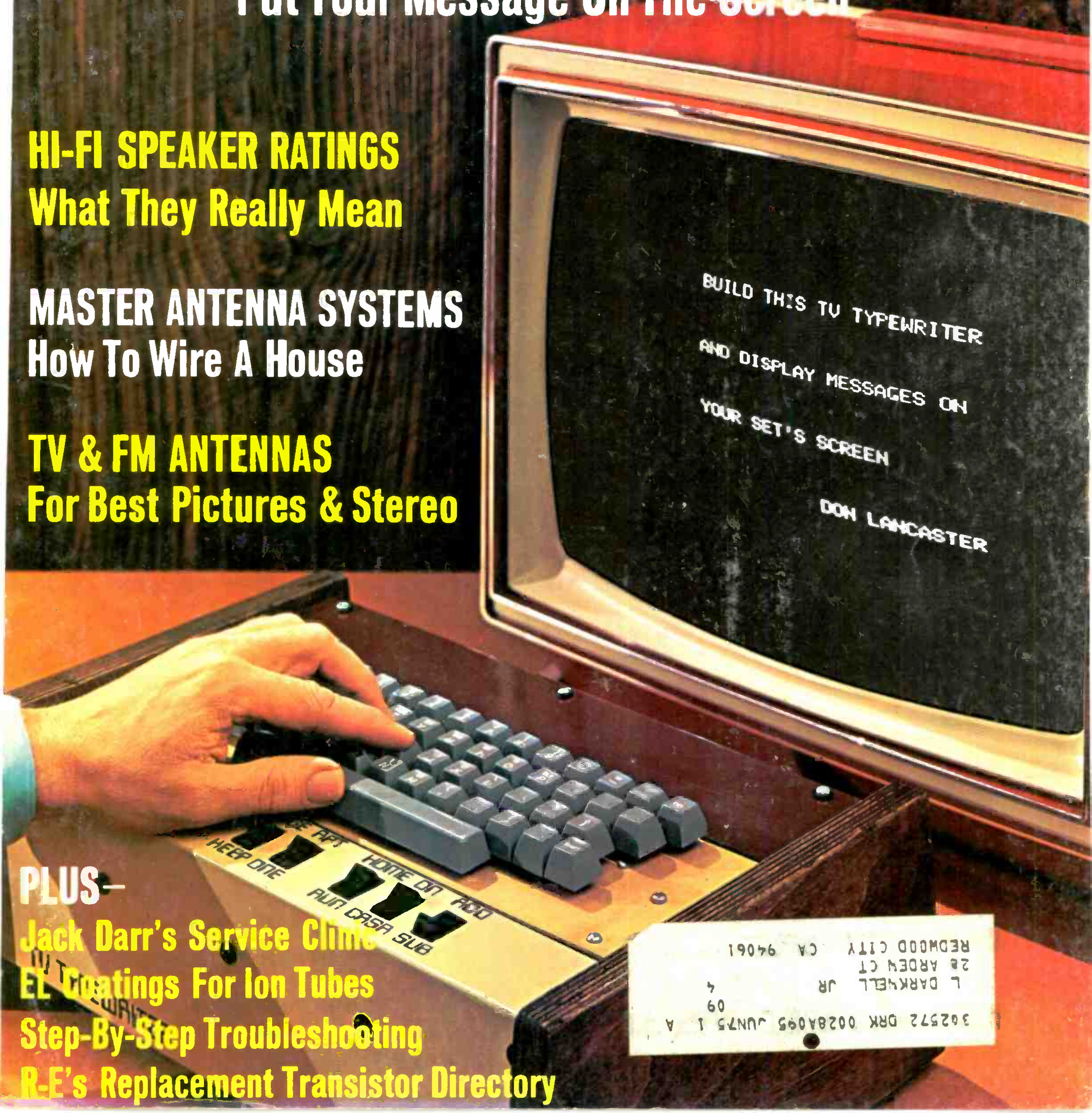
60c ■ SEPT. 1973

# Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

## BUILD A TV TYPEWRITER
Put Your Message On The Screen




## HI-FI SPEAKER RATINGS
What They Really Mean

## MASTER ANTENNA SYSTEMS
How To Wire A House

## TV & FM ANTENNAS
For Best Pictures & Stereo

PLUS–
- Jack Darr's Service Clinic
- EL Coatings For Ion Tubes
- Step-By-Step Troubleshooting
- R-E's Replacement Transistor Directory

*Circle 1 on reader service card*

# One–or more–of these Sams books may make life easier for you.


Sams is the nation's leading publisher of authoritative technical books and service manuals for electronics servicemen and technicians. Ten of their newest time-saving and problem-solving texts and references are shown here. Send for the ones that can help you—and for the free 1973 Sams Catalog, too.





**COLOR-TV FIELD-SERVICE GUIDE—Vol. 4**
**by The Howard W. Sams Engineering Staff**
The latest in Sams authoritative series of guides for use while servicing color television in the customer's home. It covers over 1800 models made between 1970 and 1972, with detailed chassis layouts, adjustment procedures, schematics, etc. A real time-saver.
**No. 20953 $4.95**

**COLOR-TV SERVICING MADE EASY—Vol. 3**
**by Wayne Lemons and Carl Babcoke**
Covers the many advances and introductions made by the industry since publication of the first two volumes. Update your knowledge and skills with its full coverage of such innovations as high-voltage regulators, "fail-safe" circuits, atc circuits, etc., as well as its coverage of new chassis series and circuitry from the leading manufacturers.
**No. 20875 $6.95**

**TRANSISTOR SPECIFICATIONS MANUAL—6th Edition**
**by The Howard W. Sams Engineering Staff**
Lists the electrical and physical parameters, along with the manufacturers of over 12,000 transistor types. Gives complete data for every specification you'll require, and includes dimensional drawings for non-standard cases. An invaluable, time-saving aid.
**No. 20974 $4.50**

**TRANSISTOR SUBSTITUTION HANDBOOK—13th Edition**
**by The Howard W. Sams Engineering Staff**
This updated guide lists well over 100,000 substitutions that can be safely made in replacing transistors. All substitutes were selected by computer following over a billion comparisons of data. Accurate, complete, even to the inclusion of manufacturers' recommendations for general replacement transistors.
**No. 20954 $2.95**

**AUTOMOBILE ELECTRONICS SERVICING GUIDE**
**by Joseph J. Carr**
Covers the servicing of am and fm car radios, cassettes, eight-track cartridges, pushbutton, manual and signal-seeking tuners in complete detail. Presents the knowledge needed to do an increasingly more complicated job with confidence.
**No. 20927 $4.95**

**TRANSISTOR RADIO SERVICING MADE EASY—3rd Edition**
**by Wayne Lemons**
Step-by-step explanations of how to find and repair the faults causing a weak, dead, noisy or squealing radio. A completely practical book that enables you to repair transistor radios including fm with maximum profit.
**No. 20976 $4.50**

**1-2-3-4 SERVICING TRANSISTOR CB & TWO-WAY RADIO**
**by Forest H. Belt**
Following the highly popular 1-2-3-4 method of finding and fixing trouble in electronic equipment, this new book provides the knowledge that enables you to service both CB and commercial two-way radios, logically and quickly.
**No. 20965 $5.25**

**FOUR-CHANNEL SOUND**
**by Leonard Feldman**
If you are faced with working on a four-channel set, converting one, or you just want to learn more about this newest development in sound recording and listening—this book contains the information you need.
**No. 20966 $4.50**

**QUESTIONS AND ANSWERS ABOUT PAY TV**
**by Ira Kamen**
Pay tv is with us for "keeps" and is well financed by business and the motion picture industry. Electronics technicians will want to know as much as they can about this growing entertainment service. This book fully answers their questions.
**No. 20971 $4.95**

**BUILDING & INSTALLING ELECTRONIC INTRUSION ALARMS**
**by John E. Cunningham**
This is a fast-growing new field for the electronics serviceman, and this new book covers it fully. Many practical, tested circuits you can build. Included are chapters on electromechanical alarms, sensors and switches; audio and vibration alarms, photoelectric, proximity and ultrasonic alarms; closed-circuit television, auto protection, etc.
**No. 20929 $4.50**

RE 093

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

Order from your Electronics Parts Distributor, or mail to Howard W. Sams & Co., Inc.
Send books checked at right. $______ enclosed.
Please include sales tax where applicable.
☐ Send FREE 1973 Sams Book Catalog.

| | |
|---|---|
| ☐ 20953 | ☐ 20976 |
| ☐ 20875 | ☐ 20965 |
| ☐ 20974 | ☐ 20966 |
| ☐ 20954 | ☐ 20971 |
| ☐ 20927 | ☐ 20929 |

Name ________________
(Please print

Address ________________

City________ State ________ Zip________

*Circle 2 on reader service card*

# Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

SEPTEMBER 1973



**BUILD ONE OF THESE**

43 **TV Typewriter**
A unique construction project that puts printed messages on any TV screen. ***by Don Lancaster***

53 **More Synthesizer Modules**
This time there's an envelope generator and a control oscillator with a built-in noise source.
***by John S. Simonton, Jr.***

98 **Build WWVB Receiver**
Part II—Final details. ***by Don Lancaster***

**TELEVISION**

28 **Equipment Report**
Castle Tuner Subber Mark IV

33 **Wire A House—For MATV**
Multiple set ownership leads to small master antenna systems for private homes. Here's how to do it.
***by Eugene Walters***

40 **TV & FM Antennas**
How to determine the best one for you.
***by Forest Belt***

68 **Step-By-Step Troubleshooting**
Flybacks and deflection yokes in vacuum-tube circuits.
***by Stan Prentiss***

73 **Service Clinic**
Noise in the picture. ***by Jack Darr***

78 **Reader Questions**
R-E's Service Editor solves reader problems.

**SOLID-STATE ELECTRONICS**

65 **State-Of-Solid-State**
New IC's and SCR's. One is a monostable multivibrator for automobile tach's and speedometers. ***by Lou Garner***

70 **R-E's Transistor Replacement Guide**
220 more transistors and their replacements are listed in this issue. ***by Robert & Elizabeth Scott***

95 **Solid-State Quiz**
***by Jud Williams***

**STEREO HI FI AUDIO**

30 **Equipment Report**
Shure VR 15-III cartridge

62 **Speaker Ratings—What Do They Mean**
It depends—this story tells which ones don't mean much, and why. It also recommends a set of meaningful specs.
***by Leonard Feldman***

**GENERAL ELECTRONICS**

4 **Editorial**
Merger—one association of all.

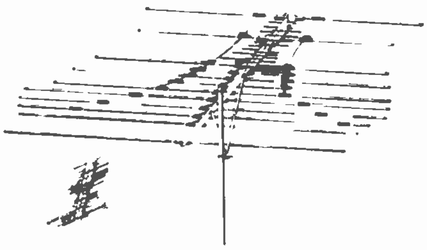
6 **Looking Ahead**
Tomorrow's news today. ***by David Lachenbruch***

60 **Ion Plasma Tube Coatings** A "magical" coating that makes it go. ***by James C. Gupton***

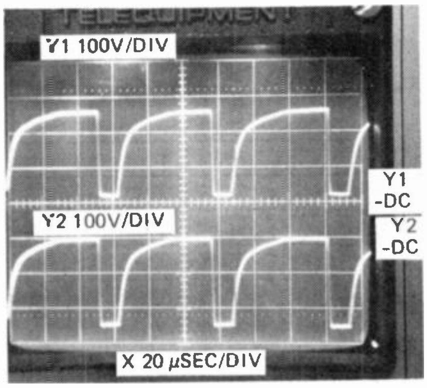
89 **Appliance Clinic**
"For beginners only." ***by Jack Darr***

**DEPARTMENTS**

99 **Books**
100 **Circuits**
22 **Letters**
12 **New & Timely**
87 **New Literature**
84 **New Products**
91 **Next Month**
111 **Reader Service Card**
96 **Try This**

**TV ANTENNA** by GC Electronics is just one of many new models to be described in this issue. To bring yourself up to date on the latest antennas . . . . **turn to page 40**




**STEP-BY-STEP** troubleshooting is easier if you use your scope. This is one of the waveforms you'll find while testing sweep circuits.
. . . . **turn to page 68**



Cover photograph by Walter Herstatt
Cover design by Marius Trinque


**Radio-Electronics** is indexed in *Applied Science & Technology Index and Readers Guide to Periodical Literature.*

**Radio-Electronics,** September 1973, Vol. 44, No. 9. Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York City 10003. Second-class postage paid at New York, N. Y. and additional mailing office. One-year subscription rate: U.S.A., U.S. possessions and Canada, $7. Pan-American countries, $8. Other countries, $8.50. Single copies 60¢.




