. It has information, such as complete specifications and electrical characteristics, for diodes, zeners, capacitors, rectifiers, and SCR's. An applications-oriented table permits the user to locate the descriptions which fit his requirements in determining the proper transistors to use. Address: International Rectifier Corp., Semiconductor Div., El Segundo, CA 90245.

SEARS POWER AND HAND TOOL CATALOG

As its name implies, tools of every description for the wood and metal working shop, the automotive do-it-yourselfer, the home repairman,

and the electronics enthusiast are listed and described in this 132-page illustrated catalog. All items are fully described, most accompanied by a photo or drawing, with prices. For the electronics enthusiast, there are metal and wood working tools, soldering irons and guns. Address: Sears, Roebuck & Co., 303 E. Ohio St., Chicago, IL 60611.

GC ELECTRONICS REPLACEMENT CATALOG

An updated line of exact-replacement rubber drives and belts is detailed in the new *Walco* cross-reference catalog just issued by *GC Electronics*. The catalog, No. FR-135-W, contains an enlarged cross-reference section, with replacement part numbers listed for equipment made by 194 manufacturers, both domestic and foreign. Special charts are included to help in choosing the proper size belt for any unusual machine types not in the cross-reference listings. Address: GC Electronics, 400 South Wyman St., Rockford, IL 61101.

WORKMAN REPLACEMENT COMPONENTS

A new 1972 catalog, No. 100, of replacement components for radio and TV is available from *Workman Electronic Products, Inc.* It contains an illustrated 68-page listing of resistors, fusing devices, circuit breakers, sockets, convergence controls, service accessories, electronics chemicals, audio cables, adapters for hi-fi and cassette-type recorders, battery holders, and

Where O'Where has your recorder's fidelity gone?

Without regular maintenance, it's probably buried under layers of accumulated dirt and oxide which can reduce the listening quality of ever the best machine.

Nortronics QM-SERIES quality maintenance accessories are designed to preserve reproduction quality from virtually every cassette, cartridge and reel-to-reel recorder/player, and also to protect expensive pre-recorded tapes through years of playing. The new QM-SERIES is the only comprehensive line of safe, effective recording accessories that will keep machines and tapes sounding like they did when they were new.

Our new "Recording Equipment Maintenance Manual" thoroughly discusses the importance of regular maintenance and the advantages of using Nortronics QM-SERIES accessories in your personal maintenance program. If you insist upon

getting the most out of your player and tapes, it should be must reading.

Available FREE at nationwide Nortronics distributors, or write to:



NORTRONICS COMPANY, INC.

6140 Wayzata Blvd., Minneapolis, Minnesota 55416

"World's leader in magnetic heads and professional recording accessories"



QM SERIES quality maintenance accessories.

CIRCLE NO. 31 ON READER SERVICE CARD

POPULAR ELECTRONICS Including Electronics World

prototype kit components. Address: Workman, Box 3828, Sarasota, FL 33578.

RUSTRAK AC VOLT-AMP RECORDER BROCHURE

A data sheet, No. 27107, which describes a new low-cost ac recorder capable of measuring both voltage and current is available from Rustrak. The sheet describes the company's Model 230 recorder with its clamp-on transducer and leather carrying case. The data sheet and further information are available from: Rustrak Instrument Div., Gulton Industries Inc., Municipal Airport, Manchester, NH 03103.

KEYSTONE ELECTRONIC COMPONENTS CATALOG

Keystone's Standardized Electronic Components Catalog No. 678 and companion supplement provide listings for all sorts of items used by the prototyper. Items listed are battery holders, plug-in housings, terminal boards and solder terminals for PC work, phenolic instrument boxes, alignment tools, etc. Listed separately in the supplement are standardized power transistor sockets, mica insulators, and mounting kits. Address: Keystone Electronics Corp., 49 Bleecker St., New York, NY 10012.

JAMES MILLEN FOR AMATEUR RADIO

Things of particular interest to amateur radio operators are listed and described in James Millen's latest catalog. The listings include

both discrete components and electrical/mechanical assemblies. In the first category are such items as tube and crystal sockets, plate/grid caps, air-wound transmitting inductors, transmitting r-f chokes, and tuning capacitors. The second category is composed of listings for dial assemblies, midjet absorption frequency meters, worm drives, and miniature i-f transformers. James Millen Mfg. Co., Inc., 150 Exchange St., Malden, MA 02148.

FREE LITERATURE FROM SMALL BUSINESS ADMINISTRATION

The following free Government booklets will be of interest to anyone thinking of going into the electronics sales and service business:

- OPI-6 "SBA—What it is—What it Does"
- OPI-18 "SBA Business Loans"
- OPI-18A "Business Loans for Veterans"
- OPI-38 "Simplified Blanket Loan Guaranty Plan"
- SMA No. 71 "Checklist for Going into Business"
- SBB No. 57 "Selling and Servicing Household Appliances, Radio and TV"

These booklets may be obtained by visiting your nearest Small Business Administration field office or by requesting them (by catalog number and title) from the Small Business Administration, Washington, DC 20416.

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



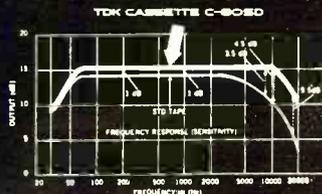
TDK SUPER DYNAMIC (SD) TAPE



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.



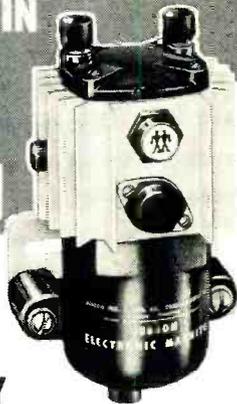
The new magnetic oxide used in TDK Super Dynamic tape distinctively differs from standard formulations in such important properties as coercive force, hysteresis-loop squareness, average particle length (only 0.4 micron!) and particle width/length ratio. These add up to meaningful performance differences: 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 C60SD and C90SD lengths.

TDK ELECTRONICS CORP.
LONG ISLAND CITY, NEW YORK 11103

CIRCLE NO. 44 ON READER SERVICE CARD

**THE ONE WORD
FOR PERFORMANCE AND
RELIABILITY IN
ELECTRONIC
IGNITION
JUDSON**



**YOU CAN HAVE
TOMORROW'S
IGNITION ON
YOUR CAR TODAY**

Don't accept "as good as" there are none.

Write Today for Literature

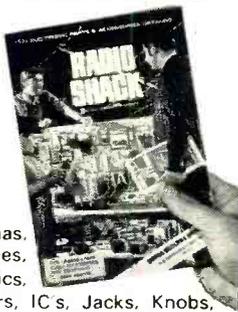
JUDSON
RESEARCH AND MFG. CO
CCNSHOHOCKEN PA. 19428
CIRCLE NO. 25 ON READER SERVICE CARD



**FREE! RADIO SHACK
Accessories & Parts Catalog**

**NEW 1972
Edition!**

THE buying guide for kit builders, CB'ers, installers, experimenters, fix-it men, hobbyists, electricians — anyone in electronics in any way!



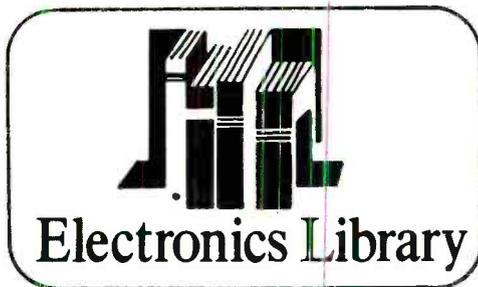
Electronics A to Z—Antennas, Batteries, Capacitors, Diodes, Educational Kits, Fiber Optics, Grille Cloth, Hi-Fi Speakers, IC's, Jacks, Knobs, L-Pads, Mikes, Needles, Oscillators, P-Boxes, Quadtracs, Resistors, Semiconductor, Telephones, Ultrasonic Alarms, VHF Antennas, Wire, Xenon Strobe, "Y" Adapters, Zener Diodes plus our Science Fair and Knight-Kit electronic kits!

ALLIED RADIO SHACK Dept. PE-22
A TANDY CORPORATION COMPANY 2725 W. 7th St.
Fort Worth, Texas 76107

Send me your FREE 1972 Catalog #215
Please PRINT Clearly

Name _____ Apt. # _____
Street or Rte. & Box _____
City _____
State _____ Zip

CIRCLE NO. 3 ON READER SERVICE CARD



SO YOU WANT TO BE A HAM, Fifth Edition
by Robert Hertzberg, W2DJJ

In earlier editions, this book was directly responsible for introducing an enormous number of readers to the satisfying hobby of amateur radio. New editions, like this one, have been brought out every few years when changes in the state of the ham radio art demand detailed explanation and coverage to keep the reader abreast of the latest developments in licensing and equipment. This new edition covers the entire field of ham radio from FCC regulations and code to operating mobile units and organizing a ham radio club. This is a general information book and has nothing to do with electronics theory.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 189 pages. \$5.25.

**UNDERSTANDING DIGITAL COMPUTERS,
Second Edition**

by Paul Siegel

This book is a comprehensive introduction to the fundamentals of digital computer "hardware." It is about principles, not specific commercial computers. Its objective is to convey a good understanding of how digital computers are designed and built. The introduction describes the digital computer and its functions, while the three remaining sections move from a theoretical discussion of arithmetic and logic to the exposition of techniques for achieving these ideas in practice. These building blocks are then combined into larger functional units from which a complete computer may be constructed.

Published by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. Hard cover. 462 pages. \$11.95.

**COMMUNICATION CIRCUITS:
DESIGN AND ANALYSIS**

by Clarke & Hess

A book written to assist advanced students and practicing engineers in analyzing and designing the latest solid-state circuits. While emphasis is on large-signal analog circuits and systems, digital circuits are also discussed. The text contains one of the most comprehensive treatments of FM theory available. In addition to a large number of

worked illustrations, more than 200 problems are given.

Published by Addison-Wesley Co., Inc., Reading, MA 01867. Hard cover. 658 pages. \$17.50.

ELECTRONIC PROJECTS FOR THE CAR AND GARAGE

by R. M. Marston

Eighteen of the 20 timely projects described in this book are intended for use in the car; two are for the garage. The circuits for the car range from those which warn of danger, such as from icing or overheating, to those which ease the driver's task and allow him to concentrate on his driving (a windshield wiper control or an automatic sidelight control, for example). The two projects for the garage are a self-regulating battery charger and a speed controller for a drill.

Published by Drake Publishers, Inc., 381 Park Ave. South, New York, NY 10016. Hard cover. 115 pages. \$5.95.

1972 WORLD RADIO-TV HANDBOOK, 26th Edition

This British book is the only annually updated publication detailing every facet of shortwave, mediumwave, and TV broadcasting—from nominal information such as call sign and frequency to the name and title of the station

manager. Thousands of users rely on the Handbook for schedules and programming; many others refer to it for information on broadcasting organizations, station identifications, interval signals, QSL policies, etc. This is a valuable reference that no SWL or broadcasting industry executive can afford to be without.

Imported from England by Gilfer Associates, Inc., Box 239, Park Ridge, NJ 07656. Soft cover. 384 pages. \$6.95.

REGULATED POWER SUPPLIES

by Irving M. Gottleib

It is the goal of this book to demonstrate that such benefits as low distortion and stable operation under varying loads are desirable and are often attained most effectively through the use of regulated power supplies. The first chapter lists other benefits obtained, including increased efficiency, greater dynamic range, feedback stabilization, higher S/N ratios, and wider frequency response. The second chapter discusses the static characteristics of regulated power supplies—dc regulation, temperature effects, stability, and long- and short-time deviations and drift. Other chapters cover dissipation control and the uses of IC's.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 160 pages. \$4.95.



MAKING "WAVES"

CADENCE—the musical instrument speakers

Making better, clearer, amplified sound waves is the **THING** Cadence does... better than anything else in the industry. Cadence Speakers are built to withstand heat from sustained notes at a high power level and the vibrations and stresses which are continually placed upon them. Cadence is guaranteed **one full year** at the power level specified. This proven speaker family has been selected by the manufacturers of most of the world's fine amplified music instruments.

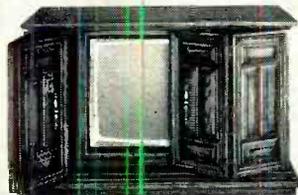
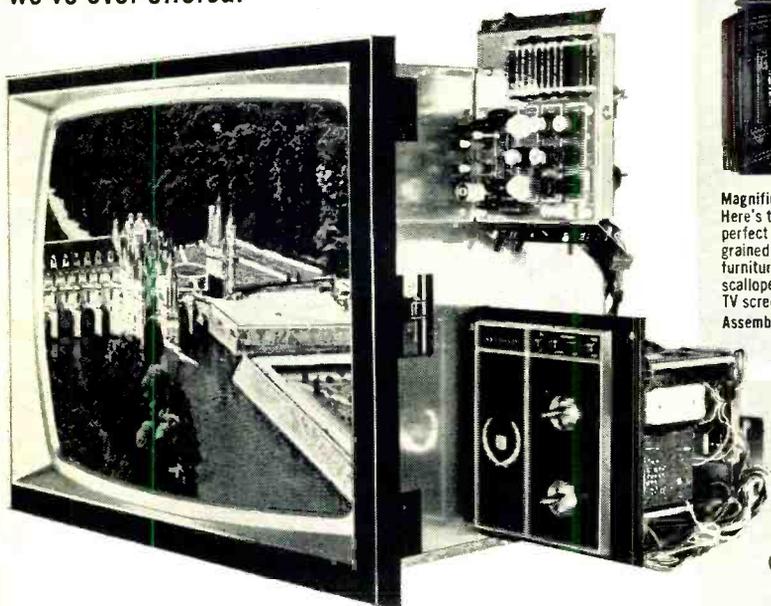
If making beautiful, clear sound waves is your thing, ask for **CADENCE SPEAKERS**. For complete information and the name of your Cadence Dealer, write:



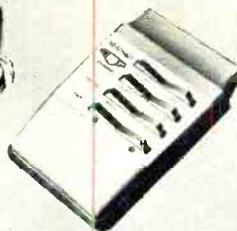
UTAH ELECTRONICS DIVISION
Utah-American Corporation
1124 East Franklin Street
Huntington, Indiana 46750

More kits than ever...over 350...all in your

The most advanced color TV kit we've ever offered.



Magnificent Mediterranean Console. Here's the finest TV cabinet we offer, a perfect choice for a GR-900. Has deep-grained pecan veneers on hand-rubbed furniture grade hardwood solids. Two scalloped double-hinged doors hide the TV screen when not in use.
Assembled GRA-405-25, 100 lbs. . . . 179.95*



Wireless Remote for your GR-900. The ultimate in armchair viewing. Gives you eight-function across-the-room control of on/off, three preset volume levels, power tuning (up or down) color, tint, UHF/VHF channel selection. Also activates Custom Wall Mount doors.
Kit. GRA-900-6, 6 lbs. 79.95*

The new Heathkit GR-900 25V Color TV has UHF/VHF detent tuning & varactor UHF tuner, angular tint control — more features than any other color TV kit! Better performance than any other set.

UHF/VHF detent power tuning. Push a button and you scan the channels in either direction with detent action locking in on VHF channels 2-13 and any 12 preselected UHF stations. A pushbutton selects either UHF or VHF mode, and a lighted dial indicates tuner position. And you can have full remote-control selection too for just a few dollars more.

New voltage-controlled varactor UHF tuner and specially designed VHF tuner with MOS Field Effect Transistor contribute to better fringe-area reception, increased sensitivity.

New angular tint control. A switch now gives you either "normal" or "wide angle" color demodulation to reduce tint and flesh tone change when changing stations and when programs change. Other deluxe features include "instant on" operation with override for conventional on/off operation; automatic fine tuning; adjustable tone control, and an output for playing TV audio through your stereo hi-fi system.

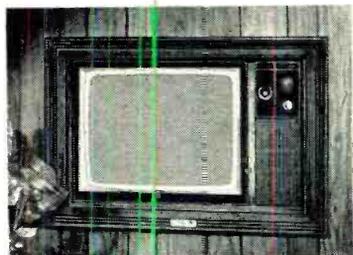
Exclusive Heath MTX-5 ultra-rectangular tube. It's the largest color screen you can buy anywhere, with a full 25 inch meas. diag., 315 sq. in. viewing area. You see virtually everything the station transmits, in the corners and at the sides. The specially etched face plate cuts glare, and reflection, increases contrast without sacrificing brightness, and each dot is projected through a matrix screen to stand out crisply against a solid black background.

Modular solid-state circuitry. Plug-in circuit boards and plug-in transistors make assembly, adjustment and servicing easy. There are 46 transistors, 57 diodes and four ICs — making this one of the most reliable sets we've ever designed.

Other features include automatic chroma control, adjustable video peaking, adjustable noise limiting and gated AGC.

Exclusive Heath self-service built-ins. Your Heathkit GR-900 includes built-in dot generator, tilt-out convergence panel for set-up and periodic adjustments. A handy volt-ohm meter included in the circuitry helps you check your work during assembly, and can be used in conjunction with the manual for any servicing. Like all Heathkit color TVs, the GR-900 gives you complete installation flexibility. There are four beautiful Heath cabinets to choose from plus the new built-in electronic wall mount with hide-away tambour doors. Or you can custom install your GR-900. We think you'll agree, the GR-900 is truly the most impressive color receiver we've ever offered.

Kit GR-900, TV less cabinet, 125 lbs. 599.95*



New Custom Wall Mount. Touch a button on the frame or on your Heathkit Remote Control unit and the folding tambour doors open to reveal your color TV. Kit includes everything needed to build your Heathkit GR-371MX or GR-900 into a wall.
Kit GRA-402-25, walnut finish, 50 lbs. 114.95*
Kit GRA-407-25, unfinished, 50 lbs. 109.95*

FREE '72 HEATHKIT Catalog



New AR-1500 stereo receiver 379.95*

Successor to the famed Heathkit AR-15, with impressive improvements in every critical area. 180 watts Dynamic Music Power. 90 watts per channel, 8 ohm load. Less than 0.2% IM and 0.25% harmonic distortion. Greater than 90 dB FM selectivity and 1.8 μ V sensitivity. Vastly superior AM, too. It's the talk of the audio world. Order yours now.

Kit AR-1500, 42 lbs. (less cabinet) . . . 379.95*
ARA-1500-1, walnut cabinet, 6 lbs. . . . 24.95*

New digital multimeter 229.95*



Now, a digital multimeter that meets lab specs at a low, low kit price! 3½ digits for 100 μ V resolution on 200 mV range; 1V on 1000V; 5 DC ranges (100 μ V—1000V, either polarity); 5 AC ranges (100 μ V—500V); 10 current ranges (100 nA—2A AC or DC); 6 resistance ranges (0.1 ohm—20 megohms). DC calibrator supplied for 0.2% accuracy without external equipment. Can be lab calibrated to 0.1%. Don't miss this outstanding instrument value.

Kit IM-102, 9 lbs. 229.95* *

New digital frequency display for Heathkit ham gear . . . 179.95*



There's nothing else like it on the ham radio market! Actually computes operating frequency. Six bright readout tubes show you exactly (to within 100 Hz) where you are as you dial across the 80-10 meter amateur bands. Designed for all Heathkit SB-Series Receivers and SB- and HW-Series Multiband Transceivers. With transceivers, the SB-650 reads and displays both received and transmitted frequencies. Manual fully describes and illustrates all interconnections for installation with the specific rig you own. Kit assembles approximately 8 hours. All solid-state circuitry—6 transistors, 35 ICs.

Kit SB-650, 9 lbs. 179.95*

The better-than-ever '72 Heathkit Catalog has the world's largest selection of fun-to-build, money-saving electronic kits...including color TV, stereo/hi-fi, organs, home appliances, engine tune-up tools, radio control, portables, shortwave, marine gear, metal locator, instruments, hundreds more. If you don't have this catalog, you've missed seeing over 50 new kits, introduced since the last edition. Send today for your free copy.



New... Heathkit solid-state 120 MHz counter...just 349.95

Another Heathkit first! The new Heathkit IB-1102 brings you a 120 MHz frequency counter with professional features, accuracy and stability rivaling counters costing far in excess of this modest kit price.

Features include eight cold-cathode display tubes, an overrange lamp, gate lamp, and two range indicator lamps for an easy-to-read display. Overall accuracy is assured by the use of temperature compensated "clock". The high-impedance (FET) input circuit presents minimum loading to the circuit under test. And an automatic triggering level offers simple "hands off" operation.

The Heathkit IB-1102 features a sensitivity of 50 mV to 100 MHz, 125 mV above 100 MHz. It will accept inputs up to 120 V rms from 1 Hz to 150 Hz, 50 V at 4 MHz, and 3 V at 120 MHz without damage to the instrument. The time base crystal is a temperature compensated TCXO offering ± 1 ppm stability from +10° to +40° C and an aging rate of less than ± 1 ppm/yr. Other features include the latest ECL (Emitter Coupled Logic) circuitry; 1 Hz resolution without switching time base. Plug-in ICs and circuit boards reduce assembly time to an easy 15 hours. And you can wire it for either 120/240 VAC operation. Kit includes handy detachable line cord, portable case with bail handle that converts to stand for best viewing angle.

Kit IB-1102, 12 lbs., mailable 349.95

Send for your FREE 1972 Heathkit Catalog today

HEATHKIT ELECTRONICS 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.; Redwood City, 2001 Middlefield Rd.; San Diego (La Mesa), 8363 Center Dr.; Woodland Hills, 22504 Ventura Blvd.; COLO.: Denver, 5940 W. 38th Ave.; FLA.: Miami (Hialeah), 4705 W. 16th Ave.; GA.: Atlanta, 5285 Roswell Rd.; ILL.: Chicago, 3462-66 W. Devon Ave.; Downers Grove, 1224 Ogden Ave.; KANSAS: Kansas City (Mission), 5960 Lamar Ave.; MD.: 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, 9296 Gravois Ave.; N.J.: Fair Lawn, 35-07 Broadway (Rte. 4); N.Y.: Buffalo (Amherst), 3476 Sheridan Dr.; New York, 35 W. 45th St.; Jericho, L.I., 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, 2221 Third Ave.; WIS.: Milwaukee, 5215 Fond du Lac.

HEATH COMPANY, Dept. 10-4
Benton Harbor, Michigan 49022

HEATHKIT
Schlumberger

Please send FREE Heathkit Catalog.
 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-432R

CIRCLE NO. 22 ON READER SERVICE CARD



Communications Scene

By Richard Humphrey

IN THE PAST, FCC Commissioner Nicholas Johnson has been accused of practically everything from inexperience and flamboyance to being “self-seeking” and politically motivated. His numerous appearances on TV talk shows, his outspoken opinions, and his opposition to vested interests—not to mention his book “How to Talk Back to your Television Set” (Little, Brown, 1970)—haven’t made him the most popular kid on the block; nor, one suspects, were they meant to.

But in a recent exclusive interview with POPULAR ELECTRONICS he revealed not only a tightly wrapped legal mind and a firm grasp on a far-ranging variety of communications interests but also what sounded suspiciously like a conservative attitude on certain questions.

That we might be listening to a new Johnson was evident when he was asked to comment on the broadcast industry’s occupation of over 80% of the radio spectrum thus leaving but a small portion for aeronautical, public safety, amateur and CB, marine and other two-way communications.

“Ever since I’ve been here,” he said, “I’ve tried to have more attention paid to the problems of those who are using the frequencies for personal communications or

business or for the kind of use the amateurs make of them; but the political and economic power of the broadcasting industry is pretty formidable because virtually all elected officials have to turn to the broadcasters to get any time to talk to their constituents.”

“But what about the uhf television channels?” he was asked. “Particularly in view of the broadcasting industry’s losing certain channels to other services because those channels weren’t being used?”

“We *have* loosened up a bit in the uhf channels,” he replied. “And I would predict that over the years to come there’s going to be increasing pressure to follow that system (take uhf channels where the use it or lose it communications philosophy applies). However, when that will be done and how far it will go is hard to say.”

It’s interesting to note that immediately following FCC action in authorizing uhf channels 14-20 (470-512 MHz) and 70-83 (806-890 MHz) for land mobile use, the broadcasters hurriedly began “double-casting” their vhf (channels 2-13) program content on selected uhf channels in a style reminiscent of the duplicate programming in AM-FM radio before the FCC put a stop to it.

The CB Situation. Commissioner Johnson backed off when pressed for specifics on the Electronic Industries Association’s petition, in February 1971, for 80 FM Citizens Band channels in the 220-222-Mhz portion of the 220-225-MHz amateur band and the rumored FCC action requiring automatic identification circuitry for practically all two-way radios. He was well within his rights in saying “no comment” since no Notice of Proposed Rule Making has been released on these two items.

When these Notices *are* released, the amateurs can certainly be expected to be

Nicholas Johnson of the FCC

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. 29 ON READER SERVICE CARD

SEND TODAY!

McIntosh Laboratory Inc.
2 Chambers St., Dept. PT-472
Binghamton, N.Y. 13903

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

vocal about the 80-channel class E CB petition although one is tempted to agree with the Electronic Industries Association's comment that the 220-225-MHz band is "seldom used". The big fuss, of course, will erupt when the Notice of Proposed Rule Making on automatic identification comes out. This reported move by the Commission was sparked mainly by the bad operating practices on the 27-MHz CB band. Talking about this situation Johnson said:

"The problem, quite frankly, is that you've got thousands of licensees and very few people at the FCC to get involved in enforcement. There's very little control, therefore, over the people operating this equipment. One way to do it," he hazarded, "would be to increase by about tenfold the number of FCC employees and send them out to track all this down."

"Is there any hope of that?"

"Well," answered Johnson, "I'm not sure that anyone wants that. There is another alternative and that is to get more self-regulation on the part of the Citizen Band operators." One could detect a warning note in the Commissioner's voice when he added: "Ultimately, they're going to kill

this off if they keep going the way they have been. One of the proposals which comes before us from time to time," he offered as a grim afterthought, "is the suggestion that the whole thing (the 27-MHz Citizens Band) simply be closed down."

The Public Interest. We wondered aloud if automatic ID and a few other things contemplated by the FCC would be in the public interest and inadvertently trod on a Johnson toe.