**Subscription Service:** Mail all subscription orders, changes, correspondence and Postmaster Notices of undelivered copies (Form 3579) to Radio-Electronics Subscription Service, Boulder, Colo. 80302.

# editorial

## *MERGER—one association for all*

Today there are two great, but separate, associations whose membership is made up of electronic service technicians. Both of these associations are totally dedicated to their membership. Both frequently fight the same battles. Both champion the service technician. Both strive to improve the professional image of the service technician. Both work to make the service technician better trained—better trained as a businessman as well as better trained in his chosen profession.

When these associations raise their voices to pursue a course of action, there are two separate voices—two medium-powered voices. Two voices that separately are, all too often, easily ignored.

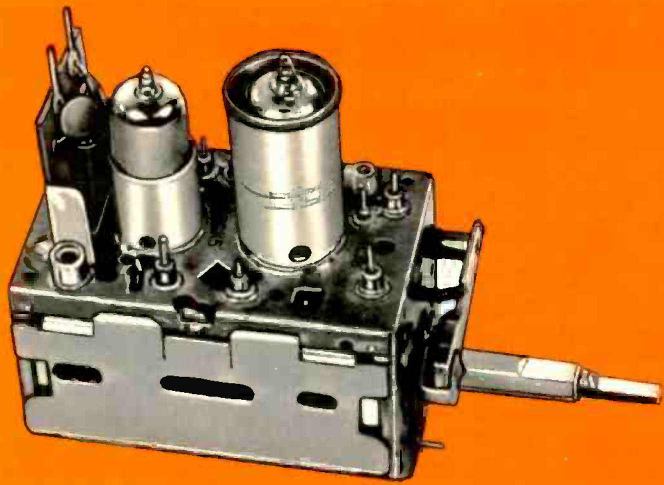
Merger would create one new, large association. It would be a giant. It would speak like a giant and would become a major influence in the betterment of the service technician.

At the joint convention in Kansas City this month (August 21st to August 26th), the membership of the two present associations will be meeting at the Crown Center Hotel. At this meeting, they will be presented with a report by the merger committee—organized one year ago in New Orleans.

I have studied the merger committee report and feel that merger represents the proper action for the membership to take. When the votes are counted, I hope they will add up to MERGER-YES!

If you are a member of NATESA or NEA, attend the convention. Let your voice be heard. Help forge your new association.

**—Larry Steckler,** CET, Editor.



# $9.75

**ALL PARTS INCLUDED**

except tubes and transistors

**ONE YEAR GUARANTEE**

# TUNER SERVICE CORPORATION

## PROVIDES YOU WITH A COMPLETE SERVICE FOR ALL YOUR TELEVISION TUNER REQUIREMENTS.

## REPAIR

VHF Or UHF Any Type $9.75.
UHF/VHF Combo $15.00.

In this price all parts are included. Tubes, transistors, diodes, and nuvistors are charged extra.

Fast efficient service at our conveniently located service centers. This price does not cover mutilated tuners.

All tuners are cleaned ultrasonically, repaired, realigned and air tested.

## REPLACE

Universal Replacement Tuner $9.75.

This price buys you a complete new tuner built specifically by SARKES TARZIAN INC. for this purpose.

All shafts have a maximum length of 10″ which can be cut to 1½″.

Specify heater type parallel and series 450mA or 600mA.

## CUSTOMIZE

Customized tuners are available at a cost of only $15.95. **(With trade-in $12.95)**

Send in your original tuner for comparison purposes to:

**TSC**

WATCH US GROW

## TUNER SERVICE CORPORATION

*FACTORY-SUPERVISED TUNER SERVICE*

**Backed by the largest tuner manufacturer in the U.S.—SARKES TARZIAN, Inc.**

| | | | |
|---|---|---|---|
| HEADQUARTERS | BLOOMINGTON, INDIANA 47401, | 537 South Walnut St. | Tel: 812-332-7251 |
| ARIZONA | TUCSON, ARIZONA 85713, | 1528 S. 6th St. | Tel: 602-791-9243 |
| CALIFORNIA | BURLINGAME, CALIFORNIA 94010, | 1324 Marsten Road | Tel: 415-347-5728 |
| CALIFORNIA | MODESTO, CALIFORNIA 95351, | 123 Phoenix Ave. | Tel: 209-521-8051 |
| CALIFORNIA | NORTH HOLLYWOOD, CALIF. 91601, | 10654 Magnolia Blvd. | Tel: 213-769-2720 |
| FLORIDA | TAMPA, FLORIDA 33606, | 1505 Cypress St. | Tel: 813-253-0324 |
| GEORGIA | ATLANTA, GEORGIA 30310 | 938 Gordon St., S.W. | Tel: 404-758-2232 |
| ILLINOIS | CHICAGO, ILLINOIS 60621, | 741 W. 55th St. | Tel: 312-873-5555-6-7 |
| INDIANA | INDIANAPOLIS, IND. 46204. | 817 N. Pennsylvania St. | Tel: 317-632-3493 |
| INDIANA | HAMMOND, INDIANA 46323, | 6833 Grand Ave. | Tel: 219-845-2676 |
| KENTUCKY | LOUISVILLE, KENTUCKY 40208, | 2920 Taylor Blvd. | Tel: 502-634-3334 |
| NEW JERSEY | JERSEY CITY, NEW JERSEY 07307, (On U.S. Highway 1 & 9) | 547-49 Tonnele Ave. | Tel: 201-792-3730 |
| OHIO | CINCINNATI, OHIO 45216, | 7450 Vine St. | Tel: 513-821-5080 |
| OHIO | CLEVELAND, OHIO 44109, | 4597 Pearl Road | Tel: 216-741-2314 |
| OREGON | PORTLAND, OREGON 97210, | 1732 N.W. 25th Ave. | Tel: 503-222-9059 |
| TENNESSEE | GREENVILLE, TENNESSEE 37743, | 1215 Snapps Ferry Rd. | Tel: 615-639-8451 |
| TENNESSEE | MEMPHIS, TENNESSEE 38114, | 1703 Lamar Ave. | Tel: 901-278-4484 |
| TEXAS | DALLAS, TEXAS 75228, | 11540 Garland Rd. | Tel: 214-327-8413 |
| VIRGINIA | NORFOLK, VIRGINIA 23502, | 4538 Princess Ann Road | Tel: 703-855-2518 |

***Franchises available—Contact headquarters.***

*Circle 4 on reader service card*

# looking ahead

## Videodisc ready

**Montreux, Switzerland**—An unscheduled attraction at the biennial International Television Symposium here was a demonstration of the first consumer videodisc system from actual pilot production. The demonstration was held by Telefunken of Germany, Decca of Great Britain and Teldec, their jointly owned phonograph record-producing subsidiary.

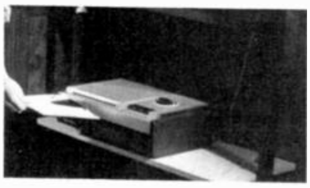
As already described in **Radio-Electronics**, the system uses a "pressure pickup" technique. The thin, flexible disc rides on a cushion of air,


**PHILIPS VIDEODISC is brightly silvered optical type used in their laser TV disc system.**

and the pickup translates embossed "hill-and-dale" impressions into electrical impulses. The player itself, scheduled for marketing in Germany, is about the size of a component turntable—which it doesn't resemble at all.

The player has three pushbuttons, a timing dial and a slot—everything else is enclosed. The eight-inch videodiscs are enclosed in two paper sleeves. The outer one is removed and the disc inserted in the slot with the inner sleeve still in place. The flexible disc is fed around a roller, the sleeve removed. The disc then is played automatically and is returned to the operator through the slot, once again in its inner sleeve.

Each disc plays for 10 minutes, in color, revolving at 1,500 rpm (speed for the U.S.



**PAPER-JACKETED disc is inserted in slot of compact Telefunken-Decca developed videodisc player.**

version will be 1,800 rpm because of the American 60-cycle TV standard). The picture, as displayed on two 25-inch Telefunken TV receivers, was excellent—better than most home sets receive off the air. Some horizontal "dropouts" were occasionally evident in the picture, but not objectionable. On close-up examination, the picture had a "soft" look, not evident at normal viewing distance.

The videodisc player and more than 200 different discs are scheduled to go on the consumer market in Germany shortly after the beginning of next year. Exact prices weren't announced, but the developers said that as a general rule the player would be priced at about half the cost of a large-screen color TV set—on the German market that will work out to about $375. An automatic-changing version will follow in about a year at between $500 and $600.

The initial programming on discs will consist of how-to material (cooking lessons, home handyman instructions, etc.); nature, science and travel; sports; pop music. The entertainment discs, spokesmen said, will be priced about same as audio LP's.

Among the unique features of the system is an "instant replay" button. When depressed, it repeats a one-second segment until released, or until the scene has been run 15 times. Using the timer knob, the disc may be quickly scanned until any portion is located. During this "search" process, the picture remains in sync at all times.

The developers of the system say that each disc can be played at least 1000 times and that the diamond stylus has a life of 80 hours (it's automatically cleaned and polished each time a record is played). After its debut in Germany, the system will be introduced on the British market. An American version will be demonstrated before this year's end, and Telefunken-Decca spokesmen say they expect at least one U.S. manufacturer to adopt the system. (Zenith has already demonstrated its own version of the system.)

Like other proposed and demonstrated videodisc systems, the Telefunken-Decca unit is for playing recorded material only; unlike videocassette systems, it doesn't permit home recording. At any rate, it now appears that the video phonograph record is about to become a home product. And Telefunken-Decca appear to have at least a one-year lead over competing systems under development by RCA and MCA Disco-Vision in the United States, Philips in Holland and Thomson-GSF in France.

## Color from b&w

The International Television Symposium also saw the first prototype showing of a unique color TV system which could lead to an extremely low-cost home color camera and lower the costs of home color recorders and videodisc systems. Called "GX," the system uses a slightly modified black-and-white vidicon camera to produce color pictures, which can be stored by any monochrome VTR for later playback in color on a standard home color set.

GX makes use of a discovery made a generation ago at Bell Telephone Laboratories that increasing the amount of green seems to sharpen up a color picture significantly, making up for low resolution in the other two colors. As demonstrated here, the system used a low-cost black-and-white industrial TV camera, modified with a transparent glass "light divider" and three side-by-side color filters (red, green and blue) between the lens and the pickup tube.

The vidicon camera produces three black-and-white pictures, one representing red, one green and one blue. These may then be stored on regular monochrome video tape and later fed to a special encoder, or fed directly to the encoder for live color TV showing. The encoder filters out most of the red and blue information, leaving the green intact. It then constructs a line-sequential color signal, consisting of as many green lines as red plus blue, in a sequence of R-G-B-G-R-G-B-G, etc.

The picture demonstrated on a Sony 12-inch color receiver from a half-inch Sony black-and-white VTR showed good colors and a crisp picture. It's too early to say whether GX represents a real cost breakthrough which can lead to a home color camera and low-cost color recording, but several major manufacturers are looking into the system, which was developed in Jaeger's laboratories in Florence, Italy. In mass production—about a million units a year—Jaeger says the camera and encoder should retail for less than $350. He adds that he is developing a low-cost play-only videodisc.

**by DAVID LACHENBRUCH**
CONTRIBUTING EDITOR

# Announcing the RCA MINI-STATE Antenna System

## The profitable new achievement in antenna technology.

The Mini-State is brand new from RCA. It's the first true miniaturized rotating antenna system on the market. *It works . . . and works well!*

This system is specifically made for your metropolitan and suburban customers who want the quality reception of an outdoor-type antenna, in a beautifully compact unit suitable for homes and apartments.

Measuring just 21" across and 7" high, the Mini-State is completely enclosed in an attractive sturdy plastic case that's weatherproof and resistant to dust and dirt. It weighs just 6 pounds and can be mounted almost anywhere: rooftop, chimney, window, attic and closet.

The RCA Mini-State's uni-directional pattern, VHF slotted ring and multi-element UHF design, combined with its completely integrated solid state circuitry, provides excellent reception on all channels, and helps avoid interference and ghosts.

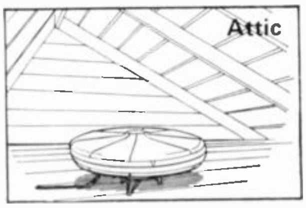
Mini-State model 5MS440, with built-in rotator, allows your customers to zero-in for best reception on any channel. Exclusive direction indicator light on the hand held control unit tells them where the antenna is aimed.