"Let's not confuse the phrase 'public interest' as it is used in the Communications Act of 1934 with the expression 'something of public interest,'" he said. "The legal term has a meaning of its own that's grown up over 37 years of FCC reports and thousands of decisions in the courts and the agencies. Whatever the term means to lawyers," he emphasized; "it does *not* mean 'something of interest to the public.'"

"But what about television coverage of a major sporting event?" we asked.

"A problem *does* arise," said Johnson, "when a sporting event takes on the dimensions of a 'national resource' (like a World Series) and has traditionally been made

SEE...
COMPARE
SELECT!!

SBE

Sidebender



23 CHANNEL SSB/AM MOBILE TRANCEIVER

Powerful, all-solid-state mobile unit gives USB, LSB and AM operation. Uses SBE's sensational "power pump" circuit for legal maximum 15W P.E.P. input! Big signals!

Unit into simple dipole, tops best 5W AM and 3-element beam combo. 23 channels, synthesized. No crystals to buy. Compact, fits easily under dash. Dynamic mic, mounting bracket supplied. 12VDC.

WRITE FOR BROCHURE

SBE 220 Airport Blvd., Watsonville, CA 95076

CIRCLE NO. 36 ON READER SERVICE CARD

ELECTRONICS—NEW TROUBLE-SHOOTER

Model EC
Patented

A compact—complete
circuit analyzer
The SERVISET



INTRODUCTORY
PRICE
\$34.95
POSTPAID

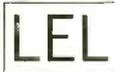
A precision engineered professional quality electronic test instrument. Ideal for field or bench servicing of all types of Communications gear.

CHECKS: sync, sweep, video, audio circuits, high voltage supplies (DC, RF or Pulse), low voltage supplies, coils, capacitors, resistors, tubes, transistors, diodes, transformers, speakers, etc. Will locate trouble to a particular stage, determine defective component and can actually be clamped in circuit to restore circuit operation temporarily in 80% of component or tube defects. Ideal for locating and confirming intermittents.

SPECIFICATIONS:

RF & AF Signal Tracer, RF & AF Signal Injector, AC & DC Voltage Indicator 0/60/550/20,000 DC Polarity Indicator 60/550/20,000 volts, Lo ohms 0-5, Hi ohms 0-500k-20 megohms. Tests Condensers, .00025-12 mfd., Tests Resistors 2 ohms-20 megohms, 2 Capacitance Sub ranges .01-1 & 4-40 mfd., 3 Resistance Sub ranges 50-500 ohms, 5k-25k, 100k-1 meg.

30 Day Money-Back Guarantee



LEE ELECTRONICS LABS., INC.
88 Evans Street
Watertown, Massachusetts 02172

CIRCLE NO. 27 ON READER SERVICE CARD

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. 11 ON READER SERVICE CARD

available to the public and then for one reason or another is no longer made available. Once an event takes on the quality of a national institution and something in which everyone feels he has the right to participate, we begin to put limitations upon what the owner (so called) can do because it affects so many millions of people."

"Actually," Johnson continued, "this happens to any institution which gets big enough—whether it's a network, General Motors, a large state university or a government agency. When the 'owner' starts acting in a fashion that is too independent and whimsical, he's apt to find some kind of regulation coming at him one way or another from consumers or taxpayers or the government. That," he concluded, "is what's happening all across our society with Ralph Nader's movement and civil protests of all kinds."

We came out of this interchange—rightly or wrongly—with the impression that there are times when "something of interest to the public" becomes "something in the public interest." But exactly when this happens, only the Lord and the FCC know.

The 27-MHz CB question comes in for its share of Congressional attention. There's an almost daily flow of letters of complaint from the Hill to various FCC Bureaus along with requests for answers and action. One Congressman (who shall remain un-named) acidly took the FCC to task when a CB'er with a long record of intentional interference was shot on the front lawn of his midwest home by his fellow (?) Citizen Banders. The Congressman said it was the Commission's fault because they did not enforce the CB frequency rules properly!

While Commissioner Johnson will probably be glad to get along without situations such as that when his term expires in July of 1973, it was clear he didn't intend to retire from the arena. When asked if his future plans included anything of a political nature, he said:

"I am interested in the area of public policy, but there are so many ways today you can do that besides holding an elective office. I'm not particularly interested in having to go out and raise millions of dollars in order to run for office. Besides," he said, "I think Ralph Nader is probably more influential than most of the 535 Congressmen."

Where's the voltmeter?

New Triggered Sweep Scope Measures Peak-To-Peak Voltage with Cali-Brain®

You're looking at it in this solid state oscilloscope. The new B & K Precision 1465 is a triggered sweep oscilloscope with CALI-BRAIN – a built-in feature for measuring voltages, automatically without computation in seconds. CALI-BRAIN will measure peak-to-peak voltage on waveforms of any complexity – and at voltage levels from 10mV to 600 V. Only B & K scopes have CALI-BRAIN – a real advance in TV test equipment.

Servicing time goes down – picture quality goes up – when you use this scope. Now, in one instrument, you get triggered sweep to eliminate those waveforms that won't lock in, a vectorscope for color TV servicing, 10 MHz response for high resolution analysis. A unique sync separator generates special sweep synchronizing pulses to let you analyze any portion of the TV waveform. For economical performance, use the B & K Precision 1465.

About the Cali-Brain® System

The CALI-BRAIN system increases your efficiency because it lets you measure its peak-to-peak voltage without changing your test set-up. Now you can confirm the manufacturer's service data exactly – checking out typical waveforms and peak-to-peak voltage readings at various test points.

Cali-Brain® in Action

Use CALI-BRAIN when you want to measure peak-to-peak voltage of the waveform displayed on the scope screen. Here's what happens when the CALI-BRAIN switch is activated:

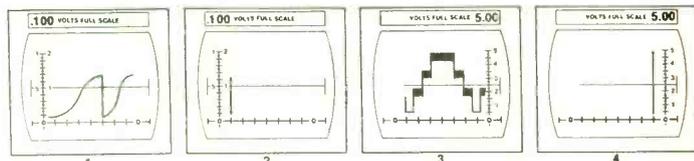
- The horizontal sweep collapses and the waveform under examination appears as a straight vertical line.
- A numerical indicator in the CRT bezel lights up to show the full scale voltage (including decimal point) corresponding to the Vertical Attenuator setting.
- A graduated scale on the graticule

overlay is illuminated on either side of the scope screen. The scale corresponds to the full scale voltage indicator in the bezel.

- The vertical waveform line on the CRT moves to either side of the illuminated scale.

The entire CALI-BRAIN action

is automatic – and takes less than a second. After you have read waveform voltage on the scale, you deactivate CALI-BRAIN system with a single switch, and the waveform is again displayed as before. One probe and one test instrument – lets you concentrate on trouble shooting, not the test equipment!



To read peak-to-peak voltages utilizing Cali-Brain, note the full scale voltage reading in the bezel above the screen (fig. 1-100 volts full scale) (fig. 3-5.00 volts full scale). Pull out the Cali-Brain knob and you will notice that the 1st waveform in fig. 2, reads .067 volts P-P and the second waveform in fig. 4, reads 4.95 volts P-P.

See your local distributor or write us for more information



Product of
DYNASCAN CORPORATION
1801 W. Belle Plaine • Chicago, Illinois 60613

CIRCLE NO. 10 ON READER SERVICE CARD

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 5/8" 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, Snooperscopes, Radios, Parts, Picture Catalog 25¢. Meshna, 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-K, Penrose, Colorado 81240.

INVESTIGATORS, latest Electronics Aids. Free Literature. Clifton, 11500-L NW 7th Ave., Miami, Florida 33168.

LOWEST Prices Electronic Parts. Confidential Catalog Free. **KNAPP**, 3174 8TH Ave. S.W., Largo, Fla. 33540.

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:** \$75. 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.

ELECTRONIC PARTS, semiconductors, kits. **FREE FLYER**. Large catalog \$1.00 deposit. **BIGELOW ELECTRONICS**, Bluffton, Ohio 45817.

RADIO—T.V. Tubes—36¢ each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

NEW SEMICONDUCTOR LIGHT EMITTING DIODES—bright red lights replace light bulbs. Typical life 100 years. Operate at 1.65 volts, 50 milliamps. Order 2 for \$2.98 **NOW**. Data sheet and instructions included. Monsanto Company, Hobby Section, 10131 Bubb Road, Cupertino, California 95014.

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.

ELECTRONIC Ignition. Various Types. Information 10¢. **Anderson Engineering**, Epsom, N.H. 03239.

LIBERTY PAYS MORE!

WILL BUY FOR CASH

ALL TYPES:

- ★ ELECTRON TUBES
- ★ SEMICONDUCTORS
- ★ TEST EQUIPMENT
- ★ Military Electronic Equipment

WIRE—WRITE—PHONE COLLECT

We pay freight on all purchases—on above only!

LIBERTY OFFERS MORE!

PRESTEL FIELD STRENGTH METER

(Model 6T4G)

Only
\$142.00

F.O.B. New York

Model MC16
Larger loud speaking
model-2.5
microvolt
only \$317.00 F.O.B.
New York

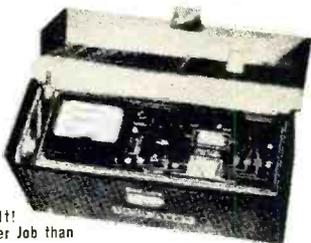
- ★ Never Anything Like It!
- ★ 1-Man Can Do A Better Job than 3 in the Same Time!
- ★ A Gold-Mine for Antenna Installers!

Calibrated from 40 to 230, and 470 to 860 in 4 Bands Megahertz, from 10 to 50,000 Microvolts. Nothing makes it easier to properly and speedily find the correct place to install TV, FM and Communication Antennas. You can measure and hear the signals with this 4 1/2 volt battery economically powered unit.

LIBERTY ELECTRONICS, Inc.

548 Broadway, New York, New York 10012
Phone (212) 925-6000

CIRCLE NO. 28 ON READER SERVICE CARD



BUILD YOUR OWN SPACE-AGE TV CAMERA



ONLY KNOWN SOLID-STATE CAMERA KIT! Ideal for experimenters, home, education, industry, etc. High quality. Ducted by over six years of lab & field testing. Fully Guaranteed. Connects to any TV set without modification. Ship by step construction manual. Model XT-1A, Sales D complete with vidicon \$149.50 postpaid anywhere in USA & Canada (less vidicon tube \$16.50pp)

PHONE OR WRITE FOR CATALOG.

DIAL 800-867-3779

Many other kits, parts and plans available including starter kits, focus-ally, vidicon tubes, conn. 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. **Interlech** 7A7, Box 5373, Station-F, Ottawa, Canada.

LEARN the facts of electronics and your privacy. Send for the **Tron-X Manual**, P.O. Box 38155, Hollywood, CA 90038. \$5.95.

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.

AMATEUR SCIENTISTS, Electronics Hobbyists, Experimenters, Students . . . Construction Plans—all complete, including drawings, schematics, parts lists with prices and sources . . . Radar—Build your own ultrasonic doppler radar. Detect motion of people, automobiles, even falling rain drops. Transistorized, uses 9 volt transistor battery—\$4.50 . . . Long-Range "Sound Telescope"—This amazing device can enable you to hear conversations, birds and animals, other sounds hundreds of feet away. Very directional. Transistorized. Uses 9V battery—\$3.50 . . . Robot Man—Moves hands and arms—\$3.50 . . . Or send 25¢ coin (no stamps) for complete catalog. Other items include Psychedelic strobes, light shows, lasers . . . 46 different projects. Technical Writers Group, Box 5994, State College Station, Raleigh, N.C. 27607.

BURGLAR ALARM SYSTEMS. We manufacture intruder-fire detection systems, radar and perimeter types. Accessories available. Free Literature. Inquiries for dealership and wholesale prices must be on letterhead. U.S. and Canada only. Microtech Associates, Inc., Box 10147, St. Petersburg, Florida 33733.

"LISTEN IN" TO POLICE-FIRE RADIO CALLS IN YOUR CAR!

WORKS WITH ANY CAR—Portable or HOME RADIO! Just PLUGS in—No wiring—3 minute hookup! Switch instantly from regular to ALL POLICE-FIRE-EMERGENCY-COMMERCIAL-TAXICAB-STATE-CITY-GOV'T 2-Way Radio calls in YOUR AREA. DUAL-HI-LOW BANDS—OVER a MILLION Radio Cars Stations. USE Everywhere—anytime—always works!

SEND ONLY \$2.00 (cash, Ck., M.O.) and pay postman \$7.99 plus COD post or send \$9.99 for ppd Del in USA. COMPLETE, ready to use with instructions. One Year service Warranty—10 DAY MONEY BACK TRIAL (if return). AMAZING OFFER good only by mail—WESTERN RADIO Dept. BPE-4 KEARNEY, NEBR. 68847



CONSTRUCTION PLANS: Laser . . . \$2.00. Investigation Aids—2-FM Microphone Transmitters . . . \$1.00. FM Telephone Transmitter . . . \$2.00. Sound Telescope . . . \$2.00. Space Monitor—Missile Tracker . . . \$2.00. Free equipment and kit catalog. Howard, 20174 Ward, Detroit, Michigan 48235.

DIAGRAMS—Radios \$1.50, Television \$3.00. Give make and model. Diagram Service, Box 1151PE, Manchester, Conn. 06042.

NOW! Enjoy the great outdoors in comfort with your pocket size electronic Skeeter Skat mosquito repeller. \$9.95 postpaid USA. Satisfaction guaranteed. Detectron, Dept. G-4, P.O. Box 243, San Gabriel, Calif. 91778.

METERS—Surplus, new, used, panel or portable. Send for list. Hanchett, Box 5577, Riverside, CA 92507.

TV TUNER REPAIRS—Complete Course Details, 12 Repair Tricks, Many Plans, Two Lessons, all for \$1. Refundable. Frank Bocek, Box 833, Redding, Calif. 96001.

RECONDITIONED Test Equipment. Reasonably priced, list available. Walter, 2697 Nickel, San Pablo, CA. 94806.

PYROTECHNICAL chemicals, casings, tools, supplies, fuse, literature. Giant, illustrated catalogue/handbook includes formulas, instructions—50¢, with samples—\$1.00. Westech, Salt Lake City, 84108.

HOBBYISTS, Supersensitive F.M. microphone transmitter. Picks up normal voice at 30 feet, kit \$14.95, wired \$19.95. Write: Collin, Inc., P.O. Box 281, Route 25, Monroe, Conn. 06468.

FREE Kit Catalog: Shortproof powersupply \$39.50. Ultrasonic Alarm \$37.25. SWTPC, Box B32040, San Antonio, Tex. 78284.

FREE catalog new electronic devices! World's smallest transmitter \$19.95! Telephone Answerer \$49.50! Telephone Recording Device \$19.95! Lie Detector \$19.95! Many more! Sonic Devices, 69-29E Queens Blvd., New York 11377.

INSTANT CIRCUITRY—apply on two enclosed PC boards, no liquids. Price \$3.00. Security Systems, P.O. Box 4754, Colorado Springs, Colorado 80910.

JOHNSON CB RADIOS. Low discount prices, prepaid shipping. MasterCharge. Free list. Hughes Electronics, Box 6487A, Asheville, N.C. 28806.

FREE Kit Catalog: Color Organs \$11.00. Psychedelic Strobes \$17.50. Professional quality—lowest prices. SWTPC, Box F32040, San Antonio, Tex. 78284.

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
½ 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 chargers available separately. \$15. each.

Includes rechargeable nickel cadmium battery pack and charger. (Crystals & tuning, add \$50.)

\$148.

Lots of 5 less 10% . . . \$133.20
Lots of 10 less 15% . . . \$125.80

Now—15,000 2-Way FM Mobile Units IN STOCK . . . Send for new '72 catalog

GREGORY ELECTRONICS CORP.
249-F 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 1096, Flushing, N.Y. 11352, giving the following information.

If you have no label handy, print OLD address here.

name _____ please print

address _____

city _____

state _____ zip-code _____

REPLACE LABEL

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. 0652

name _____ please print

address _____

city _____ state _____ zip _____

Add'l postage: \$1 per year outside U.S., its possessions & Canada.

DISCOUNT electronic guaranteed goodies. Motorola HEP170 Epoxy Diode 2.5A/1000PIV 39¢; MOT 7090PAMP 50¢. Quote short-wave receivers. Industrial, Amateur, CB, Madison Electronics, 1508 McKinney, Houston, Texas 77002 (713) 224-2668.

BURGLAR Alarm Systems equipment, dealers and private. Write: United Security, Box 2428, Dublin, Calif. 94566.

PANORAMA of industrial and government electronic surplus in our monthly picture catalogs. Startronics, Box 17127, Portland, Oregon 97217.

ELECTRONIC HOBBYISTS and professional builders love our 3¢ film resistors; 16¢ electrolytics and 1% micas. Great catalog 35¢. Electrovalue-America, Box 276, Swarthmore, Pa. 19081.

ELECTROENCEPHALOPHONE, Brainwave feedback equipment. J&J Enterprises, 24120-E 3rd West, Bothell, Wash. 98011.

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.

120 VOLTS AT 3,000 WATTS of electricity from ANY alternated vehicle using our special adaptor! Operate electric drills, lights, heaters, portable saws, AC-DC TV's and many more AC devices! Arc Weld 1/2" steel plates! Fully charge 6, 12, 24 volt batteries in minutes! Will not harm alternator! Installation takes only ten minutes! Guaranteed one full year! Send only \$6.95 for complete construction plans, \$12.95* for complete kit, \$15.95* for assembled adapter or \$18.95* with voltage indicating light (comes on when alternator is producing 120 volts!) *add \$1.25 for postage—PLUS MANY OTHER PRODUCTS JUST AS USEFUL!—Construction plans \$5.00 each, ultra-sensitive metal detector—X-ray fluoroscope machine—silver recovery unit!—Coin cleaner/electroplater—chemical formulary (home products)—electronic oven—PLUS MANY MORE!—ask for our FREE color catalog—Creative Products, 1551 East Loop 820, Department ED, Fort Worth, Texas 76112.

LOGIC Circuits, an introduction, \$2.00. Digital Clock readout, 6 digit 7 seg., AM, PM, \$10.00. 8 digit misc. readout, 7 seg., \$13.50. John R. Brethauer, 330 Abbott Ave., Milpitas, Calif. 95035.

PRINTED Circuit Drill Bits. Trumbull, 833 Balra Drive, El Cerrito, Calif. 94530.

CIRCUIT board material XXXP 2¢ per sq. in. Minimum order \$5.00. JETCA, INC., Box 418, Monon, Indiana 47959.

ENVIRONMENTAL LIGHTING: Color Organs, Idiot Boxes, Sound to Light Converters, Strobes, from \$6.00. Completely assembled; Free Catalog. OLIVER SUDDEN LIGHTING, Dept. M., Nine Andover Street, Peabody, Massachusetts 01960.

DIGITAL and analog computer modules. LED numeric displays. Pulse generators. FREE LITERATURE. Scientific Measurements, 2945 Central, Wilmette, Illinois 60091.

PHOTOFASH CAPACITORS 490MFD @ 500VDC, 5/8 x 1 1/2" \$1.50 each, postpaid. Electronic Surplus, 1224 Prospect, Cleveland, Ohio 44115.



PROVED SCHEMATICS: Acoustic burglar alarm acts before entry. Portable detector grants protection on beach, gives professional tape-slide synch. Plans \$2.00. Studio mixer circuit offers as many stereo/mono channels as you need. Plans \$3.00. Microphone line amp feeds 500 feet of unshielded wire. Plans \$1.00.

THE MILLERS, P.O. Box 145
Cleveland, Ohio 44121

"All three with my picture. \$5.00." Free catalog of wired units.

5,000 PER BOX copper wire leads with ring terminals and flag fasteners. Union Carbide Corporation, P.O. Box 8361, South Charleston, W. Va. 25303.

PARTS! CORNELL TUBES!

FREE Send For FREE CORNELL'S New Color Catalog 40 Pgs. New Items IN LOTS OF 100 IN 24 HOURS!

33¢ per tube **36¢ per tube**

ORDER FREE IF NOT SHIPPED

4219 UNIVERSITY AVE. SAN DIEGO, CALIF. 92105

CD Ignitions—Free information. Dealers invited. Southland, Box 3591, Baytown, Texas 77520.

OVER 1,000 new electronic parts, list \$240.00, yours \$19.95. 28 Music pages \$1.25. All postpaid. Hobbytronics, 921 East 19th, San Angelo, Texas 76901.

ELECTRONIC ORGAN KEYBOARDS, Oscillator coils, printed circuits and other components for organ circuitry. 25¢ for catalog. Devtronix Organ Products, 5872 Amapola Drive, San Jose, Calif. 95129.

POCKET SIZE ELECTRONIC CALCULATOR

THE ULTIMATE IN MINIATURIZED POCKET CALCULATORS. The Craig Model 4501 Calculator Adds, Subtracts, Multiplies and Divides, using positive or negative numbers • The Model 4501 employs a memory that will produce a constant K-Factor and square numbers automatically • The readout is composed of a L.E.D. 8 digit display with an extra digit for adding any input error, output overload, low battery or negative sign. Fully Guaranteed. The calculator will operate off of A.C. or its own self-contained rechargeable batteries • Model 4501 • \$194.50

1629 SALINA BARON ELECTRONICS WICHITA, KANSAS 67203

RESISTORS—High quality, low prices, Free flyer. Kingtree, Box 3092, Columbus, Ohio 43210.

WHOLESALE burglar alarm supplies. Catalog \$1.00 (refundable). Ellin, 161 Bonad, Chestnut Hill, Mass. 02167.

ELECTRONIC plans and kits. Something for everyone. Catalog, 25¢. TA, Box 1266, S. Lake Tahoe, Ca. 95705.

ANY quantity, \$1.00 each IN830, IN830A, IN831, IN831A. Mitek, Box 82, Melrose Highlands, Mass. 02177.

HOBBYISTS: Logic IC project kits. Combination Lock, \$5.95. Catalog free. John Huntley, 1351 Mahoney, Rodeo, Calif. 94572.

IC's, displays, books, low prices. Marco Enterprises, POB 216, Dayton, Ohio 45401.

SCHEMATICS on military surplus electronic equipment. Price \$2.00, postpaid. Send order with military model number. Bill Slep Company, Drawer 178, Ellenton, Florida 33532.

Laser parts catalog 60¢. Moynihan, 107 North Brighton, Atlantic City, New Jersey 08401.

SURPLUS MINIATURE REGULATED POWER SUPPLIES for logic, linear IC's, function modules. Voltages: 5 to ±24V. Currents: 25 to 1000 mA., \$9.00 to \$18.00. Stock list. Instant Instruments, 306 River Street, Haverhill, MA. 01830.

AUTOMATIC activated phone patch for recording those important calls on your cassette recorder; kit \$12.95, plans \$3.50. 115DB solidstate alarm sounder, 3 to 24 volts at low current, less speaker, \$9.95. Burglar alarms, remote control tone Encoders and Decoders, Receiver speech scrambler decoders, other kits, plans, and components. Catalog 25¢. Krystal Kits, Box 4232, Little Rock, Ark. 72204.

FIRE & BURGLAR ALARMS
1972 Handbook & Catalog

Save Hundreds of Dollars



Professional equipment famous manufacturers, not readily available from local sources. **NEW & EXPANDED** to include laser photo-electronic systems, dialers, electronic sirens, perimeter controls, and a **NEW RADIO ACTUATED SYSTEM** that installs in less than 2 hours. Also includes switches, bells, control panels, wire and hardware. Save up to 75%. This handbook is a must for every homeowner and businessman. Just \$1 cash, check or M.O. \$1 refunded with first order.

ALARM COMPONENT DISTRIBUTORS
33 New Haven Ave., Dept. P.E., Milford, Conn. 06460

NEW INTEGRATED CIRCUITS

LM309K five volt, 1A, TO-3 power supply module provides fully regulated 5 volts w/10.0V DC input \$2.50 each 5 for \$10.00

LM100 positive voltage regulator 2 to 30 volts out @ 20ma 15 amps. w/external transistor, TO-5 \$5.80 each 10 for \$7.50

84 24 Smetie low power dual flip-flop (10 MCI D11) package w/plastic carrier and notes 10 for \$3.60

Prepaid Orders \$5.00 or More—Free Flyer

BABYLON ELECTRONICS
PO Box 85, Carmichael, CA 95608

IMPOSSIBLE? BARGAINS IN SURPLUS ELECTRONICS AND OPTICS

SANKEN HYBRID AUDIO AMPLIFIERS AND SUPPLY KIT



We have made a fortunate purchase of Sanken Audio Amplifier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F, Sanken and the Sanken U.S. distributor. Available in three

sizes: 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanken amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

- 10 Watt RMS Amplifier \$ 4.75
- 25 Watt RMS Amplifier \$14.75
- 50 Watt RMS Amplifier \$22.50
- Complete kit for 100 watt rms stereo amplifier (200 watt music) including two 50 watt Sanken hybrids, all parts, instructions, and nice 1/16" thick black anodized and punched chassis \$88.00
- Same for 50 watt rms stereo amplifier includes two 25 watt Sankens, etc. \$58.00
- Same for 20 watt rms stereo, includes two 10 watt Sankens, etc. \$30.00

SUBMINIATURE TOGGLE SWITCHES

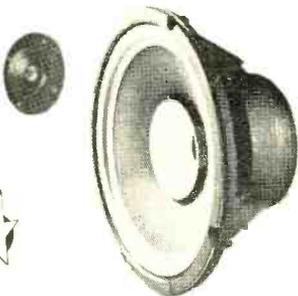


These are nice, American made switches, of a size compatible with subminiature equipment and digital control panels. Available in two electrical configurations, conventional on-off SPDT, or on-off-on momentary SPDT. Specify which type. All brand new, at 1/3 catalog price.

- Subminiature Switches (specify on-off or momentary)
 - \$1.00 each
 - 10 for \$ 8.50
 - 100 for \$75.00

THIS MONTH'S SUPER SPECIAL!

JENSEN HIGH COMPLIANCE SPEAKER SYSTEMS



A local manufacturer went out of the speaker enclosure business, and we were lucky enough to buy his inventory of Jensen high-compliance (acoustic suspension) speaker systems. These systems consist of a 12" extended range woofer, a hemispheric dome tweeter, plus crossover. The dome tweeter response extends into the supersonic.