The RCA Mini-State rotating antenna system includes: The antenna with built-in amplifier. Built-in rotator and hand held remote control unit. A 120 volt AC power supply. A VHF-UHF antenna matching transformer. An outdoor mast clamp. Legs which can be snapped into place for indoor use.

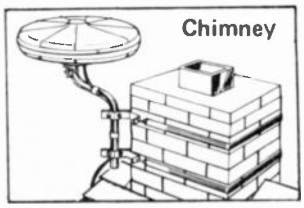
Although regular coaxial and rotator cable may be used, a unique combined coaxial and rotator cable is available in prefabricated lengths for quick, easy installation. (A fixed non-rotating model 5MS330 is also available.)

Yes, this new RCA Mini-State antenna system can mean maxi-profits for you. See your RCA Parts and Accessories distributor today, or contact RCA Parts and Accessories, P.O. Box 100, Deptford, N.J. 08096. Make sure you're in on the ground floor of this profitable new era in TV antenna systems.

**RCA**






*Circle 80 on reader service card*

# NRI's "discovery" method is the result of over half a century of leadership simplifying and dramatizing training at home

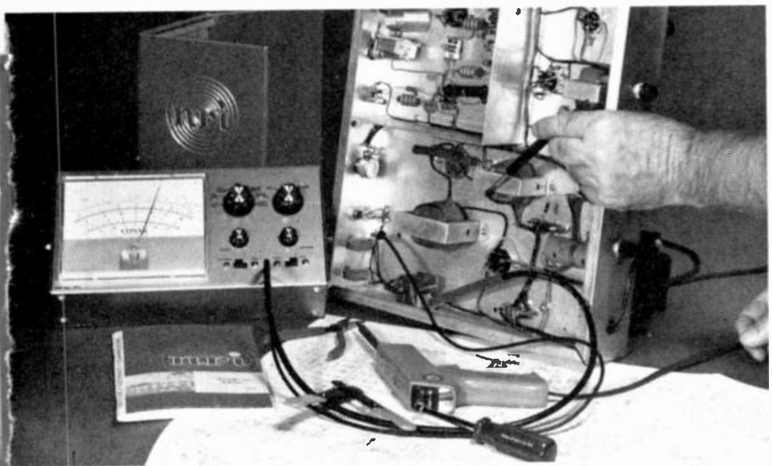
The FIRSTS described below are typical of NRI's half century of leadership in Electronics home training. When you enroll as an NRI student, you can be sure of gaining the in-demand technical knowledge and the priceless confidence of "hands-on" experience sought by employers in Communications, Television-Radio Servicing and Industrial and Military Electronics. Everything about NRI training is designed for your education . . . from the much-copied, educator-acclaimed Achievement Kit sent the day you enroll, to "bite-size" well-illustrated, easy to read texts programmed with designed-for-learning training equipment.

## YOU GET YOUR FCC LICENSE OR YOUR MONEY BACK

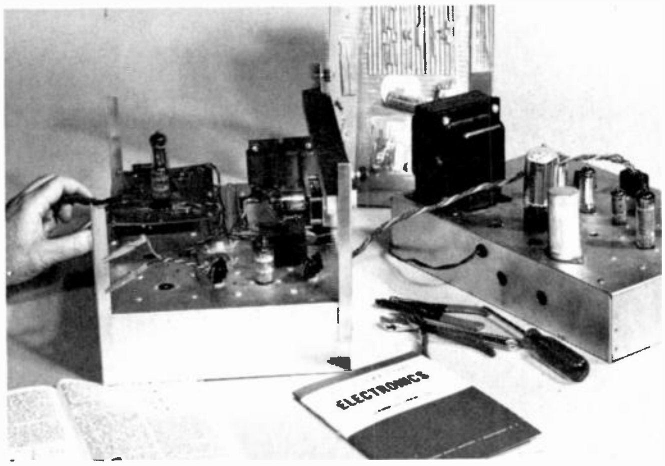
There is no end of opportunity for the trained man in Electronics. You can earn $6 or more an hour in spare time, have a business of your own or qualify quickly for career positions in business, industry, government. And if you enroll for any of five NRI courses in Communications, NRI prepares you for your FCC License exams. *You must pass* or NRI refunds your tuition in full. No school offers a more liberal money-back agreement. The full story about NRI leadership in Electronics training is in the new NRI Catalog. Mail postage-free card today. No salesman is going to call.
NATIONAL RADIO INSTITUTE, Washington, D.C. 20016

**APPROVED UNDER NEW GI BILL** If you have served since January 31, 1955, or are in service, check GI line on postage-free card.

# designed from chassis up for your education



**first** to give you true-to-life experiences as a communications technician. Every fascinating step you take in NRI Communications training, including circuit analysis of your own 15-watt, phone/cw transmitter, is engineered to help you prove theory and later apply it on the job. Studio equipment operation and troubleshooting become a matter of easily remembered logic.




**first** to give you completely specialized training kits engineered for business, industrial and military Electronics. Shown above is your own training center in solid state motor control and analog computer servo-mechanisms. Telemetering circuits, solid-state multi-vibrators, and problem-solving digital computer circuits are also included in your course.

# new & timely

## "Music center of the future" demonstrated at Chicago show

A prototype home audio center of the future, as conceived by Zenith engineers, was on exhibit at the Consumer Electronics Show held during the summer in Chicago.

Featuring—among other things—loudspeaker systems that do not need to be connected to the set, the Concept 4X music center can reproduce music in twelve ways, including Zenith's new discrete four-channel FM system (which was linked by cable to a transmitter, since the FCC has not yet approved any four-channel FM system).

Besides the four-channel discrete FM, the instrument receives ordinary FM, stereo FM and AM, plays monophonic, stereophonic and four-channel records, both mono and stereo sound on cassette tape, and mono, stereo and four-channel discrete sound on 8-track tapes.

Two of the instrument's four speakers are connected to the equipment in ordinary fashion. The other two are actuated by infrared light transmission. Another new feature is the touch-type controls, which light on contact and activate the function, while the light indicate the mode that is operating.

**HOME AUDIO CENTER OF THE FUTURE, using speakers (seen left, beyond the console) that activate from across the room with signals from infrared devices. It also uses touch-type electronic controls that light when contacted.**

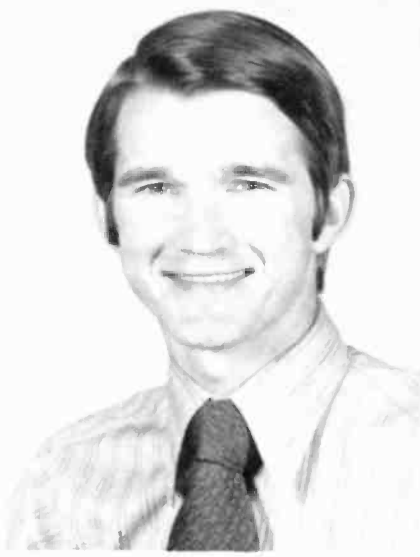
## Robert E. Williams is Gernsback Award winner

Robert E. Williams of Arlington, Texas, has been selected by National Technical Schools to receive the Hugo Gernsback Scholarship Award for 1973. The award is a $125 grant given annually to an outstanding scholar in each of nine leading electronics home-study schools.

Mr. Williams is a graduate of the University of Texas, with a degree in Electrical Engineering Technology and certification from the American Society of Certified Engineering Technicians. He writes:

"Even though my major course of study in college was electronics, there was little time for radio and TV. After checking with several friends who had taken the National Technical Schools course, I felt it would do an excellent job of filling in the gaps.

"After getting through the fundamentals, which I might add were quite thorough, I found that the subject sequence, along with kits supplied with the course, made everything fall into place. I am already doing some part-time work on radio and TV equipment. After completing the course and getting some experience, I hope to open my own shop.



"I am 25 years old and married. My wife, Paula, is an elementary school teacher. I am now employed by Lanier Business Products as an electronics technician. We service a complete line of interoffice communications equipment."

## Aeronautical Satellite Program to ensure transatlantic safety

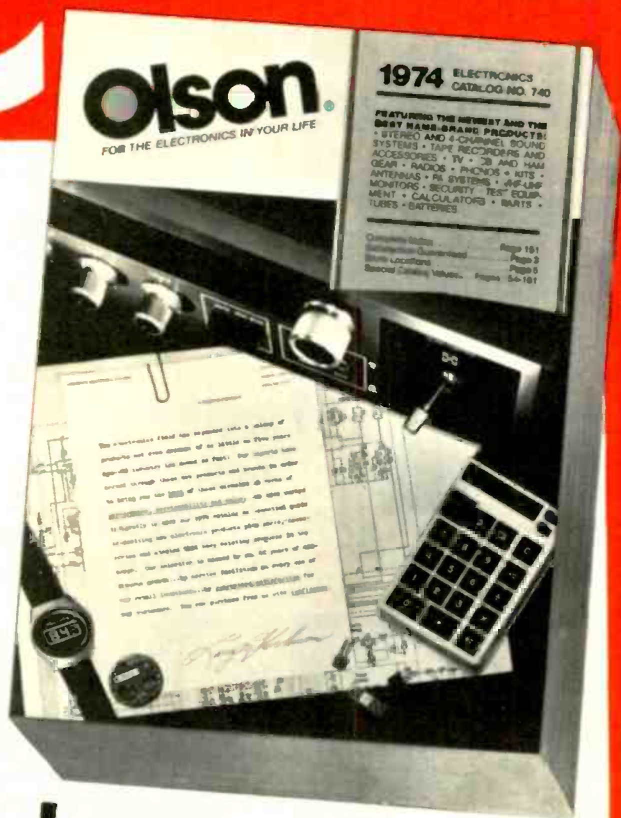
A "quantum jump" in improving communications for ocean air-traffic control will be necessary if international aviation is not to "strangle on its own growth" in the '80's or before. This statement was made by Howard Hawkins, chairman of RCA Global Communications, addressing the Aviation/Space Writers at the opening of their annual conference at Las Vegas.

To meet the threat of strangulation, he said, an experimental program is already being initiated jointly by the United States, Canada and the European Space Research Organization (ESRO). Called the Aeronautical Satellite Program (Aerosat) it proposes to employ two synchronous satellites to relay communications and position data direct between transatlantic aircraft and air traffic control centers In North America and Europe.

*(continued on page 14)*

# free

**OVER 93 FAMOUS NAME ELECTRONICS PRODUCT LINES . . . MOST IN FULL COLOR**




## 1974 VALUE PACKED

## Olson® CATALOG

YOUR COMPLETE ELECTRONICS BUYING GUIDE for home or business . . . over 8,000 quality-tested items clearly described and illustrated on big 8¼ x 10¾" pages. Shop leisurely in the comfort of your own home — order what you want by mail or through the catalog order station at your nearby Olson store. Any way you do it — you pay the same low Olson catalog price!

**FEATURING THE BEST OF THE NAME BRANDS PLUS EXCLUSIVE TELEDYNE AND OLSON PRODUCTS**

• Stereo and 4-Channel Sound Systems • Tape Recording Equipment • Car Stereo and Accessories • Easy-to-Build Electronic Kits • Citizens Band Radios • Police Receivers • Books • Amateur Radio Equipment • Antennas • Radios • PA • Test Equipment • Electronic Security Systems • Electronic Calculators and Timepieces • PLUS 1000's of PARTS, TUBES, BATTERIES, HARDWARE!

**SAVE ON "THE ELECTRONICS IN YOUR LIFE" — Buy with Confidence**

**FREE SEND TODAY!**

**Olson®**
for the electronics in your life

The VALUE Leader
Since 1931

**STORES NATIONWIDE**
**Check Your Yellow Pages**
**or Shop by Mail**

**Olson. electronics** Dept. LK
260 S. Forge St., Akron, Ohio 44327

☐ Rush me your free 1974 Electronics Catalog

Name ______________________ Apt. ________

Street ______________________________

City ____________ State ____________ Zip ________

☐ Send a 1974 Olson Electronics Catalog to my friend.

Name ______________________ Apt. ________

Street ______________________________

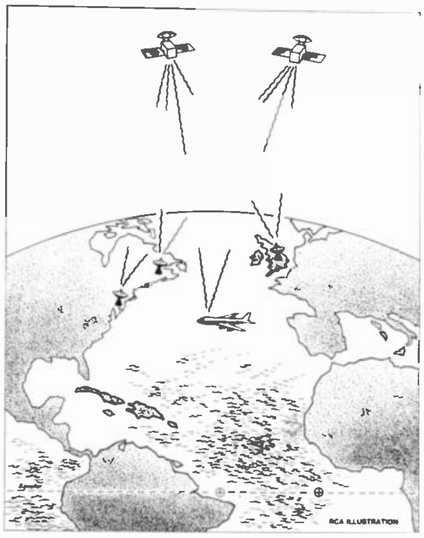
City ____________ State ____________ Zip ________

*Circle 5 on reader service card*

# new & timely

*(continued from page 12)*

The present communications system for the North Atlantic now operates up to 85 per cent of capacity during peak traffic periods, and does not allow direct contact between pilot and air traffic controller during most of a transatlantic flight. Neither can the air-traffic control centers track an aircraft's position directly.