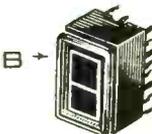
The dome shape provides an ideal polar pattern response. The system is ideal for use with our Sanken Amplifier Systems, or any system capable of putting out at least 20 watts rms per channel. Full instructions for cabinet construction are included.

- Single System (One Woofer, Tweeter and Crossover) \$29.00
- Shipping weight 10 lbs.
- Stereo System (Two of Above) \$55.00
- Hi Compliance Woofer Only (8 lbs.) \$22.00
- Dome Tweeter only (3 lbs.) \$5.75

7 SEGMENT READOUTS



A

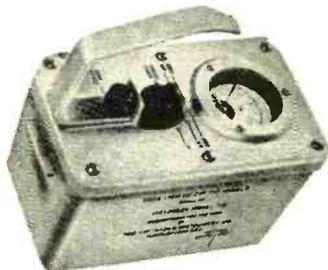


B

7 Segment Readouts. Two types are available, a large size model with wire leads for P.C. Board Mounting illustrated at (A) and a small size low-current version in a Dual In-Line type package for miniature battery operated instruments illustrated at (B).

- Large Size Readout (Illus. A) \$3.45
- Low Current Version (Illus. B) \$3.25
- Complete counter kit, including 7490 decade counter, 7447 decoder and printed circuit board, and choice of either readout. Price \$8.25
- Complete counter as above, with 7475 latch, for storage. Price \$10.25
- Complete Bi-directional counter, with 74192 instead of 7490, for up-down counting \$11.25
- Complete Bi-directional counter, with latch for storage (74192 7475-7447) \$12.25

RADIATION METER ("Geiger Counter")



You can buy a complete radiation meter, complete with original instruction books, at less than the price of the meter movement alone. Range is 0.02 to 50 Roentgens/hour. This is not sensitive enough for prospecting, but useful for other radiation measuring and monitoring purposes. If not used for its original function, then the case,

meter and battery holder alone are worth our asking price as a basis for building a metal locator, etc. Uses standard D cell and 22.5 volt Battery.

- Radiation Meter \$9.50 + \$1.00 postage & handling
- 80 PAGE CATALOG - Free with any order or send \$0.25

To our customers:

B and F is moving to a new location: 119 Foster Street, Peabody, Mass. 01960 (same address, but different building). Our apologies to any customers who experienced delays in shipments during the move. Our new expanded shipping and storage areas will allow us to service your order faster than ever before. Retail customers are now welcome at all working hours (Monday through Friday, 9 - 5, Saturday, 9 - 3). Special few of a kind items are being cleared out, so come and visit our new location with twenty five thousand square feet of surplus bargains.

ALL ITEMS (WHERE WEIGHT IS NOT SPECIFIED)
POSTAGE PAID IN THE U. S. A.

CHARGES WELCOME!

Phone in charges to 617 531-5774 or 617 532-2323. BankAmericard - Mastercharge. \$10.00 minimum. No C.O.D.'s please.

B. & F. ENTERPRISES

Phone (617) 532-2323

P.O. Box 44, Hathorne, Massachusetts 01937

CIRCLE NO. 5 ON READER SERVICE CARD

PLANS AND KITS

KITS—Color organs, synchronizers, strobes. Workshop, Box 3932, Bethpage, New York 11714.

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. Laboratories, 745-L Cordone, Reno, Nevada 89502.

FREE Kit Catalog: Amazing new Universal Digital Instruments with plugins as featured in Popular Electronics. Unbeatable prices. SWTPC, Box D32040, San Antonio, Tex. 78284.

EMERGENCY power from automobile alternator. 110 volts at flip of switch. Simple plans \$1.00. Electronics, P.O. Box 336, McGehee, Ark. 71654.

BRAINWAVES—Build your own machine. We have plans, kits. Write: Extended Digital Concepts, Box 9161, Berkeley, Calif. 94709.

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.

COMPUTER, high speed general purpose with stored program. Most adaptable and easily understood type. Build with surplus integrated circuits. Plans \$5.00. Buckley Electronics, 927 Marco Pl., Venice, Calif. 90291.

COLOR Organ Kits \$7.50. IC's 25¢. Catalog. Murphy, 204 Roslyn Ave., Carle Place, N.Y. 11514.

TALKING Fire: Make gas flame a loudspeaker. Spaceage discovery. Reproduce sound through fire, complete directions. \$3.00. Savage News, Box 2353, Sunnyvale, Ca. 94087.

HIGH FIDELITY

OVER 20 YEARS Successful Discounting of Audio Equipment insures best value and service. Specialize in Stereo Components, Tape Recorders, Cassettes, Magnetic Cartridges, Sleep Learn Equipment, etc. Low Quotes, Free Catalog. DRESSNER 1523PE Jericho Turnpike, New Hyde Park, New York 11040.

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, P.O. Box 69, Kensington Station, Brooklyn, New York 11218.

HEGEMAN "OMNI-DIRECTIONAL" SPEAKERS \$100. Creighton Audio Labs, Haven Pl., Linden, N.J. 07036.

McGEE RADIO COMPANY
World's Best Selection of Speakers
Almost Every Size From 1½ to 18"
WOOFER — TWEETERS — CROSSEOVERS
MANY HIGH FIDELITY KITS.
McGee's 176 Page 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

STEREO Components at lowest prices. Send for free catalog. Carston, Box 1094-A, Danbury, Conn. 06810.

FREE Kit Catalog. Amplifiers: Lil Tiger \$1.10, Universal Tiger \$30.00. Preamp \$44.50 (Featured in Popular Electronics) Mixer-6 Input \$13.75. SWTPC, Box A32040, San Antonio, Tex. 78284.

WANTED

QUICKSILVER, Platinum, Silver, Gold, Ores Analyzed. Free Circular. Mercury Terminal, Norwood, Mass. 02062.

CASH immediately for old Gold, Silver, Platinum, Mercury, Watches, Diamonds. Free information. Rose Industries, 29-PB East Madison, Chicago Ill. 60602.

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.

TUBES

RADIO & T.V. Tubes—36¢ each. Send for free Catalog. Cornell, 4213 University, San Diego, Calif. 92105.

RECEIVING & INDUSTRIAL TUBES, TRANSISTORS. All Brands—Biggest Discounts. Technicians, Hobbyists, Experimenters—Request **FREE** Giant Catalog and **SAVE!** ZALYTFON, 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.

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. **BARFY ELECTRONICS**, 512 Broadway, New York, N.Y. 10012.

TUBES receiving, factory boxed, low prices, free price list. Transleteronic, Inc., 1306 40th Street, Brooklyn, N.Y. 11218A, Telephone: 212-633-2800.

DISCARD tubes, solid state plug-ins, send stamped envelope for list, Precision Specialties, Box 912, Waco, Texas 76703.

TAPE AND RECORDERS

STEREO TAPE RENTAL for particular people. Free catalog. Gold Coast Tape Library, Box 2262, Palm Village Station, Hialeah, Fla. 33012.

STEREO TAPE TRANSPORT—7" reel—2 speeds—pause control—made for famous manufacturer—50 to 15,000 Hz—with rec/play and erase heads, without case. Send m.o. or check for \$19.50 to Alshemer Audio Electronics, 218 Columbia St., Utica, N.Y. 13502. \$2.50 for prepaid shipping and insurance.

BUY Irish Tape Open Reel & Cassettes & 8-Track Blanks at Discount Prices. Write: Direct Mail Cassette Corp., Box 71, Plainview, N.Y. 11803.

RECORDING TAPE made by top American manufacturer, guaranteed not "seconds" or "white box"; 2400' mylar, \$2.29; 1800' mylar \$1.69; 1200' acetate \$1.79. Send for information and quantity pricing. Alshemer Audio Electronics, 218 Columbia Street, Utica, New York 13502.

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.

OLD Radio Programs. Catalog \$1.00. (Refundable). Radio Vault, Box 9032, Wyoming, Michigan 49509.

VIDEO TAPE, 1 inch x 1 mil. x 1700 feet. Used. On computer reels. \$12.00 each. LAHILL, P.O. Box 656, Martinsburg, W. Va. 25401.

SCOTCH TAPE #150, 1800 foot, 7" reel, polyester, \$1.95, postpaid. Recorders, cassettes, open reel music tapes (100-page discount catalog 25¢). Saxitone Tape Sales, 1776 Columbia Road, Washington, D.C. 20009.

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.

RECORDING? DUBBING? EDITING? Use the "Dubie" control. Integrate two or more recorders into your music system. End tangled cables, ruined tapes. Brochure A-5, Dubie Co., 1509 Oklahoma, Norman, Okla. 73069.

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.

PC ARTWORK, negatives, boards etched. Reasonable prices. Specifications on request. Arts Unlimited, 411 Abbot, Richland, Washington 99352.

ELECTRONIC EXPERIMENTER'S HANDBOOK



148 pages of the most fascinating and challenging construction projects for the electronic hobbyists. All with complete schematics, illustrations, parts list, and easy-to-follow instructions.

- 1972 Winter edition ... \$1.25. #40
- 1971 Spring edition ... \$1.50. #26
- 1971 Winter edition ... \$1.50. #33
- 1970 Spring edition ... \$1.50. #14
- 1970 Winter edition ... \$1.35. #97
- 1968 Spring edition ... \$1.25. #84

Order by number from

Ziff-Davis Service Div., 595 Broadway • N.Y., N.Y. 10012
Enclose an additional 35¢ per copy for postage and handling.
(Outside U.S.A. all magazines are \$2.50 per copy, postpaid.)

PAYMENT MUST BE ENCLOSED WITH ORDER

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.

F. C. C. 1st phone license training in 5 weeks. R.E.I.'s intensive training produces outstanding results. For information and free brochure call toll free: 1-800-237-2251, or write home office, Radio Engineering Incorporated Schools, 1336 Main Street, Sarasota, Florida 33577. Florida residents call (813) 955-6922.

HIGHLY effective home study courses in Electronics Engineering Technology and Electronics Engineering Mathematics. Earn your Degree. Write for Free Descriptive Literature. Cook's Institute of Electronics Engineering, (Dept. 15), P.O. Box 10634, Jackson, Miss. 39209. (Established 1945).

ASSOCIATE DEGREE IN ELECTRONICS through correspondence instruction. G.I. Bill approved. Free catalog. Grantham, 1509 N. Western, Hollywood, California 90027.

Save! GIANT SALE ON NEW TTL TEXAS & NATIONAL ICs

Buy Any 3 — Take 10% Discount
100 or more, 25% discount

Type	Function	Sale
<input type="checkbox"/>	SN7400N Quad 2 input NAND gate	\$.29
<input type="checkbox"/>	SN7400M SN7400 with open collect	.39
<input type="checkbox"/>	SN7402N Quad 2 input NOR gate	.39
<input type="checkbox"/>	SN7404N Hex inverter	.39
<input type="checkbox"/>	SN7405N Hex inverter, open collect	.39
<input type="checkbox"/>	SN7410N Triple 3 input NAND gate	.39
<input type="checkbox"/>	SN7420N Dual 4 input NAND gate	.39
<input type="checkbox"/>	SN7430N 8 input NAND gate	.39
<input type="checkbox"/>	SN7440N Quad 4 input NAND buffer	.39
<input type="checkbox"/>	SN7441N BCD-to-Decimal driver	1.50
<input type="checkbox"/>	SN7446N BCD-to-7 seg. dec./driver	2.25
<input type="checkbox"/>	SN7447N BCD-to-7 seg. dec./driver	2.25
<input type="checkbox"/>	SN7472N J-K Master slave flip-flop	.69
<input type="checkbox"/>	SN7473N Dual J-K Master slave flip-flop	.69
<input type="checkbox"/>	SN7474N Dual D triggered flip flop	.69
<input type="checkbox"/>	SN7475N Quad bistable latch	1.25
<input type="checkbox"/>	SN7473N SN7473, with preset-clear	.88
<input type="checkbox"/>	SN7481N 16-bit memory (scratch pad)	1.50
<input type="checkbox"/>	SN7483N 4-bit binary full adder	1.88
<input type="checkbox"/>	SN7490N Decade counter	1.40
<input type="checkbox"/>	SN7491N 8-bit shift register	1.25
<input type="checkbox"/>	SN7492N Divide by 12 counter	1.25
<input type="checkbox"/>	SN7493N 4-bit binary counter	1.25
<input type="checkbox"/>	SN7494N 4-bit shift register	1.25
<input type="checkbox"/>	SN7495N 4-bit register right-N-left	1.50
<input type="checkbox"/>	SN74154N Divide by 16	3.45
<input type="checkbox"/>	SN74181N Arithmetic Logic Unit	8.50
<input type="checkbox"/>	SN74192N Bi-directional counter	3.45
<input type="checkbox"/>	SN74193N Binary up-down counter	3.45

Factory Guaranteed
Factory Tested
Factory Marked

BRAND NEW! LINEAR IC AMPS

Type	Description	Sale
<input type="checkbox"/>	SN5510L 40MZ, Video Amp	\$3.50
<input type="checkbox"/>	702 High Gain, DC amp TO-5	.79
<input type="checkbox"/>	703 RF-IF, 14 hookups, TO-5	\$1.19
<input type="checkbox"/>	709C Operational Amp***	.59
<input type="checkbox"/>	710C Differential Amp***	.59
<input type="checkbox"/>	711C Memory, Sense, Amp***	.59
<input type="checkbox"/>	723A Voltage Regulator ***	1.49
<input type="checkbox"/>	TVR-2000 Hi-power 723 ***	1.59
<input type="checkbox"/>	741C Freq. Comp. 709***	.95
<input type="checkbox"/>	748C Freq. Adjustable 741***	.95
<input type="checkbox"/>	709-709 Dual 709's (DIP)	1.49
<input type="checkbox"/>	741-741 Dual 741's (DIP)	2.25
<input type="checkbox"/>	739-739 16 Transistor stereo PREAMP (DIP)	2.49
<input type="checkbox"/>	749-749 Dual channel audio amp (DIP)	2.49



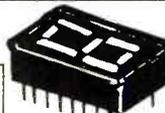
Factory Guaranteed
Factory Marked
Factory Tested

Buy Any 3
Take 10%
Discount!

*** State 1st. 2nd choice, Dual In Line, TO-5.

ALPHA- NUMERIC 7-SEG. READOUTS

Either Type — Only \$3.95
Buy any 3 — Take 10% Discount



A Poly Pak exclusive! Two different types. Both compatible with SN7446, SN7447, SN7448, SN7475, SN7490 and SN74192 IC's. Both with decimals, 0 to 9 numerals and 10 letters. With specs & hookups.

16-PIN MICRO MINIATURE

Fits into 16 pin dual in line socket. Life: 250,000 hours. Delivers 700-ft. Lambert's brightness with 5 volts 8 mils per segment. Characters .362" H. x .197" W.

9-PIN TUBE TYPE

For printed circuit board or socket. Life: 100,000 hours. Delivers 6,000-ft. Lambert's with 5 volts 23 mils per segment. Characters .47" H. x .26" W.

7-SEGMENT READOUT SOCKETS 16-Pin in line . \$4.99
 9-Pin Tube type . \$1.39

ALLEN BRADLEY'S "MICRO-POTS"

Type G, 1/2" dia. x 1/2" high. Mounts 1/4" hole, with shaft, linear, immersion-proof high freq.



	Ohms	Ohms	Ohms	Ohms	Any 2 for \$1
<input type="checkbox"/>	100	1.0K	10K	100K	1 Meg.
<input type="checkbox"/>	250	2.5K	25K	250K	2 Meg.
<input type="checkbox"/>	500	5.0K	50K	500K	5 Meg.

Terms: add postage. Rated: net 30, cod's 25%.
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 211 Albion St., Wakefield, Mass.

POLY PAKS

P.O. BOX 942 E
Lynnfield, Mass. 01940



CIRCLE NO. 34 ON READER SERVICE CARD

We have had many calls asking us if the components we sell are rejects? We would like to announce here that EVERY item sold by us is manufacturer's FIRST-RUN, fully tested and in perfect BRAND NEW condition. These parts are purchased through huge blanket orders mainly for our manufacturing requirements, and we are happy to pass on the savings to you. All parts are GUARANTEED to be brand new, NOT EVEN SURPLUS NEW; but first-runs, manufactured within the last 9 months.

Manufacturers, schools, universities, hobbyists; we can save you hundreds of dollars on your requirements, while offering a permanent source which you can depend on indefinitely, not until one's surplus stock is exhausted.

DELIVERY PROBLEMS? Every item advertised here will be shipped within 24 hours after receipt of your order (days, or orders paid for by personal checks) or we will allow you a 10% discount on back-ordered items. For SUPER-FAST service give us a call and we will ship COD the same day!

ALLEN-BRADLEY MIL-GRADE (5-BAND) RESISTORS. Any of the 94 STANDARD values from 2.7 to 22M. EACH..... \$2.50
Please specify 1/4 or 1/2 WATT.



**LED
7-SEGMENT
DISPLAY**
\$4.95 Each

50-99 \$4.75
100-999 4.50
1000 up 4.25

Similar to the popular MM-1, but with improved brightness. Has left hand decimal point. Fits in a DIP socket. Expected life: Over 100 years! We bought a huge quantity of these for two of our products and you are invited to share the savings. Regularly \$12.95 in single lots! These are brand new with full data sheet and 4-page MULTIMETER Application Note, No. 7447 for driver. We can supply you with one or ten thousand FROM STOCK.

Incandescent type of 7-segment display. Has right-hand decimal point. Fits in a DIP socket or solder directly to PC board. Rated 8mA per segment at TTL supply of 5V. Design life of 50,000 hours. EACH.....\$3.25

MOLEX IC SOCKET PINS:
Don't solder your IC's to PC boards. Use these economical socket pins. Sold in continuous strips.

100 for...\$1.00 200 for...\$1.80
300 for...\$2.60 400 for...\$3.40
500 for...\$4.20 600 for...\$5.00
700 for...\$5.80 800 for...\$6.60
900 for...\$7.40 1000 for...\$8.20
Each additional 1000 pins...\$7.50

TTL DIGITAL IC'S				LINEAR IC'S	
7400	296	7450	296	74150	\$2.00
7401	296	7451	296	74151	\$1.40
7402	296	7452	296	74152	\$2.15
7403	296	7453	296	74153	\$2.50
7404	306	7450	296	74155	\$1.75
7405	306	7470	656	74156	\$1.75
7406	706	7472	606	74157	\$1.95
7407	706	7473	606	74158	\$1.95
7408	306	7474	606	74160	\$2.00
7409	306	7475	\$1.20	74161	\$2.00
7410	306	7480	906	74162	\$1.85
7411	306	7480	906	74163	\$2.00
7413	756	7483	\$1.55	74164	\$1.85
7416	606	7484	\$2.25	74165	\$1.85
7417	606	7485	\$3.25	74166	\$1.85
7420	296	7486	806	74167	\$3.50
7421	306	7489	\$6.00	74176	\$1.35
7423	756	7490	\$1.20	74177	\$1.35
7426	506	7491	\$1.35	74180	\$2.00
7430	296	7492	\$1.20	74181	\$6.00
7432	996	7493	\$1.20	74182	\$1.70
7437	706	7494	\$1.45	74190	\$3.50
7438	706	7495	\$1.45	74192	\$2.40
7440	296	7496	\$1.40	74193	\$2.20
7441	\$1.35	7497	\$4.00	74196	\$1.75
7442	\$1.30	74100	\$1.95	74197	\$1.75
7443	\$1.25	74107	816	SN7511	\$2.25
7444	\$1.35	74121	806	SN75107	2.45
7445	\$1.75	74122	906	1N278	15c
7446	\$1.65	74123	\$1.40	1N4154	15c
7447	\$1.65	74143	\$1.50	1N751A	30c
7448	\$1.55	74145	\$1.50	1N4002	15c
				1N914	10c

All IC's are supplied in 8-, 14-, 16-, or 24-pin plastic DIP (Dual in-Line) package, except for NE536, NE537, NE540, and SE540 which come in TO-5 package.

We give free data sheets upon request, so ask for those data sheets that you NEED, even for those IC's that you are not buying! On orders over \$50.00, we'll send you a new 250-page COMPLETE TTL IC data book FREE. Or you may obtain a new 200-page LINEAR data & application book. Orders over \$100.00 receive both books. Orders over \$150.00 will receive a complete LIBRARY of 7 DIGITAL & LINEAR data & application books totaling 1000 pages FREE. PLEASE NOTE: Data books will be shipped separate from your order. Allow three weeks for delivery.

CERAMIC DISC CAPACITORS. Type 5GA-1000VDC. 5, 7.5, 10, 12, 15, 20, 22, 25, 27, 30, 33, 39, 50, 56, 68, 75, 82, 100 values from 2.7 to 22M. EACH..... \$2.50
Please specify 1/4 or 1/2 WATT.

LOW VOLTAGE DISCS, Type UK. 1.0 mF, 3V.....25c
0.1 mF, 10V.....12c
0.47mF, 10V.....10c

ELECTROLYTIC CAPACITORS: All values are available in both axial or upright (PC Board) mount. Please indicate your choice. 10 mF, 15V.....15c
100 mF, 25V.....25c
500 mF, 25V.....30c

VOLTAGE REGULATORS. Internally-set, overload and short-circuit proof regulators need no external components to set. With data sheet and application notes. TO-3 Package. LM-315, 15V, 600mA.....\$2.95
LM-316, 15V, 400mA.....\$3.85
LM-317, 15V, 450mA.....\$4.05
20 Watt PC-Board Type HEAT SINK.....\$3.20

MASTERCHARGE **SOLID STATE SYSTEMS, INC.**
Bar/Amcard P. O. BOX 773
WELCOMED! COLUMBIA, MO. 65201
PHONE: 314-443-3673

TERMS: RATED FIRMS GET 30 DAYS. OTHERS CHECK OR MONEY ORDER with order. ADD 35 cents to orders under \$5.00 for postage & handling. For FIRST-CLASS or UPS delivery please add 15c cents to your 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. COD orders are FOB Columbia, with 65 cents COD fee additional.

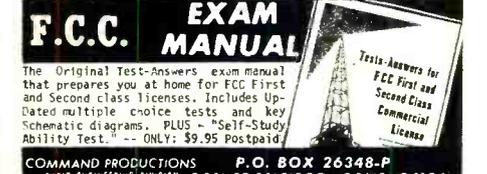
MISSOURI RESIDENTS: Please add 4% sales tax.

WRITE OR CIRCLE READER SERVICE CARD FOR OUR CATALOG OF PARTS & SERVICES. IT'S FREE!

CIRCLE NO. 42 ON READER SERVICE CARD

F.C.C. TYPE EXAM . . . Guaranteed to prepare you for F.C.C. 3rd, 2nd, and 1st phone exams. 3rd class, \$7.00; 2nd class, \$12.00; 1st class, \$16.00; complete package, \$25.00. Research Company, 3206 Bailey Street, Sarasota, Florida 33580.

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.



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

TEST-ANSWERS FOR FCC First and Second Class Commercial License

COMMAND PRODUCTIONS P. O. BOX 26348-P
RADIO ENGINEERING DIVISION SAN FRANCISCO, CALIF. 94126

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, 501-H Thirteenth Street N.W., Washington, D.C. 20004.

DO-IT-YOURSELF

FCC First and Second Tests. \$8.95. Electronic Tutoring, Box 24190, Cleveland, Ohio 44124.

PROFESSIONAL ELECTRONICS PROJECTS—\$1.00 up. Catalog 25¢. PARKS, Box 25665A, Seattle, Wash. 98125.

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, Dept. MMW, Tulsa, Oklahoma 74151.

PERSONALS

INVESTIGATORS, Latest Electronics Aids, Free Literature. Clifton, 11500-K NW 7th Ave., Miami, Florida 33168.

INVENTIONS WANTED

MAKE FRIENDS WORLDWIDE through international correspondence. Illustrated brochure free. Hermes, Berlin 11, Germany.

INVENTIONS wanted. Patented; unpatented. Global Marketing Service, 2420-P 77th, Oakland, Calif. 94605.

COMPUTER Dating Explained. Free information, House of Hoke, Box 101-PE, Sebring, Florida 33870.

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.

BOOKS

PATENT Searches including Maximum speed, full airmail report and closest patent copies, \$6.00. Quality searches expertly administered. Complete secrecy guaranteed. Free Invention Protection forms and "Patent Information." Write Dept. 9, Washington Patent Office Search Bureau, 734 15th St. N.W., Washington, D.C. 20005.

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.

MAGAZINES

JAPAN PUBLICATIONS GUIDE Business, pleasure, education. \$8.00. INTERCONTINENTAL, CPO 1717, Tokyo 100-91.

HYPNOTISM

"**MALE-FEMALE** Hypnotism" Exposed, Explained! "Secret Method"—They Never Know! \$2, Rushed. Guaranteed! Isabella Hall, Silver Springs, Florida 32688.

SLEEP learning. Hypnotic method. 92% effective. Details free. ASR Foundation, Box 7545PL, Fort Lauderdale, Florida 33304.

RECORDS

POPULAR organ albums factory direct. Concert Recordings, Lynwood, Calif. 90262.

CHAPEL Records Club—Free catalog. 1000-B Richmond, China Lake, Calif. 93555.

RUBBER STAMPS

RUBBER Address Stamps \$2.00. Signature \$3.50. Free Catalog. Jackson's, Box 443-G, Franklin Park, Illinois 60131.

MAGNETS

COPYRIGHTED Scientific Curiosity—Gold, Lead, Brass, Copper, Aluminum, etc. Will all adhere to a permanent magnet. simple, anybody can do it. Send one dollar for clear photograph and instructions to: Magnets, 114 N. White Street, New Orleans, Louisiana 70119.

EMPLOYMENT INFORMATION

EXCITING Overseas jobs. Directory \$1.00. Research Associates, Box 942-E, Belmont, California 94002.

ELECTRONICS/AVIONICS Employment Opportunities. Report on jobs now open. FREE details. Aviation Employment Information Service, Dept. EW, Box 240, Northport, N.Y. 11768.