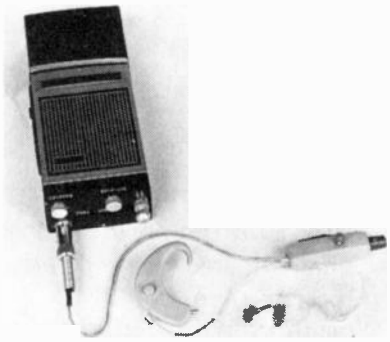
**AERONAUTICAL SATELLITE PROGRAM would use two geostationary satellites, working with ground stations to provide exact position information on and direct communication with the aircraft during the whole transatlantic flight.**

With air traffic expected to double before 1980 and to increase six times by 1990, obviously present systems would be oversaturated. The greater density of aircraft would also demand closer spacing between planes than at present, which would require the closer direct traffic control that Aerosat could provide.

It is expected that contracts for building the first Aerosat spacecraft will be awarded in 1974, with the first satellite to be orbited in 1976. Using the lessons provided by the experimental program, an operational system would be expected by the early 1980's.

## New two-way radio headset reverses bone-conduction unit

Reversing the function of the usual bone-conduction unit, widely used as a transducer in hearing aids, a new personal communication unit has a bone-conductor microphone. It is mounted with the earphone in a hearing-aid type unit and worn behind the ear. A projection on the case makes contact with the head. Since it is purely a conduction-type unit, the new microphone is claimed by the manufacturer, Dynacommand Corp. of Hicksville, NY, to be particularly effective in high-noise areas, where ambient noise might make conventional microphones ineffective.



**PERSONAL COMMUNICATION HEADSET uses a conventional acoustic earphone, with a bone-conduction microphone. The control unit, at left, has a push-to-talk switch and a volume control. Button shown on the earborne unit is the microphone contact, which is worn toward the head in use. Lead between the ear unit and control is longer than shown (note cut lead).**

The unit is designed to be compatible with practically all portable two-way communicators, and has its own "head" amplifier built into the hearing-aid type case, to adjust microphone output to suit the various pieces of equipment into which it may be plugged.

## Two Virginia associations install new officers

Two local chapters of the Virginia Electronics Association, Inc., installed their officers in a joint meeting and Ladies night held early in June. Virginia Electronics Association President John McPherson, CET, came from Yorktown to perform the installation.

VEA-Peninsula's officers, elected at the annual meeting in May, are Terry Woodley, Langley TV, president; Jim Zimmerman, Jim's Radio and TV, vice president; William Crawford, Newmarket Electronics, secretary; Robert Mason, Electronic Service, treasurer. All the firms mentioned are in Hampton.

The officers of VEA-Tidewater are John C. Wood, Jr., Campostella Electronics, Norfolk, president; Clyde Crowe, Crowe's TV, Norfolk, vice president; Richard Ambrose, A & T TV, Portsmouth, secretary; Paul Whosdos, Jr., Atlantic

*(continued on page 16)*

# Announcing the Panasonic Parts Hot Line.

## In 48 hours we can ship you anything we've got.

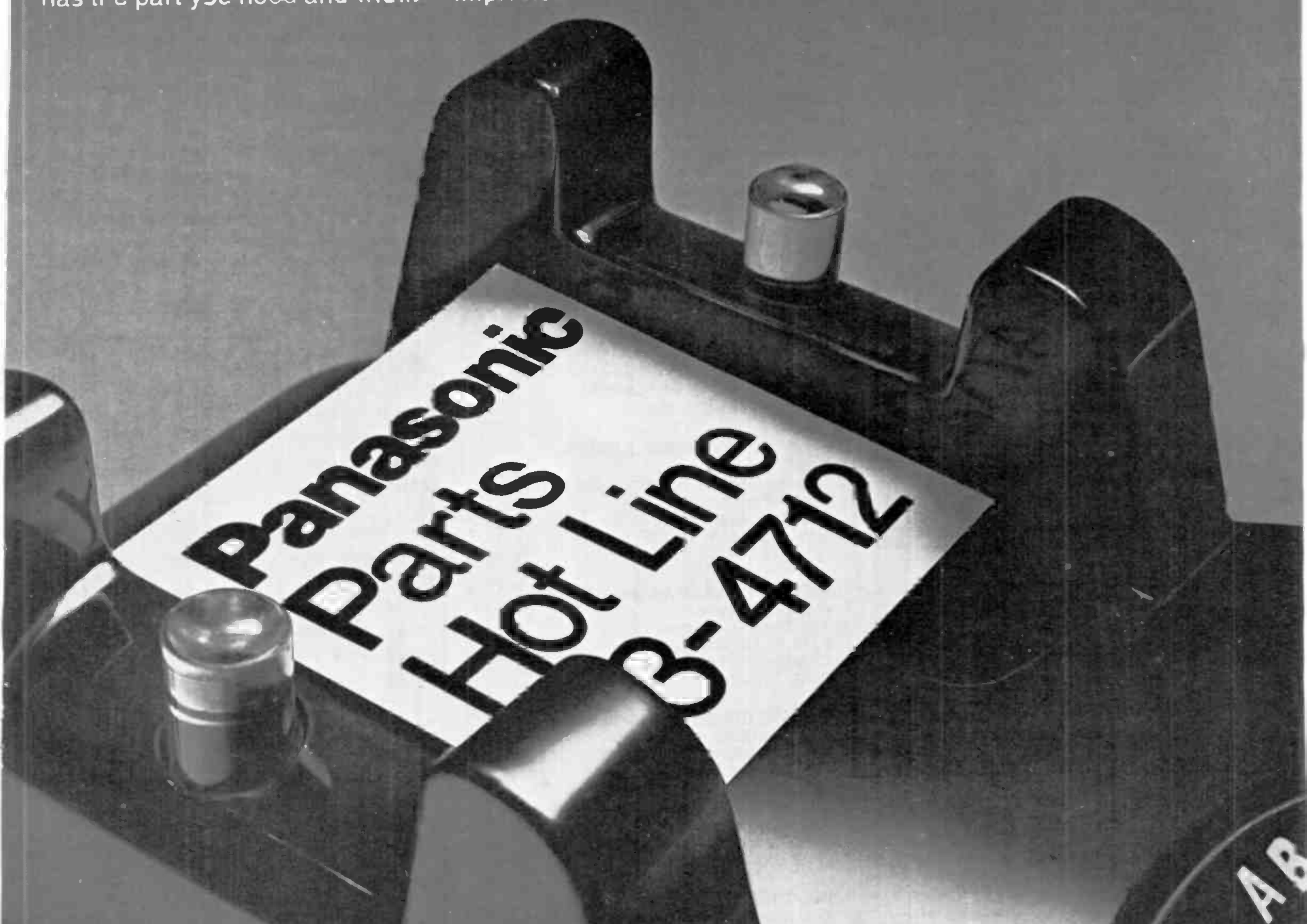
The New Panasonic Parts Hot Line is a performance promise: 24-hour-a-day, 7-day-a-week service. Now, if you have a problem getting the part you need just call one central number.

Then things start happening fast: we'll ask our computer to locate your part (or parts) by searching all five regional Panasonic parts depots. In just seconds. Electronically. Then we'll telex an order to the depot which has the part you need and within 48 hours, your order is on its way.*

And we can make this promise with confidence, because our warehouses are now fully automated. We've got the 2,000 fastest moving parts on electronic order pickers. At the touch of a button any of these high traffic parts is at our fingertips.

To become a member of the Panasonic Parts Hot Line, call the toll-free number below. We'll send you a bright red emblem imprinted with the hot line number for your particular region. We'll also send you an easy-reference booklet that gives you the names of authorized Panasonic parts distributors in your area and information on other Parts Division services.

We know that your business depends upon having the right parts at the right time — when your customer needs them. Our business is standing right behind your business, with quality parts for over 1,000 products.




**Panasonic**
just slightly ahead of our time

Call toll-free anywhere in the U.S. 800-523-5336. (in Pa. 800-523-5395)

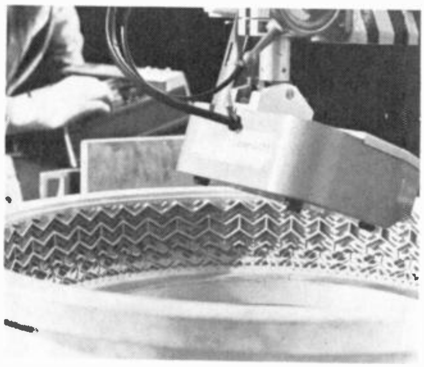
*Of course we cannot ship on weekends and holidays.

# new & timely

*(continued from page 14)*

TV, Virginia Beach, treasurer.

Dick Ambrose of Portsmouth served as toastmaster for a varied program of short speeches, awards and entertainment. A record crowd of 88 attended. All ladies present received flowers and gifts.



**BETTER TIRES PRODUCED BY LASER. A new laser measuring instrument introduced by Siemens checks the accuracy of tire molds with precision heretofore unattainable. Because the dimensional stability of these molds vitally affects the characteristics of the tires that are made from them, the device makes it much simpler to make tires that run round. Measurements are made by a sort of radar principle, the laser beams being bounced from the tire to a reference plane.**

## Static electricity heals fractures in bones

Encouraging results in experiments on increasing the speed at which bone fractures heal by using static electricity are reported by the Director of the Orthopedic Research Labs at Columbia University. The director, Dr. C. Andrew Bassett, said that studies with rabbits indicate that, by using static electricity, fractures can be healed in half of what is now the normal time.

It is known that applying weak direct currents can speed healing of bone fractures, and has in some cases succeeded on fractures that otherwise would not heal. The present method, still considered experimental, though increasing rapidly in use, is to implant electrodes on either side of the fracture and cause a small current—in the order of microamperes—to flow.

In the static method, the fractured limb is placed in an electric force field maintained by two metal plates that can be mounted in a cast similar to the casts normally used on fractured limbs. Implanting electrodes would become unnecessary. **R-E**


**Radio-Electronics** is published by Gernsback Publications, Inc. 200 Park Ave. S. New York, N.Y. 10003 (212) 777-6400
President: M. Harvey Gernsback
Secretary: Bertina Baer

**ADVERTISING SALES**

**EAST**
Stanley Levitan, Eastern Sales Mgr.
Radio-Electronics
200 Park Ave. South
New York, N.Y. 10003
(212) 777-6400

**MIDWEST/Texas/Arkansas/Okla.**
Ralph J. Bergen
The Ralph J. Bergen Co.
6319 N. Central Ave.
Chicago, Ill. 60646
(312) 792-3646

**PACIFIC COAST/Mountain States**
Jay Eisenberg
J.E. Publishers Representative Co.,
8732 Sunset Blvd., 4th Floor
Los Angeles, Calif. 90069
(213) 659-3810
420 Market St.,
San Francisco, Calif. 94111
(415) 981-4527

**SOUTHEAST**
E. Lucian Neff Associates
25 Castle Harbor Isle,
Fort Lauderdale, Florida 33308
(305) 566-5656

# NEW LOW PRICES ON WINEGARD® QUALITY ACCESSORIES!

## set couplers—2-way splitters—band separators—matching transformers reduced up to 31%

Why buy "second line" TV components when you can buy the best . . . Winegard engineered-and-built for less and get the same high quality and performance?

Check with your distributor for new low pricing on these items.

**Reduced 31%**

**CC-482 82 CH. 4-SET COUPLER**—Deluxe low loss coupler connects four TV-FM sets to a single 300 ohm downlead. Efficient coupler circuit provides a maximum amount of signal to each receiver. Specially designed for color, black and white and stereo.

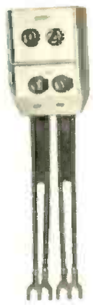
**Reduced 31%**

**CS-387 75 OHM V-U-FM BAND SEPARATOR**—Band Separator for making connection between 75 ohm coaxial downlead and separate 300 ohm antenna terminals of TV set and FM receiver. Features latest printed circuit design for low loss, high isolation and perfect match. Excellent for quality color and FM stereo reception. Connector included.

**Reduced 14%**

**CS-285 300 OHM V-U BAND SEPARATOR**—High quality, low loss Band Separator for adapting single 300 ohm download to separate 300 ohm VHF and UHF antenna connections of TV set. Perfect match insures perfect color and black and white reception.

**Reduced 18%**



**CS-380 300 OHM V-U-FM BAND SEPARATOR**—Latest Band Separator design adapts 300 ohm downlead to separate VHF and UHF antenna terminals of TV set and provides FM stereo thru handy no-strip screw terminals. Unique printed circuit design has extremely low loss, excellent match and high isolation for perfect color and FM stereo.

**Reduced 22%**

**CS-175 75 OHM V-U BAND SEPARATOR**—Quality 75 ohm Band Separator for attaching coaxial cable to separate 300 ohm antenna terminals of TV set. Features printed circuit and latest circuitry for low insertion loss and perfect color transmission. Connector included.

**uced 28%**

**CC-33 82 CH. 2-SET COUPLER**—Inexpensive coupler for connecting two TV or FM sets to a single 300 ohm downlead. Features handy no-strip terminals for easy connection.

**Reduced 26%**

**CC-282 82 CH. 2-SET COUPLER**—Efficient 300 ohm coupler connects two TV-FM sets to a single 300 ohm downlead. Input and output connections are handy no-strip type for easy installation. Quality circuitry insures perfect color and black and white reception.

**Low Price!** *NEW*

**LS-27 82 CH. LINE SPLITTER**—High quality line splitter for dividing a single 75 ohm coaxial cable into two trunk lines. Indoor type with transformer network features excellent match. Connectors included.

**Low Price!** *NEW*

**T-12BLK 82 CH. MATCHING TRANSFORMER**—Compact indoor Matching Transformer for attaching coaxial cable to 300 ohm antenna terminals of TV or FM receiver. Packed 6 per poly bag, 8 bags per master carton. Connectors included.

WINEGARD ANTENNA SYSTEMS
3000 KIRKWOOD ST. • BURLINGTON, IOWA 52601

*Circle 8 on reader service card*

# program which gives you n electronic circuit design

## only CREI offers you a complete college-level Electronic Design Laboratory to speed your learning

**Electronic circuit design**—source of all new development in the application of electronics to new products and services. Without this skill, we would be unable to monitor the heartbeat of men in space. Without it, the computer revolution would never have occurred. And we would have yet to see our first TV show. *Yet, only CREI teaches electronic circuit design at home.*

**ELECTRONIC CIRCUIT DESIGN**
A key skill which paces our nation's progress in countless fields—from pollution control to satellite tracking to modern medicine to exploring the ocean's depths. And beyond. A skill which *you* must have to move to the top in advanced electronics.

**CREI programs open up new worlds of opportunity for you.**

In addition to electronic circuit design, CREI provides you with a full advanced electronics education in any of thirteen fields of specialization you choose. Communications, computers, space operations, television, nuclear power, industrial electronics—to mention just a few of the career fields for which CREI training is qualifying. With such preparation, you will have the background for a career which can take you to the frontiers of the nation's most exciting new developments. And around the world.


**This free book can change your life. Send for it.**

If you are a high-school graduate (or equivalent) and have previous training or experience in electronics, then you are qualified to enroll in a CREI program to move you ahead in advanced electronics.

Send now for our full-color, eighty page book on careers in advanced electronics. In it, you will find full facts on the exciting kinds of work which CREI programs open up to you. And full facts on the comprehensive courses of instruction, the strong *personal* help, and the professional laboratory equipment which CREI makes available to you. All at a surprisingly low tuition cost.

**And when you have it, talk with your employer about it.**

Tell him you're considering enrolling with CREI. He'll undoubtedly be happy to know you are planning to increase your value to him. *And he may offer to pay all or part of your tuition cost.* Hundreds of employers and government agencies do. Large and small. Including some of the giants in electronics. *If they are willing to pay for CREI training for their employees, you know it must be good.*

**Send for Advanced Electronics today. You'll be glad you did.**


CREI Dept. E-1409D
3939 Wisconsin Avenue
Washington, D.C. 20016

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

Name ______ Age ______
Address ______
City ______ State ______ ZIP ______
If you have previous training in electronics, check here ☐
Employed by ______
Type of Present Work ______
Veterans and servicemen, check here for G. I. Bill information ☐

CREI
CAPITOL RADIO ENGINEERING INSTITUTE
WASHINGTON, D.C. 20016

# letters

## PHONE SENTRY PROBLEM

I've made some changes in the Phone Sentry I built from your article (June 1973) to provide better operation. First I paralleled T1 and T2 to improve audio quality in both playback and record. Then I added a parallel RC network in series with the secondary of T1, between T1 and the connection to the fixed contact of RY1. (680-ohm resistor in parallel with two 20-μf, 50V electolytics wired back to back—positive to positive) Then I added a 150-ohm resistor from the fixed contact of RY1 to ground. Adding these parts improve the matching impedance to the telephone line. They also cause pin 4 of IC2 to go low whenever power is applied to the circuit initially, either by a ring or by pressing the TEST switch.

ROGER E. OUSTERHOUT
*Ogdensburg, N.Y.*

*I have suggested the following changes to those having trouble with the "Phone Sentry".*

1. *Parallel the primary (10K) side of T2 with 1800 ohms.*
2. *Switch locations of C3 & C9 (make C9 = 1μF.*
3. *If the capacitor supplied for C2, in the kit, is marked "Whale 10μ F/150 volt," replace it—it is probably leaky.*
4. *The neon should fire at 70 volts dc, if not—replace.*
5. *Lettering on upper left corner of coverplate (in the kit) should be "EAR" (wire to P1).*

*The transformer changes suggested by Mr. Ousterhout are OK but adding the 1800-ohm resistor to T2 is simpler. The main thing is to present 500 ohms to the phone line so central office switching relays operate properly.*

*The change on pin 4 of IC2 would be better if the resistor went to +6V (connect between pins 4 and 8) rather than to ground. I have used this change and it is more effective than the added capacitor between pins 1 and 8 to suppress turn-on triggering.*

*I was glad to hear from Mr. Ousterhout and appreciate his comments.*

ROGER SMITH
*Phoenix, Arizona*

## WWVB SERVICE IMPROVED

If you are building the WWVB receiver for Superclock (**Radio-Electronics**, August and September 1973), you'll be interested in this change in WWVB service.

The National Bureau Of Standards will be eliminating all Tuesday maintenance schedules. The time code, therefore, will be continously broadcast, except for unforseen maintenance problems or commercial power outages.

DONALD E. LANCASTER

*(continued on page 24)*


# SONY® PS 2251:
# a declaration of independence.

Independence of belts, pulleys, idler wheels and all the other paraphernalia that can cause wow, flutter and rumble. Independence from fluctuations in power line voltage that can effect the precise speed of the turntable. And independence of acoustical feedback. The new, direct-drive Sony PS-2251 has declared itself independent of all these potential intruders upon the enjoyment of your records.

Most turntables use belts, pulleys, idler wheels to make their turntables spin at the record's speed, instead of the motor's. Look underneath Sony's new PS-2251 and all you'll see is the motor. We don't need all those extras, because our motor's speed is precisely the same as the record's.

Eliminating all those parts also eliminates the wow and flutter and rumble they can cause. So, our rumble figure is a remarkable −58dB (NAB). And because our motor turns so much slower than conventional ones, the rumble frequency is lowered too, making the rumble even less audible than that −58 dB figure indicates.

To maintain precise speed accuracy at slow speeds, we use an AC servo system (superior to a DC servo system because of its uniform magnetic field strength). Its precise speed is not affected by variations in line voltage or in line frequency. But its speed can be varied ±4% by the built-in pitch control and returned to a precise 33-1/3 or 45 rpm, with the built-in self-illuminated strobe.

Then we matched it with a statically-balanced tonearm that tracks records as precisely and faithfully as our turntable turns them. We added viscous-damped cueing and effective anti-skating. And we mounted the PS-2251 on a handsome wood base using an independent spring suspension system to completely isolate it from externally caused vibrations. At $349.50 (suggested retail) including arm, wood base and hinged dust cover, the PS-2251 is today's most advanced turntable.

We also offer a moderately priced, single-play component turntable with the convenience of automatic operation, the PS-5520. The complete system: turntable, arm, walnut base and hinged dust cover, $159.50 (suggested retail) Sony Corporation of America, 9 West 57th Street, New York, New York 10019.

*Circle 9 on reader service card*

LETTERS
*(continued from page 22)*

### MORE TESTING DATA

I read with great interest your article "8 Ways To Test Hi-Fi Amplifiers" in the July 1973 issue. Can I obtain more information on such tests? Is there a bibliography that could point me toward more data?

JOHN K. KIRKLAND
*Chicago, Ill.*

*There sure is! This article was based heavily on a Sony publication titled "Sony Hi-Fi Test Procedures—Audio Amplifiers" which was prepared by M. J. Salvati, Technical Publications Department, Sony Corporation Of America. The original booklet showed how to perform a complete series of tests on specific Sony equipment. In preparing the article this information was enlarged and generalized to make it adaptable to all makes of hi-fi amplifiers.*

### MORE AUTOMOTIVE ELECTRONICS

I really enjoyed your article, Electronics For Your Car, in the April 1973 issue, and would like to know more about electronic systems in automobiles. Where can I look?

FRANK MCCORMICK
*Los Angeles, Calif.*

*There is an excellent comprehensive book on automotive electronics in print now. It's titled "Automotive Electronics," written by George Whalen and Rudolph Graff, and published by Howard Sams.*

### HEAR, HEAR

In the article "Hearing Through The Teeth" (**Radio-Electronics,** June 1973), note is made that Dr. Collard heard the tuning fork via vibrations transmitted through the teeth after it was "not loud enough to be heard by ear." (Presumably it means by holding the tuning fork by the ear.)

If this is so, a visit to an ear specialist (there are many good ones in California) might be of help to him if he has not already done so. His personal observations suggest a conductive hearing loss which may be correctible.

While there is a place for bone conduction hearing aids, at the present time the efficiency of the air conduction reproducers is more than enough to compensate for a conductive hearing loss. Hence bone conduction hearing aids are of limited use.

It may be that Dr. Collard might devise something better than what is currently available in bone conduction hearing aids. If so, this might be of benefit to the many people with hearing problems.

WALTER K.W. YOUNG, M.D.
*Honolulu, Hawaii*

R-E


# As you can see, your Sylvania distributor has 200 picture tubes in stock.

And they're all in just five Sylvania cartons.

Because our line of five color bright 85XR® OEM-quality tubes gives maximum coverage of 19V, 21V, and 25V diagonal sets with a minimum of stock.*

It also means faster service because these Sylvania picture tubes are direct replacements. You replace a kimcode with a kimcode, a bonded with a bonded.

And then, there is the biggest advantage of all: You can count all your large-screen color tube needs on the fingers of one hand.

See your local GTE Sylvania distributor for a complete replacement list. With needs that you can count on one hand, you can bet he has the tube you want in his hands.

Sylvania Electronic Components, 100 First Ave., Waltham, Mass. 02154.

*XR23VANP22/
SRE25BGP22 ........ Replaces 53 types
XR23VAQP22/
SRE25BHP22 ........ Replaces 27 types
XR19VABP22 ......... Replaces 22 types
XR18VAHP22 ......... Replaces 82 types
XR18VADP22 ......... Replaces 16 types

**GTE SYLVANIA**

**A. Build your own Heathkit 25V Color TV...599.95*** less cabinet

The GR-900 is the most advanced TV you can build. Yet everything goes together with traditional Heathkit simplicity. And the built-in convergence board and test meter for at-home maintenance add further savings over the life of the set. You preset any 12 UHF channels for positive pushbutton power tuning, and you can scan both UHF and VHF channels in either direction. An ultra-rectangular black matrix tube, voltage controlled varactor UHF tuner, MOSFET VHF tuner and an exclusive angular tint control for better flesh tones combine to produce an absolutely brilliant color picture.
Mailing weight, 125 lbs.