SHORTWAVE LISTENING

WORLD RADIO, TV HANDBOOK, 1972 edition. 384 pages. Frequencies, schedules and languages broadcasted on short wave. Still \$6.95. Many other frequency lists. GILFER Associates, Park Ridge, N.J. 07656.

POWER TRANSFORMER SPECIALS

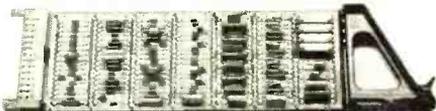
Every electronic project starts with a power supply. Dual primaries, dual secondaries. Makes 12 volt 4 amp. or 24 volt 2 amp. or 48 volt 1 amp. supply.
STOCK NO. F9201 3.50 ea. 3/10.00

Two 12 volt 2 Amp. secondaries. Makes 2 12 volt 2 amp. or 1 12 volt 4 amp. or 1 24 volt 2 amp. supplies.
STOCK NO. F9202 2.95 ea. 2/5.00

42 volt ct. 4 amp. and 18 volt ct. 2 amp. secondaries. Many voltage combinations possible.
STOCK NO. F9250 3.25 ea. 2/6.00

All transformers come with wiring diagram, and several suggested power supplies.

HONEYWELL COMPUTER BOARD



Honeywell Computer boards, 4½"x12". Transistors, diodes, zeners, capacitors, precision resistors, heat sink, trimmers etc. 2 Different boards \$1.00. 3 lb. Stock No. F9082

COMPUTER GRADE CAPACITORS (BRAND NEW)

40,000 mfd. 10 volts 1.25 ea. 6/7.00 Stk. No. F2026
70,000 mfd. 10 volts 1.75 ea. 6/9.00 Stk. No. F2118
6000 mfd. 55 volts 1.50 ea. 7/9.00 Stk. No. F2117
3,750 mfd. 75 volts 1.75 ea. 6/9.00 Stk. No. F2116

MINIMUM ORDER \$3.00

Many other items—send for new 32 page catalog. All merchandise guaranteed. Please include postage. Excess will be refunded.



DELTA ELECTRONICS CO.

BOX 1, LYNN, MASSACHUSETTS 01903

CIRCLE NO. 12 ON READER SERVICE CARD

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.

VARIABLE CAPACITANCE DIODES

(Similar to 1N5463A) used to tune VHF, color TV, & FM broadcast sets. \$1.00

PROGRAMMABLE UJT's

Similar to D13T \$1.75

TTL IC SERIES (DIP)

7441 BCD Decimal Decoder	1.75
7475 Quad Bistable Latch	1.40
7476 Dual Mast-Slave JK FF	1.00
7490 Decade Counter	1.50
7492 Divide By Twelve	1.85
7481 16 bit read/write memory	1.75
7404 Hex Inverter	.40
7447 BCD to seven decoder driver	2.00
74121 Monostable multivibrator	.90
7413 Dual Schmitt-trigger	1.75
7480 Full adder	1.75

T1543 UJT's 2N2819 N channel FET's 45 ELECTRONIC LSI CALCULATORS. Commodore (U.S. made) C108 calculator has an 8 digit readout with a 16 digit round-off. It adds, subtracts, multiplies & divides, has an error correcting button and keyboard rollover memory. 115 230 v power. 2 x 6 1/2 x 9" dimensions. Weights 3 lbs. They are new with a full one year unconditional guarantee \$192.50

TRIACS

PRV 1A 10A 15A 20A*				
100	.40	.70	1.00	1.20
200	.70	1.10	1.50	1.60
300	.90	1.35	1.90	2.00
400	1.10	1.60	2.70	2.40
500	1.50	2.00	3.20	2.80

*Press Fit

Silicon Power Rectifiers

PRV 1A 3A 12A 50A				
100	.06	.09	.30	.85
200	.07	.16	.33	.25
400	.09	.20	.45	1.50
600	.11	.30	.70	1.80
800	.15	.40	.85	2.30
1000	.20	.55	1.10	2.75

Silicon Control Rectifiers

PRV 3A 7A 20A 70A				
50	.25	.32		
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

2N3055 7 amp NPN Silicon Transistor \$1.25

DECADE COUNTER KIT

Consists of:
1-Nixie tube & socket (8754)
1-490
1-7475
1-7441
\$6.75

709C OPER AMP \$.60
741 OPER AMP \$.80
723 VOLTAGE REGULATOR \$1.25

NIXIE TUBES

Similar to Raytheon 8734, with socket & data sheet \$2.25

Terms: FOB Cambridge, Mass. Send check or Money Order. Include Postage. Average Weight package 1 1/2 lb. No C.O.D.'s. Minimum Order \$3.00. Rated companies 30 days net Cambridge, Mass.

Send \$2.00 for our Latest catalog featuring Transistors and Rectifiers; 325 Elm St.,

SOLID STATE SALES

Post Office Box 74A

Somerville, Mass. 02143

Tel. (617) 547-4005

CIRCLE NO. 41 ON READER SERVICE CARD

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-PEL, Box 248, Walnut Creek, California 94597.

FREE CATALOGS. Repair air conditioning, refrigeration. Tools, supplies, full instructions. Doolin, 2016 Canton, Dallas, Texas 75201.

INEXPENSIVE, Home—Auto Fire, Burglar Alarms, Extinguishers. 200% Profits. Nation's Watchdog, Williamsburg, Ohio 45176.

PIANO TUNING learned quickly at home. Tremendous field! Musical knowledge unnecessary. GI Approved, Information Free. Empire School, Box 327, Miami Florida 33145.

MAILORDER MILLIONAIRE helps beginners make \$500 weekly. Free report reveals secret plan! Executive (1K4), 333 North Michigan, Chicago 60601.

FREE BOOK "999 Successful, Little-Known Businesses." Work home! Plymouth BGD, Brooklyn, New York 11218.

MAILORDER—How to prepare your own catalog for pennies. Free catalog! Obie-BGC, Brooklyn, New York 11219.

MAKE \$25,000 with new mailorder plan! Quick, remarkable results! Only \$3! Guaranteed! Limited offer! order now!! Goldco, Box 1749, New York City 10022.

BE your own boss. Manufacture your product. free report write. Simpson (4E4) 10014 South Paxton, Chicago 60617.

REAL ESTATE

FREE . . . BIG . . . 256-page CATALOG! Describes and pictures hundreds of farms, ranches, town and country homes, businesses coast to coast! Specify type property and location preferred. UNITED FARM AGENCY, 612-EP West 47th St., Kansas City, Mo. 64112.

TREASURE FINDERS

TREASURE FINDER locates buried gold, silver, coins, treasures. 5 powerful models. \$19.95 up. Free catalog. Relco-A33, Box 10839, Houston, Texas 77018.

FREE: Jetco Electronics 24-page Treasure Finder Catalog. Find Gold, Silver, Coins, Metals, Minerals, relics. Jetco, Dept. PEC, 3933 Barranca, El Paso, Texas 79935.

FISHER DETECTORS. You deserve the best! Free literature, FRI, Dept. PE-4, P.O. Box 490, Belmont, CA 94002. Since 1932.

TREASURE Hunters! Prospectors! Rockhounds! Hobbyists! Find gold, silver, relics with world famous Detectors Metal Detectors. Free information. Delivery immediate. Detectors, Dept. 4-PE Box 243, San Gabriel, Calif. 91778.

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.

MUSIC

SONGS — POEMS

Wanted for publishing and recording consideration.

Accepted songs will be published & recorded at our expense - for information write to Talent, 17-PE Longwood Rd., Quincy, Ma. 02169

POEMS & LYRICS OF RELIGIOUS, REVERANT & INSPIRED NATURE WANTED FOR IMMEDIATE RECORDING WE ARE ONLY INTERESTED IN SONGS OF HOPE, GOD'S LOVE, THE COMFORT OF HIS WORDS AND WISDOM. SEND TO:

CATHEDRAL RECORDING CO.
P.O. BOX 78, STUDIO PE
NO. WEYMOUTH, MASS. 02191

MUSICAL INSTRUMENTS

30% DISCOUNT name brand musical instruments. Free catalog. Freeport Music, 127-N Sunrise Highway, Freeport. N.Y. 11520.

WHOLESALE! Professional Amplifiers, PA Systems, Guitars. Free Catalog. Carvin, Escondido, Calif. 92028

ORGAN OWNERS AND BUILDERS GET THE FACTS about Electronic and Pipe Organs, kits and accessories. Send \$2.00 for new book "ORGAN BUILDING FOR FUN AND PROFIT," By Robert L. Eby. FREE parts catalog included. Newport Organs, Dept A, 846 Production Place, Newport Beach, Calif. 92660.

MOVIE FILMS

PRO SPORTS FILMS of your choice for Home Entertainment—200 titles, 50¢ Catalog. \$1.00 off on first purchase. Super 8/Reg. 8; Color/B&W. **SPORTLITE**, Elect. Dept., 20 N. Wacker Drive, Chicago, Illinois 60606.

MISCELLANEOUS

WINEMAKERS: Free illustrated catalog yeasts, equipment. Semplex, Box 12276, Minneapolis, Minn. 55412.

GUIDE TO EARNING EXTRA INCOME

A Ziff-Davis Publication



All new—first time ever published! Everything you need to know about full and part time money-making. How to start your own mail order business • 22 proven and profitable home business ideas • How to earn extra \$'s • Franchising • Vending machines • Advice on cutting living costs. Only 75¢.

Order from Ziff-Davis Service Division,
595 Broadway, New York, New York 10012.

Enclose an additional 25c for postage and handling.

YOUR Classified or Display Classified Ad in these columns will be seen, read and regularly responded to by America's largest audience comprising Electronics Professionals and Hobbyists. Cost is low, results high. Send copy and payment now!

DELUXE

MAGAZINE CASES

Designed Exclusively for
POPULAR ELECTRONICS

● The ideal way to save your valuable copies, keep them well protected and make it easy for you to refer to any issue at any time. This bold new design is both decorative and attractive enough to enhance the decor of any room. Each case holds a full year's copies.

Constructed of reinforced fiberboard, these tough and durable cases are covered in a rich textured, leather-like fabric. The gold embossed back adds to its elegance and makes each case a welcome addition to your bookshelf, end table, desk—or for that matter, anywhere in your home or office.

In addition to Popular Electronics, cases are available for any of your favorite magazines. They're only \$3.95 each, 3 for \$11.00, 6 for \$21.00, in any combination of titles ordered. Add 50c per order for postage and handling. Outside U.S.A. add \$1.00 per case ordered.

Ziff-Davis Pub. Co., Dept. 23, 1 Park Ave., N.Y., N.Y. 10016

Enclosed is \$_____. Please send Magazine Cases for the titles indicated below @ \$3.95 each, 3 for \$11.00, 6 for \$21.00. Add 50c per order for postage and handling. Outside U.S.A. add \$1.00 per case ordered. PE-472

TITLE	QUANTITY
POPULAR ELECTRONICS	_____
_____	_____
_____	_____

Check One: All Black Maroon Back • Black Sides

Print Name _____

Address _____

City _____ State _____ Zip _____

PAYMENT MUST ACCOMPANY ORDER

POPULAR ELECTRONICS

Including Electronics World

APRIL 1972

ADVERTISERS INDEX

READER SERVICE NO.	ADVERTISER	PAGE NO.
1	Acoustic Research, Inc.	87
2	Allied Radio Shack	8
3	Allied Radio Shack	90
4	Antenna Specialists Co., The	14
5	B. & F. Enterprises	103
10	B & K Division, Dynascan Corporation	99
8	BSR (USA) Ltd.	67
9	Bose	11
CREI, A Division of the McGraw-Hill		
	Continuing Education Company	13, 38, 39, 40, 41
6	Cleveland Institute of Electronics	18, 19, 20, 21
7	Cobra Communications, Dynascan Corporation	27
11	Crystek	98
12	Delta Electronics Co.	107
18	Delta Products, Inc.	17
14	EICO	72
15	EICO	73
16	Edmund Scientific Co.	110
17	Edsyn	82
13	Electro-Voice, Inc.	FOURTH COVER
19	Electronics and Control Engineers' Book Club	7
21	Gregory Electronics Corp.	101
22	Heath Company	92, 93, 94, 95
23	Jermyn	87
24	Johnson Company, E. F.	9
25	Judson Research and Mfg. Co.	90
26	Lafayette Radio Electronics	83
27	Lee Electronic Labs., Inc.	98
28	Liberty Electronics, Inc.	100
29	McIntosh Laboratory, Inc.	97
30	Mallory Distributor Products Company	85
	National Radio Institute	SECOND COVER, 1, 2, 3
	National Technical Schools	74, 75, 76, 77
31	Nortronics Company, Inc.	88
32	Olson Electronics	69
35	PTS Electronics, Inc.	63
33	Pickering & Co., Inc.	12
34	Poly Paks	105
	RCA Institutes, Inc.	56, 57, 58, 59
36	S B E	97
37	Sams & Co., Inc., Howard W.	15
38	Schober Organ Corp., The	73
39	Sescom, Inc.	83
40	Shure Brothers, Inc.	24
41	Solid State Sales	108
42	Solid State Systems, Inc.	106
43	Sonar Radio Corp.	86
44	TDK Electronics Corp.	89
45	Tescom Corporation	82
	U.S. Army	22, 23
46	Utah Electronics Division	91
47	Valparaiso Technical Institute	72
	CLASSIFIED ADVERTISING	100, 101, 102, 104, 105
		106, 107, 108, 109



LIVE IN THE WORLD OF TOMORROW... TODAY! NEW PRODUCTS, NEW MATERIALS, NEW IDEAS!
UNUSUAL ECOLOGICAL SCIENCE BUYS
UNIQUE HARD-TO-FIND BARGAINS FOR FUN, STUDY OR PROFIT

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.