**B. Heathkit 18V Color TV...349.95*** less cabinet

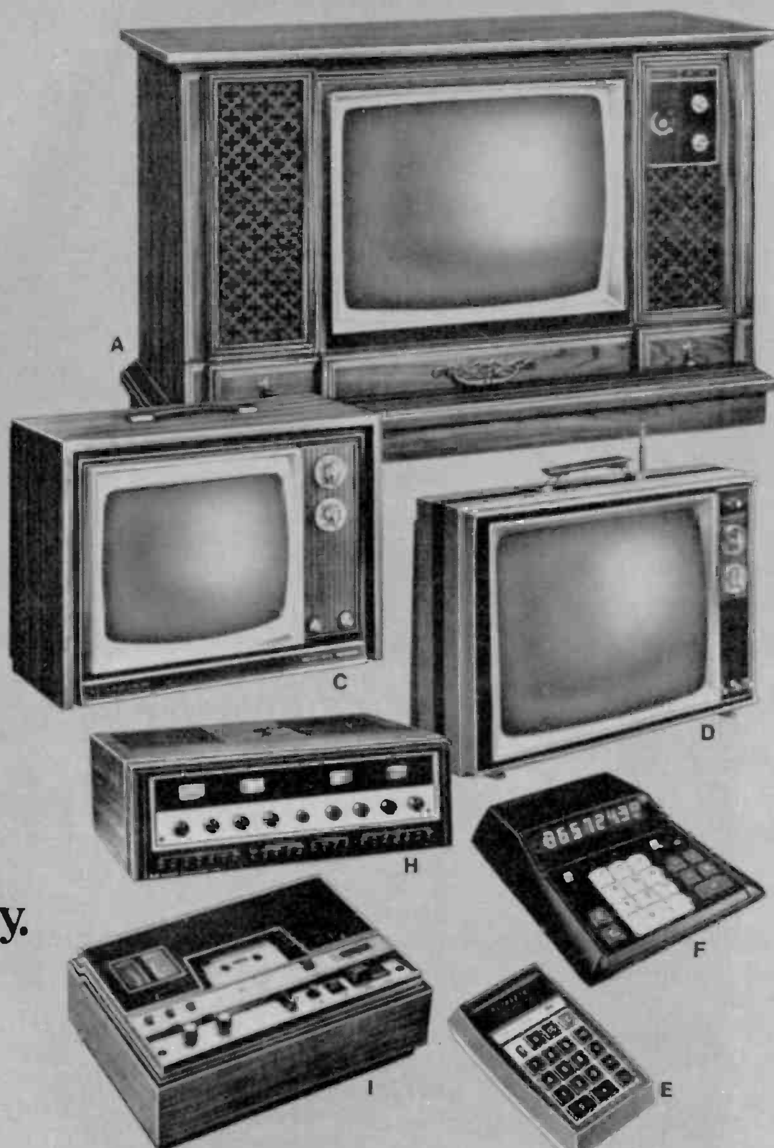
Solid-state modular circuitry spells reliable operation and easy assembly. And the GR-269 comes with a full complement of alignment and self-service equipment — dot generator, convergence board, test meter and troubleshooting book. Factory assembled and aligned AFT module for perfect picture & sound at a touch. VHF tuner with MOSFET circuitry and UHF tuner with hot-carrier diode design for low noise, high sensitivity. Both tuners & IF assembly factory assembled & aligned "Instant-on", switch-controlled degaussing, hi-fi sound output; 75 & 300 ohm antenna inputs; exclusive Heath Magna-Shield, standard.
Mailing weight, 100 lbs.

**C. Heathkit 14V Color TV...299.95*** includes cabinet

Set aside about a dozen evenings. Build up 10 circuit boards, prepare the chassis. Install the wiring harness. Result: the Heathkit GR-169, with picture purity at the top of its class. And you keep it that way — with plug-in modular circuit boards, trouble-shooting meter and data book to help you fix it right at home. A "big" little TV, the GR-169 has all the secondary controls found in our larger models — color, tint, contrast, horizontal & vertical hold, height, AGC, color killer, switch-controlled degaussing. Carry it room to room or across the country — this is the portable that bounces back with console-like performance.
Mailing weight, 69 lbs.

**D. NEW Heathkit 19V B&W Portable TV...179.95*** includes cabinet

The new GR-1900 is like no other B&W portable! With advanced solid-state "modular" design — most circuitry mounts on just 4 plug-in boards. Just 2 tubes; picture & high voltage. Total detent tuning on all 70 UHF channels as well as VHF. "Instant-on." Front panel controls of VHF/UHF fine tuning; brightness; contrast, master on/off; vert. hold; AGC & height. New ultrarectangular tube for a full 184 sq. in. view. Other




# Start a Heathkit hobby...

## It's fun, easy, and it saves you money.

"big" set features are Automatic Vertical Linearity; dual-controlled AGC; extra-wide Video Bandwidth; 4-circuit grounded-base VHF tuner. A kit even the novice can build; both tuners come preassembled & aligned; transistors & ICs plug into sockets; and all chassis wiring is color coded. Mailing weight, 56 lbs.

**E. NEW Heathkit Pocket Calculator...92.50***

The new Heathkit IC-2009 is a fully portable calculator with rechargeable nickel-cadmium battery. Or you can leave it connected to the plug-in charger for permanent desk-top use. Weighs just 12 oz. And check over these features: 8-digit capacity. Four arithmetic functions. Floating decimal. Constant key. Chain calculation capability. Clear-entry key. Entry & total overflow indicators. Low battery indicator. Battery-saver circuitry. And you can build it in three evenings. Mailing weight, 3 lbs.

**F. New Heathkit Desk-top Calculator...79.95***

The Heathkit IC-2108 — a great looking full-function electronic calculator for home or office. You can assemble it in two spare evenings. Features include: Addition, subtraction, multiplication and division functions. Floating and fixed decimal. Constant key. Chain calculation capability. Clear display key. Entry and result overflow indicators. Negative answer indicator. 120 or 240 Volt operation. Mailing weight, 4 lbs.

**G. New Heathkit Small-engine Tune-up Meter...39.95***

Kit CM-1045 — for all 2- and 4-cycle engines, 1 to 4 cylinders, with conventional, CD, or transistorized ignitions. Great for motorcycles, snowmobiles, outboard marine engines, etc. Clip-on leads let you check dwell, volts, ohms and continuity without tearing down the engine to get at systems buried beneath the flywheel. A built-in inductive-pickup tachometer works with any number of cylinders. Blue high-impact plastic case stores leads and three "C" batteries for ultimate portability. Mailing weight, 5 lbs.

**H. Heathkit 4-Channel Amplifier with decoder...359.95* less cabinet**

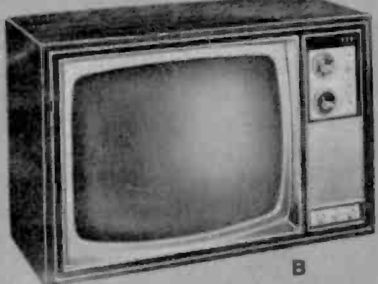
You select discrete 4-channel, or switch-in the "Universal" decoder for reproduction of all the matrixed 4-channel discs now on the market, plus "derived" 4-channel from conventional stereo. Four solid-state amplifiers produce 200 watts (4x50 IHF) into 8 ohms, with power bandwidth on all channels from less than 5 Hz to greater than 45 kHz at 0.25% distortion. Kit AA-2010, mailing weight, 37 lbs. AAA-2004-1, pecan cabinet 24.95*. Mailing weight, 7 lbs.

**I. Heathkit Cassette Deck with Dolby circuitry...249.95* less cabinet**

The Heathkit AD-1530 is a kit-form cassette deck utilizing the famous Dolby* noise reduction system. Accommodates the greater fidelity and dynamic range of chromium dioxide cassettes. Independent switches provide Dolby on/off and regular or $CrO_2$ bias control. Domestic-make tape transport comes preassembled for easy kit building. Mailing weight, 20 lbs.

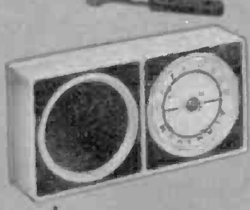
**J. New Heathkit AM Radio...14.95***

The Heathkit GR-1008 is a smartly styled, great sounding solid-state radio that makes a great introduction to Heathkit building. Eight-transistor circuitry mounts on one printed board, big 3½" speaker mounts in high impact plastic case. If you've never built a kit before you can probably have this one together in one fun evening. Uses 9-volt battery (not supplied). Order the Heathkit GR-1008 for yourself or the kids. Mailing weight, 2 lbs.



B

G



J

HEATHKIT ELECTRONIC CENTERS—ARIZ.: Phoenix; CALIF.: Anaheim, El Cerrito, Los Angeles, Pomona, Redwood City, San Diego (La Mesa), Woodland Hills; COLO.: Denver; CONN.: Hartford (Avon); FLA.: Miami (Hialeah); GA.: Atlanta; ILL.: Chicago, Downers Grove; IND.: Indianapolis; KANSAS: Kansas City (Mission); MD.: Baltimore, Rockville; MASS.: Boston (Wellesley); MICH.: Detroit; MINN.: Minneapolis (Hopkins); MO.: St. Louis; N.J.: Fair Lawn; N.Y.: Buffalo (Amherst), New York City, Jericho; L.I.: Rochester; OHIO: Cincinnati (Woodlawn), Cleveland; PA.: Philadelphia, Pittsburgh; TEXAS: Dallas, Houston; WASH.: Seattle; WIS.: Milwaukee.

**OVER 350 KITS TO CHOOSE FROM IN THIS NEW FREE CATALOG**

FREE

**SEND FOR YOUR 1974 HEATHKIT CATALOG**

— it describes more than 350 Heathkit projects

HEATH
Schlumberger

HEATH COMPANY, Dept. 20-9
Benton Harbor, Michigan 49022

☐ Please send FREE Heathkit Catalog.
Enclosed is $________, plus shipping
☐ Please send model(s)________
Name________
Address________
City________ State________ Zip________

*Mail order prices; F.O.B. factory CL-469

*Circle 100 on reader service card*

# equipment report

## *Castle Mark IV Tuner Subber*


*Circle 85 on reader service card*

SUBSTITUTING A TUNER IS NOT A NEW thing; even I have been doing it for years. A Castle Mark IV Tuner Subber *is.* It'll do all kinds of tricks, all of them very handy. One of them is a brand-new one; I certainly wish I'd thought of it.

The Mark IV is a solid-state, 13-position vhf tuner, with a 40-MHz i.f. output. It also has a 40-MHz input, in the uhf position, for testing uhf tuners. The vhf input and the if output are electrically isolated; the Mark IV can be used with all TV sets; tube, solid-state, modular, hybrid, etc. The 40-MHz i.f. amplifier stage is very stable. This permits the use of two Subbers in cascade, if a very high level i.f. is needed.

In almost all cases, this will be strictly a "plug-in" operation. The coax from the i.f. input to the tuner, in most sets, uses the "RCA phone-plug" type of connector. Just pull this out of the set's tuner, plug it into the jack on the back of the Mark IV, hook up the antenna and away you go. No power connections are needed. This gives you an instant and accurate answer to the old question, "Is it the tuner or something else?"

You can check i.f. stages, too. Hook the antenna to the Mark IV, plug in the cable with clip leads, pull the set's i.f. input cable. Now, connect the 40-MHz i.f. output to the i.f. input. If this doesn't get a signal through, there's another very handy test you can make. (*This* is the one I wish I'd thought of!)

You can check not only the i.f., but the agc. Just move the output clip to the input of the *last* i.f. stage in the set. Turn up the rf gain control of the Mark IV, and you should see a picture, and hear sound. Now you can "walk out" any i.f. trouble, by moving the clip back toward the i.f. input one stage at a time.

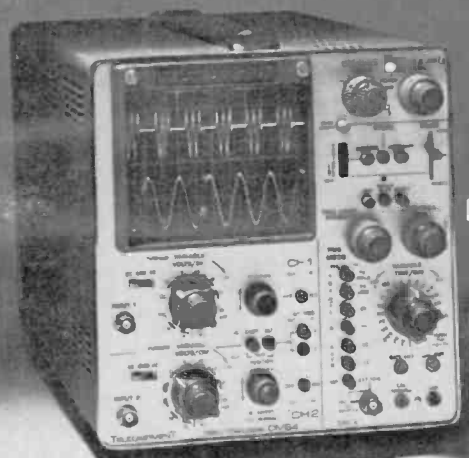
If you move back to an agc controlled stage and lose the picture and sound, you've got two possible causes; a defective i.f. stage, or trouble in the agc. Now comes the cute one. You can check for agc trouble by going back to the last i.f. stage where you can get a picture through. You know that you have the required *signal* on the agc stage, and it's easy to check for the presence of the keying pulse, dc voltages, and so on. The operation of the agc circuit is "normal", and not masked by an agc clamp or override bias. By varying the rf output of the Mark IV, you can check for variation of the agc voltage with signal strength, as it should. Of course, if you do *not* get a signal through from the last i.f. stage, then you know where to go. Back to the video detector, video amplifier and so on.

This is a vhf tuner. It has a uhf position, in which the amplifier stage is automatically switched to an i.f. input, as we said before. To check a uhf tuner, just pull the cable which normally goes to the set's vhf tuner, and plug it into the jack on the Mark IV. Be sure to set the vhf tuner on the TV to uhf, so that the uhf tuner will get its normal B+ supply. Most vhf tuners switch this on only in the uhf position. If the set's tuner works on vhf, and the uhf tuner works when connected through the Mark IV, then this points to some trouble in the set-tuner's uhf position.

The Mark IV comes in a handy, tough plastic case with a handle on top. A full set of hookup cables is included; the plug-in type for vhf, another with alligator clips for the i.f. tests, a uhf interconnecting cable, and even a cable with no termination at all. This is for use with sets having the i.f. coax soldered in. Just lift the hot

*(continued on page 30)*

MORE
# VALUE
IN
TELEQUIPMENT
# DUAL-TRACE OSCILLOSCOPES



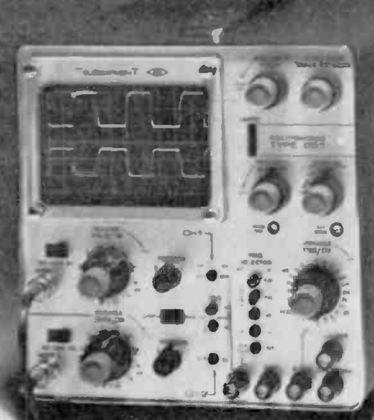
NEW
BISTABLE STORAGE

DM64 10 MHz, 1 mV/cm, 100 ns/cm **$1095**

**$975** D67 25 MHz, 10 mV/cm, 200 ns/cm

NEW

**$795** D66 25 MHz, 10 mV/cm, 100 ns/cm



**$595** D54 10 MHz, 10 mV/cm, 200 ns/cm

U.S. Sales Prices FOB Beaverton, Oregon

The Telequipment line is growing . . . and offers you a greater selection for your next dual-trace scope. Take the new **DM64** . . . it offers 25 cm/ms bistable storage with auto erase, 10-MHz conventional operation, alternate or chopped dual-trace displays and convenient single-button X-Y operation. The new **D66** offers 25-MHz dual-trace performance and X-Y. The **D67** offers laboratory performance with delayed sweep, regulated power supplies, and 3% accuracy. The **D54** offers dual-trace convenience at lowest cost. All have triggered sweeps.

All are backed with the same warranty as other TEKTRONIX products, and are marketed and supported through an international network of Tektronix Field Offices, Service Centers, Distributors and Representatives. Call your nearest office or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.

# Part of the Telequipment line from Tektronix, Inc.

*Circle 82 on reader service card*

**EQUIPMENT REPORTS**

*(continued from page 28)*

wire and tack this one in its place.

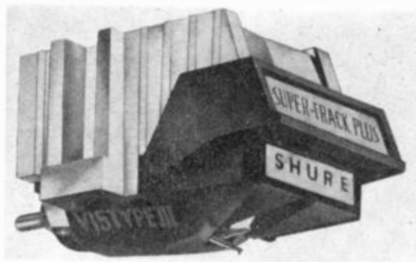
The Mark IV has a rather "firm" fine-tuning, with a "preset-memory" fine-tuner (which works). I hooked it up to my test set and found that every channel was tuned right on the button, color and all. The fine-tuning does not shift when channels are changed. I tried to jar it off and couldn't.

Being entirely self-contained, and very compact, the Mark IV can be taken along on service calls. With some of the huge stereo theater sets we run into today, this could save a lot of work. If you could take only the tuner to the shop, it would certainly be easier.

Two standard 9-volt transistor batteries, in series, power the Mark IV. An on-off switch on the front panel, along with what I think is a LED pilot light, helps to conserve them. The rf gain control has a gain reduction of 60 dB. The other things are on the back: the 300-ohm input terminals, and the 40-MHz i.f. input and output jacks.

If I may repeat myself, any piece of test equipment that will pay for itself in time-saving is worth having. The Mark IV Tuner Subber would very definitely fall into that category. **R-E**

## *Shure VR15-III stereo cartridge*



*Circle 86 on reader service card*

WHILE AMPLIFIERS USED IN HIGH FIDELITY equipment can be designed for near optimum performance across a 20 Hz to 20 kHz spectrum, the transducers—speakers and phono pickups—work well only within a limited frequency range. For example, the pickup designed for optimum low-frequency performance will be less than optimum at the higher frequencies due to tracking problems. We get around the "limited range" problem in speakers by using multiple devices designed for proper operation within a limited spectrum: a *woofer* for the lows, a *tweeter* for the highs and possibly one or two *honkers* for the mid-range (in larger speaker systems).

But we have not yet reached the stage in technology where we can use more than one stylus or bandwidth-sensitive coils in a single phono pickup. Therefore, a phono pickup must be designed for the best possible performance in terms of the *total* high-fidelity spectrum—which is 20 to 20 kHz. Total spectrum performance involves many trade-offs, such as sacrificing some low-frequency performance for cleaner ("shimmering") highs. Alternately, if the pickup is designed for optimum low-frequency performance the highs will be less than optimum. The frequency-vs-performance trade-off is necessary because the stylus compliance (among other aspects) required for optimum high-frequency tracking is not the same as what is needed for optimum low-frequency tracking.

For many years the top-of-the-line Shure pickups—the V15 series—were designed for the best possible compromise in full spectrum tracking, and the V15 was always rated among the finest pickups, with many audiophiles and experts rating it as *the* finest, the reference to which all others were compared. Though the latest product from Shure still retains the V15 series designation, the V15 Type III is a totally new design—almost from the ground up—whose tracking ability considers not just the normal 20-20 kHz frequency range, but also the excessive velocities created by the *warps* inherent in virtually all records. (The stylus designed to track the maximum recorded velocity must also track the excursion which is *added* by a warp(s). If the stylus fails to track both velocity components it must generate distortion which appears as a sound product.)

Another consideration in the Shure V15 Type III pickup is a mechanical resonance above the audible limit of 20 kHz. When the resonance occurs below 20 kHz it will result in a "peaked" electrical response at the resonant frequency. It is, therefore, necessary to design into a pickup electrical attenuation complimentary to the mechanical "peak" so that the overall electrical output is "flat". Unfortunately, it is extremely difficult to design electrical attenuation into the pickup which is the exact compliment of the mechanical resonance, and most pickups, even the finest in terms of overall sound quality, have a moderate peak in the order (generally) of 2 dB at some frequency around 15 kHz.

As a result of this peak and its electrical correction there is a broad dip in the frequency response, generally between 3 and 8 kHz, also just a few dB. The whole effect is like a child's teeter-totter. If the dip is elimi-

*(continued on page 88)*


# WHEN YOU'VE GOT SOLID STATE SENSITIVITY IN A 5" GENERAL SERVICE SCOPE WITH TV-V & TV-H... YOU'VE GOT

LBO-511 $349.95

**What's more, the LBO-511 delivers calibrated vertical input along with rock-like stability, recurrent sweep and automatic synchronization. This outstanding wide-band oscilloscope/vectorscope is the newest in a series of solid state instruments, Leader developed to give you more for your money. Sweep frequency is in 4 ranges from 10Hz to 100KHz and we've added a versatile phasing control, continuous from 0 to 140°. Overall sensitivity is 20mVp-p/cm to 10Vp-p/cm and vertical input is calibrated. The solid-state stability and distortion-free displays are the result of Leader's exclusive FET input stages plus DC coupling and push-pull amplifiers. Bandwidth is DC to 10mHz. And, there are special inputs to obtain vectored pattern displays for color TV circuit testing. Complete with probe, adapter and test leads, the LBO-511 weighs just 15 lbs. and is unusually compact.**

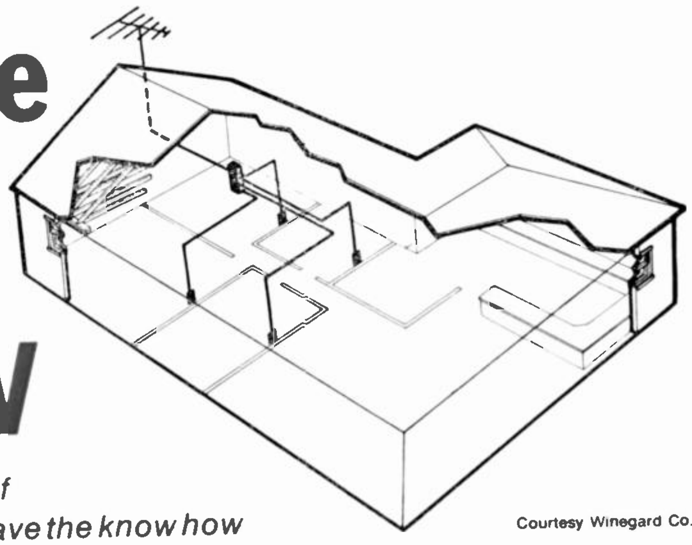
# LEADER.

"Put us to the test"

LEADER INSTRUMENTS CORP. 151 DUPONT STREET, PLAINVIEW, L.I., NEW YORK, 11803 (516) 822-9300

*Circle 13 on reader service card*

# How To Wire A House for MATV



Courtesy Winegard Co.

*Antenna systems are easy to handle if you use the right equipment and have the know how*

**by EUGENE WALTERS**

YOU MAY NOT HAVE A CUSTOMER WHO wants to run 10 TV sets simultaneously, but if his household is fairly typical, he is likely to want to run three TV's and an FM stereo receiver or two—all from one antenna at the same time. Once upon a time, if someone wanted to add a couple of TV sets to the antenna, you just installed a coupler and let it go at that. The 20-dB drop in signal level didn't mean much, since everyone was watching black-and-white, and the picture still looked pretty good.

But today, with color sets abounding, and the stringent signal requirements of the FM stereo buff, a single antenna may have a lot of hardware hanging from it, and the idea is to give each one of these receivers a good signal to work with.

Before you can even start, you have to make a couple of important decisions. Should you install a TV antenna outlet wall-mounted in *every* room of the house? There may be only three television sets, but if two of them are portables and mobility is desired, suggest the wall jack for each room; it has definite advantages (and disadvantages). Also, decide if a mast-mounted preamp is needed. There are three ways to go with antennas: mast-mounted preamp; no preamp, but using a distribution amplifier; and using both the preamp and distribution amplifier. Also, you must decide if you are going to provide vhf, vhf/uhf, vhf/FM, or vhf/uhf/FM. Not only do antennas come in all these possible configurations, so do the preamps and distribution amplifiers.

A mast-mounted preamp is a must when the signal level from the antenna is insufficient to drive the distribution amplifier or couplers effectively. The preamp must be located as close to the antenna as possible, and is powered by a low-voltage power supply in the attic or other convenient location near an ac outlet. Power to the preamp is carried from the power supply to the preamp by the antenna lead-in, so a second cable is not needed.

A distribution amplifier performs two functions. It provides broadband amplification of all TV and FM channels (if you're using it in that mode) mainly to overcome the insertion loss effects of using multi-set couplers and tapoffs. It does not correct for a weak signal at the antenna, and using a distribution amplifier without a good, crisp antenna signal can result in severe loss of signal at each antenna tapoff. This will mean lots of noise (snow) in the picture, running colors, interference and other related evils.

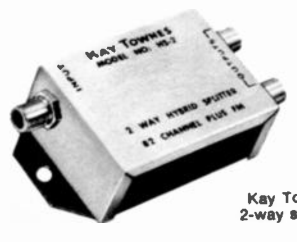
Typically, there are several types of amplifiers to choose from. A typical catalog lists some six different models for home use. These are models for: vhf/FM at 300 ohms; vhf/FM at 75 ohms; vhf/uhf/FM at 300 ohms; vhf/uhf/FM at 75 ohms; vhf/uhf at 300 ohms with built-in two-set coupler; vhf/uhf at 75 ohms with built-in two-set coupler. All are designed for continuous 117-volt ac operation. Depending on the model, ac power consumption can be as much as 3.6 watts.

## Signal loss

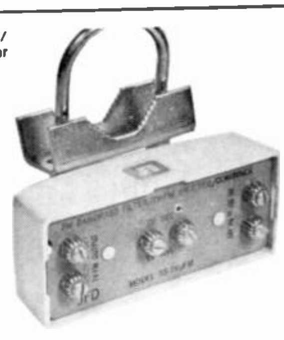
Multi-set couplers, no matter how good, must cause a certain amount of signal loss. This can vary, but a typical figure is 5 to 9 dB for each such coupler. If there is a strong signal at the antenna and only two sets are to be coupled to it, then all other types of hardware may not be necessary. But this is the exception rather than the rule, and certainly in any household with more than two sets operating on a single antenna, some kind of amplification is a must.