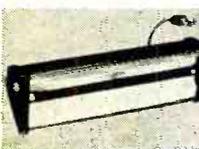
Stock No. 70.003AV \$10.75 Ppd.
 4 1/4" dia. x 3 3/4"
 Stock No. 70.004AV \$16.95 Ppd.
 6" dia. x 4"
 Stock No. 70.005AV \$24.50 Ppd.
 8" dia. x 5"
 Stock No. 70.006AV \$44.50 F.O.B.
 10" dia. x 13 1/4" 30 lbs
 Stock No. 7D.007AV 12 1/2" dia. x 2 1/2" 46 lbs \$72.50 F.O.B.

\$8.95 ELECTRONIC STROBE



Hand-sized solid state electronic strobe light at fantastically low price. Produces bright psychedelic effects like jangle, far more expensive Xenon strobes, yet it's just 254 X 4 X 134" thick. Adjustable flash rate, approximately 3-10 flashes per second. Make stop motion effects, posters come alive. Great to take with you to parties, dances, outings, etc. Requires 2 or transistor batt. (not incl.). Instructions. Stock No. 41.443AV \$8.95 Ppd.
 4 REPLACEMENT LAMPS 1.00 Ppd.
 P-41.444AV

BLACK-LIGHT MIGHTY MITES



Relatively small (12") fixtures give surprisingly bright black-light. Mirror-finished reflector makes instant starting. 8-watt, high-intensity bulb look like 40-watter. Up to 5,000 hours of safe, long-wave (3660Å) black-light to really turn on parties, light & theatrical shows, psychedelic decors, holiday decorations. Shockproof end-caps remove for safe, easy replacement of bulb and starter. Stands upright or horizontal. Aluminum case. Stock No. 71.274AV \$14.95 Ppd.
 DELUXE OUTDOOR INDOOR MODEL
 Stock No. 71.299AV \$19.95 Ppd.

UNIQUE LIGHTING HANDBOOK



100 information packed pages! Fully explains latest in psychedelic lighting equipment, techniques, developments. Covers all facets of psychedelic light-show production including strobes, black lights, projectors, crystals, organic slides, mirrors, color organs, polarized color, light boxes, MusicVision, etc. Shows how to "psychedelize" parties, musical groups, shows or how to set up "electric trips" for private gatherings. 8 1/2" X 11" looseleaf paper for 3 rings. Stock No. 9100AV \$3.00 Ppd.

HELIUM BALLOONS MAKE A "BALL"



Anytime there's a balloon the air is festive. Especially when the "air" is helium which makes a balloon perky and adventurous. Now here's 25 times the fun—25 various colored balloons of 4, 6, or 8" diameter when inflated. With them, a pressurized 300 lbs./sq. in. can containing 21 liters of helium to inflate all 25. For adults or kids' parties, give-aways, bazaars or just demonstrating "lighter than air". Helium is a safe non-toxic inert gas. Stock No. 71.289AV \$3.00 Ppd.



MAIL COUPON FOR GIANT FREE CATALOG!

148 PAGES • MORE THAN 4000 UNUSUAL BARGAINS!

Completely new Catalog. Packed with huge selection of telescopes, microscopes, binoculars, magnets, magnets, prisms, photo components, ecology and Unique Lighting items, parts, kits, accessories—many hard-to-get 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 _____

TREMENDOUS WAR SURPLUS VALUE in excellent condition. Mark 57, Mod O, 1-meter Erect Image Coincidence Rangefinder—ranges from 100-10,000 yds. accurate to 12-arc seconds. Optics & mount alone worth more than price. Erect image precision optical instrument. 5 1/2" X 7" dia. Yellow, dark neutral, polarizing & clear ray glass filters. Non-magnetic construction. 2 bearing mounting surfaces (1 1/4 X 5/8" O.D. & 1 1/4 X 5 1/2" O.D.). Storage box, instrs. Stock No. 85.208AV (Shipp. Wt.—200 lbs.) \$450.00 F.O.B.
\$1,250 HAND HELD 50 CM MODEL
 No. 85.213AV (Shipp. Wt.—11 lbs.) \$600.00 F.O.B.

\$15,000 RANGEFINDER



LOW-COST DISSOLVE UNIT



Adds professionalism to Light Shows or A.V. presentations. Permits synchronized control of 2 projectors for dramatic fade-in, fade-out, smooth dissolves. Eliminates eye-focusing blurring. Designed for Kodak Carousel and Ektagraphics slide projectors. Unit (3 X 3 1/4 X 8 3/4") permits cool, showing of up to 280 slides, 110-120v, 60 Hz. Cord & instructions. Stock No. 71.567AV \$71.50 Ppd.
VERSATILE DELUXE AUTO UNIT
 Stock No. 71.563AV \$202.00 Ppd.

HI-VOLTAGE ELECTROSTATIC GENERATOR

Van De Graaf low-amperage, 200,000 volt potential, yet completely safe. Demonstrates lightning, St. Elmo's fire, repulsion of charges, electrostatic dust collection, many other electrical wonders. Meter, 110v, 60 cycle, AC. Humidity range, 0-60%. Current 1 to 2.5 microamps. Aluminum base, frame and charge collector. Unbreakable plastic insulating column, 17" height, 6 3/4" diam. Full instructions. Stock No. 70.264AV \$53.75 Ppd.
STARTER SAFETY GENERATOR
 Stock No. 70.070AV \$19.50 Ppd.



Go treasure hunting on the bottom! Fascinating fun & sometimes profitable! Tie a line to our 3 lb. Magnet—drop it overhead in bay, river, lake or ocean. Trawl it along bottom—you "treasured" haul can be outboard motors, anchors, other metal valuables, 3 1/2-lb. Magnet is war surplus—Alnico V type—Gov't. cost \$30. Lifts over 150 lbs. on land—much greater weights under water. Stock No. 70.751AV 5 1/2 lbs. \$14.00 Ppd.
 No. 60.215AV 1 1/2 lbs. \$5.75 Ppd.
 Stock No. 70.570AV 3 1/2 lbs. (40 lbs.) \$8.75 Ppd.
 Stock No. 85.152AV 15 3/4 lbs. (30 lbs.) \$33.95 F.O.B.

"FISH" WITH A MAGNET



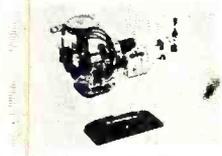
NEW! ELECTRONIC DIGITAL COMPUTER KIT!

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—do your own programming after completing simplified 116 page instructive booklet. Includes step-by-step program diagrams. Circuits easily changed. Readout from illuminated control panel. Icc. 2 1/2" batt. (not incl.). Best model we've seen—for home, school, industry. Stock No. 71.434AV (11" X 12 1/2" X 4") \$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 Gai, recently paid \$70 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, slide shift on-off switch. Req. 2—1.5V batt. (not incl.). Stock No. 71.424AV (4 1/2" X 5" X 9") \$6.75 Ppd.



44 COLOR FILTER SHEETS, BOOK FORM

Cover entire color range from frost through violets, blues, greens, yellows and reds. Ideal for photographers, artists, teachers, hobbyists, experimenters, science & industry. Heavy gauge acetate. 0.01 thick. Moisture proof, heat resistant. Loose leaf form, sheets easily removed for single or multi-color overlays. Stock No. 70.638AV (8" X 10") \$21.00 Ppd.
 Stock No. 60.403AV (5" X 8") \$11.25 Ppd.



EDMUND SCIENTIFIC CO. 300 EDSCORP BLDG. BARRINGTON, NEW JERSEY 08007

CIRCLE NO. 16 ON READER SERVICE CARD

ORDER BY STOCK NUMBER • SEND CHECK OR MONEY ORDER • MONEY-BACK GUARANTEE

Printed in U.S.A. POPULAR ELECTRONICS Including Electronics World

READER SERVICE

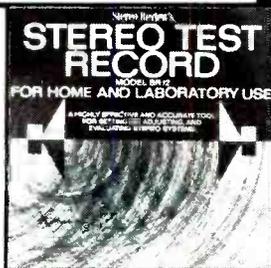
FREE INFORMATION

Announcing the *NEW STANDARD*
in Stereo Testing!

The All-New Model SR12 STEREO TEST RECORD

The most complete...
most sophisticated...
most versatile Test Disc
available today...

For Just \$5⁹⁸!



Who needs the New Model SR12? You do. Whether you're an avid audiophile, a casual listener, or a professional technician . . . the new MODEL SR12 will be the most important disc in your entire collection. MODEL SR12 has been produced by Stereo Review Magazine for music lovers who want immediate answers to questions about the performance of their stereo systems and how to get the best possible sound reproduction. It is the most complete test record of its kind—containing the widest range of checks ever included on one test disc.

Make these important stereo checks **BY EAR** . . . (no test instruments required)

• Frequency response • Separation • Cartridge tracking • Channel balance • Hum and rumble • Flutter • Cartridge and Speaker Phasing • Anti-Skating Adjustment • "Gun Shot Test" for Stereo Spread • Multi-purpose Musician's "A" • Equal-tempered Chromatic Octave • Guitar-tuning Tones.

Attention professionals: For the ultimate in stereo testing, 7 critical **TEST EQUIPMENT** checks . . .

- 1,000-Hz square waves to test transient and high-frequency response of phono pickups.
- 500 to 20,000 Hz frequency-response sweep.
- Sine-wave tone-bursts to test transient response of pickup.
- Intermodulation test using simultaneous 400-Hz and 4,000-Hz signals.
- Intermodulation sweep to show distortion caused by excessive resonances in tone arm and cartridge.
- 1,000-Hz reference tones to determine groove velocity.
- 3,000-Hz tone for flutter and speed tests.

Sample waveforms—illustrating both accurate and faulty responses are provided in the Instruction Manual for comparison with the patterns appearing on your own oscilloscope screen.

FREE Instruction Manual Includes Detailed Instructions, Charts, Tables and Diagrams

ONLY \$5.98 POSTPAID
SEND NO MONEY

Use the postage-paid order card located at the top of the flap to the right to order your record. In the event the card has already been detached you can also place your order by circling #110 on the information Service Card below. Either way, your selection will be mailed to you along with an invoice for the regular price of only \$5.98 for each record ordered, postpaid.

SR12 Stereo Test Record—Circle #110

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.

A report in the 4-channel war of the matrixes: **The war is over!**



And (unlike real wars) everybody has won. Columbia Records has announced release of encoded 4-channel records. And because support from major record companies

is essential to 4-channel, we welcome them. Columbia now joins the many pioneering record manufacturers who've already produced thousands of 4-channel discs.

We must admit that at first we were concerned. Because while most of the original matrixes were basically compatible, these new SQ discs were different. Which could have led to a battle of the matrixes and even more confusion in the marketplace.

But we knew our matrixing system was best, so what to do about this promised flood of seemingly incompatible discs? The answer: a new "universal" E-V decoder now in production. Not only does this improved decoder handle our STEREO-4™ (and all similarly-encoded material) but we've added sophisticated circuitry to decode SQ records accurately. It even does some things decoders built solely for the SQ format don't, like more correctly controlling the position of a front-center soloist.

So, now the E-V Decoder is the only one for all matrix 4-channel programs. And now —

more than ever — matrixing (encoding four channels of sound into two) continues to grow as the method to get 4-channel sound on records, FM, and tape to the listener... now and in the foreseeable future.

What about our "old" EVX-4 Decoder? Well, despite the algebra, it actually decodes SQ records remarkably well. It just doesn't offer complete rear directionality from these different discs. But unless it is directly compared with our improved decoding this has proved a minor issue for many listeners.

In addition we doubt that independent record companies will give up the advantages of STEREO-4 encoding in favor of the SQ system. Because the "new" decoder is more complex — hence more expensive — we'll continue to sell both models. One of them is for you!

But having now created the "universal" decoder we're not resting on our laurels. We're going on to refine it in future models with such features as gain riding to make it by far the best circuit in the industry.

So, hopefully, order is restored. Record companies can get on with software in increasing numbers using any matrixing system they prefer... while you begin to really enjoy the fruits of all our labors.

Peace.

THE **EV STEREO-4** FOUR-CHANNEL FAMILY OF PRODUCTS



EVX-4 Stereo-4 Decoder



E-V 1244X Combined Stereo Amplifier/Decoder



New Universal Decoder



EVR-4X4 AM/FM Stereo 4-Channel Receiver

ELECTRO-VOICE, INC., Dept. 424P, 630 Cecil Street, Buchanan, Michigan 49107
In Canada: EV of Canada, Ltd., 345 Herbert Street, Gananogue, Ontario
In Europe: Electro-Voice, S.A., Lyss-Strasse 55, 2560 Nidau, Switzerland

Electro-Voice™

a GULTON subsidiary

CIRCLE NO. 13 ON READER SERVICE CARD

www.americanradiohistory.com