Fig. 1 shows a typical setup using all of the available hardware. A two-set coupler is used for the color TV receiver and for the FM stereo rig in the family room. A four-set coupler, which has a higher insertion loss, is used to feed smaller monochrome TV sets and a secondary FM receiver in other rooms.

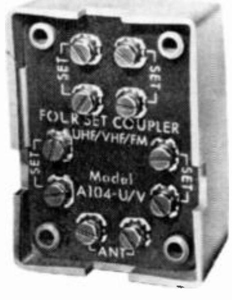
Equipment is available from a va-



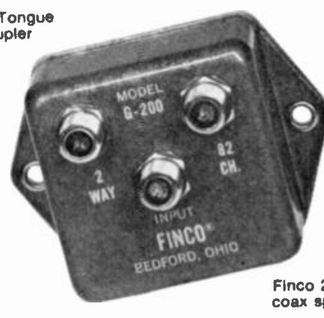

Kay Townes 2-way splitter



JFD filter/splitter/combiner




Blonder-Tongue 4-set coupler




Finco 2-way coax splitter

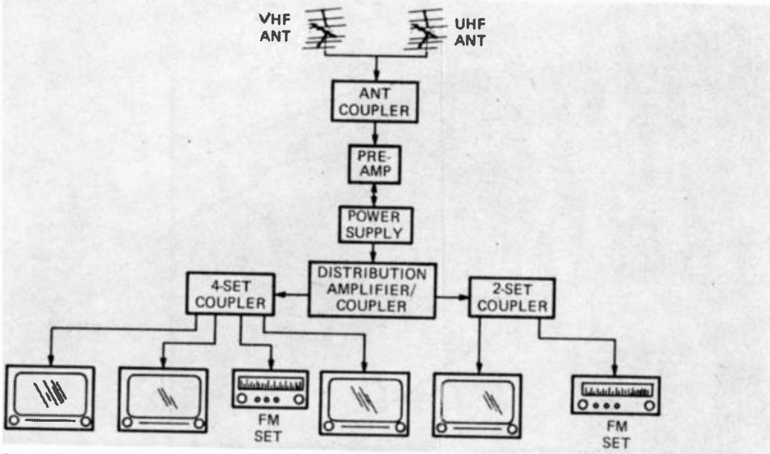



**FIG. 1—TYPICAL MATV WIRING SETUP** in block diagram form. Remember this is a system for a one-family home and is, therefore, relatively simple.

riety of suppliers (see list at the end of this article) for both 300-ohm twinlead and for 75-ohm coax. We're not going to discuss the relative merits of twinlead vs coax here, but each cable type has inherent advantages and disadvantages, and each has its staunch adherents. Whichever type of cable you elect to use, there's hardware for it.

In any master antenna system, the chances are good that more than one TV set will be turned on at the same time. If the home is in a signal area with TV stations coming in from different directions, the obvious solution of an antenna rotor won't work here—not if you want to keep freedom of channel selection available at all TV set locations. There's also the FM listener to consider with this setup.

A fairly painless solution to the problem is two antennas mounted on the same mast, pointing in different directions. These can be combined into a single downlead by using a two-set coupler in the line from the two antennas in reverse order. Fig. 2 shows how this works. The result is that just a single antenna lead-in line feeds all the TV sets, even though you may have two different antennas facing in different directions.

There is a particular hazard in using this setup, though. In a situation where unwanted channels are too strong on the wrong antenna, phase differences can cause some ghosting. In one area of New Jersey, for example, one antenna is pointed at New York, the other at Philadelphia. But Philadelphia's Channel 3 comes in strong on the New York-facing antenna, and when mixed with the signal from the other antenna, this can create multipath problems.

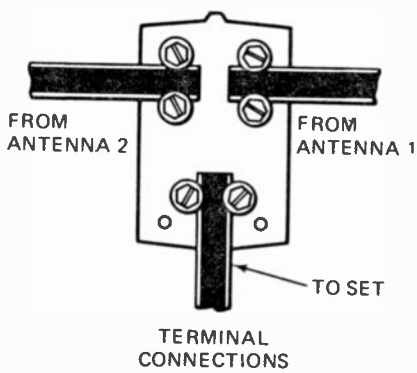



**FIG. 2—A TWO-SET COUPLER** used backwards combines two antennas.

The solution to this and also for too-strong local TV channels that might swamp the receiver's tuner is to use a selective attenuator in the line. Models are available from several manufacturers for vhf low-band, vhf high-band, and the FM band. Each of the vhf traps can attenuate one, two, or three channels, and has adjustments to set the amount of attenuation. For example, in the New Jersey situation, a low-band trap would be set to attenuate Channel 3 on the New York-facing antenna line only. It would be installed between the New York antenna and the combiner as shown in Fig. 3.

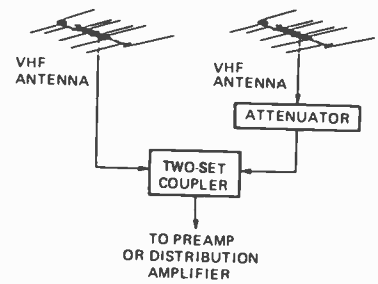
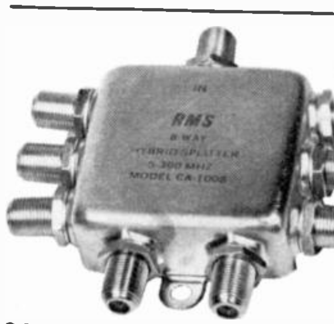



**FIG. 3—TWO ANTENNAS** are handy when signals come from opposite directions.

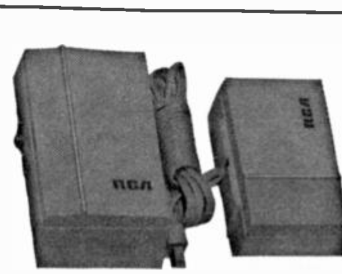
Frequency bands splitters can provide a convenient way to avoid multi-set coupler line losses. Splitters, or frequency-band separators of the all-channel variety have three sets of outputs: vhf, uhf and FM. The insertion loss of one of these devices is so low that it's negligible. Yet, using the FM output has the same effect of using a two-set coupler installed for a TV and FM. The coupler has a line loss of 5 or 6 dB; the splitter has almost no loss at all. So where installations might call for another coupler just to install an FM receiver, opt instead for a band-separating splitter; it saves a lot of dB's.

Another important factor is tilt—something that most home-type distribution amplifiers just don't have. Tilt is the uneven amplification of different TV channels; the higher-band channels get more amplification than the lower-frequency channels. This is to overcome the increasing transmission line signal loss at higher channels. Ideally, amplifiers designed to use coaxial cable should have the greatest amount of tilt, because high-band channels are attenuated more in coax than they are in twinlead. Professional amplifiers have an adjustable tilt control; home-type amplifiers have none. The reason for this flat frequency response is because the amount of high-channel loss in the relatively short cable distribution systems in the home don't warrant tilt. Also, tilt *must* be adjustable to compensate for different cable lengths in a commercial system—installations that have so much cable that severe high-channel losses are inevitable.




RMS 8-way splitter

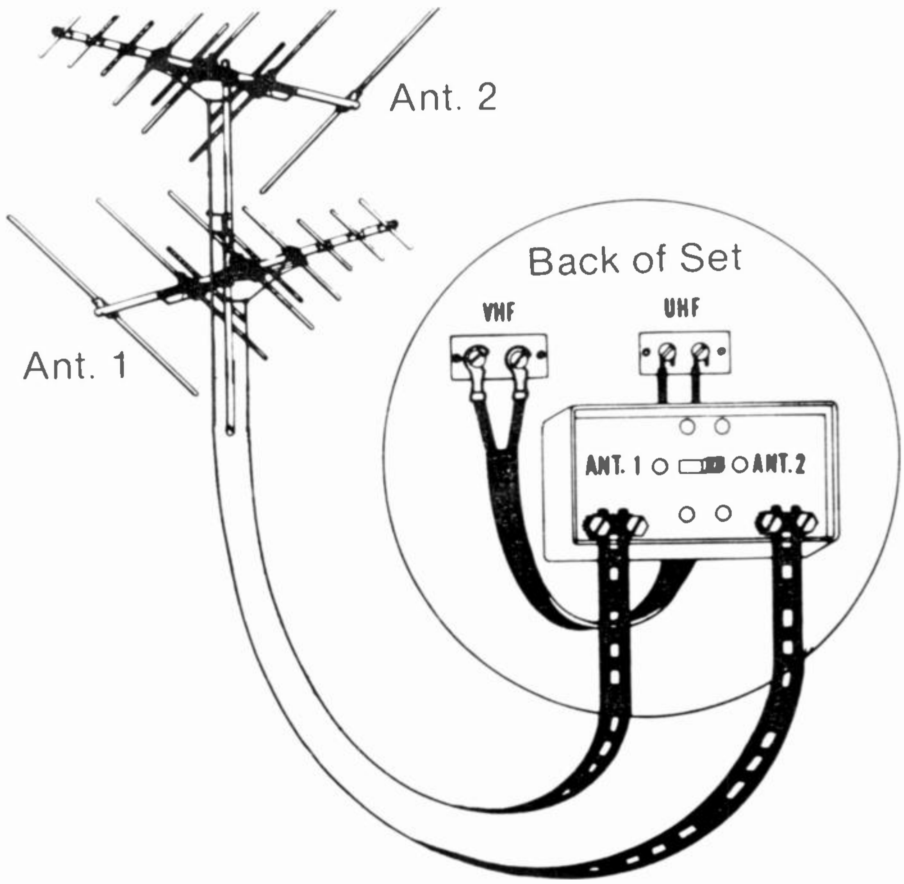

Finco vhf/FM amplifier




RCA preamp

If you opt for a 75-ohm system, consider just where you want to use that coax cable. You may only need it for long antenna-to-distribution amplifier runs, and can possibly use twin-lead for the rest of the system. No matter how you slice it, a 75-ohm system means lots of matching transformers.

The most conventional type of transformer can hang right on the antenna terminals of the TV set. However, in these days of uhf and FM, a splitter is also called for. But this minor headache has been relieved with some new sensible designs—a combined balun and splitter all in one. The mini-handfull gadget takes a 75-ohm antenna lead-in, and has the appropriate vhf, uhf and FM outputs for 300-ohm lines.




**ANTENNA SWITCH-SPLITTER divides uhf and vhf signals from two separate antennas through a switching network.** **Photo courtesy Winegard Co.**

Easiest place to hang a transformer is in a Gem box behind one of those oh-so-neat antenna wall-mounting plates. They're available in various styles from every major manufacturer as well as from sources that aren't well known at all. Some of these outlet plates already contain the 75/300-ohm matching transformer, which can make life a lot easier when doing the installation.

Frequency selection is an important planning factor. In your particular area, vhf may be all that you have available, so you don't have to go to the extra expense of installing all-channel equipment. The same is true for the FM band, especially if there are few good FM stations within reach of your antenna.

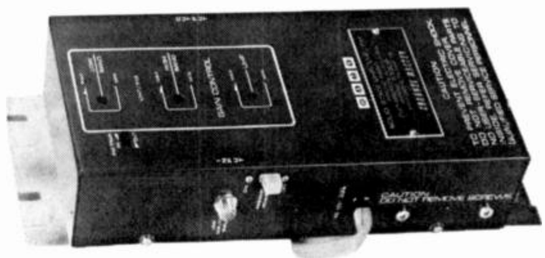
Then too, FM can be a problem, causing herringbone interference on adjacent TV channels (mainly channels 6 and 7). If there is FM interference present, you can do one of several things. First use a vhf-only antenna. Second, install an FM trap in the antenna line. Third, use the FM attenuator switch on the broadband amplifier, if your amplifier is equipped with one. This is a rather drastic step, though, and leaves you with no alternative but to set up a separate FM antenna and run its own cables and distribution. Even more severe measures are necessary when a strong FM station operates at half the frequency of a TV station's video carrier.

Distribution systems for the home are simple and straightforward. Special new accessory items make these systems easy to install and a pleasure to use. Take for example, the combination antenna/rotor wall plate. This lets you hook up an antenna rotor control to the same plug-in wall plate as the antenna.

But it's in the professional system, such as for an apartment or hotel complex that designs get really sophisticated. For a large commercial MATV system, several cut-to-frequency Yagi antennas may be used, with each antenna feeding its own single-channel amplifier. Even where one or two all-channel master antennas are used, individual single-channel amplifiers are called for, since these provide the greatest amount of flexibility, individualized control (such as tilt), and special attenuation (on strong local channels) and other needed features. Interference filters and traps can be wired into the affected channel's amplifier, and coax can be used throughout the system with idealized tilt to compensate for high-band losses.

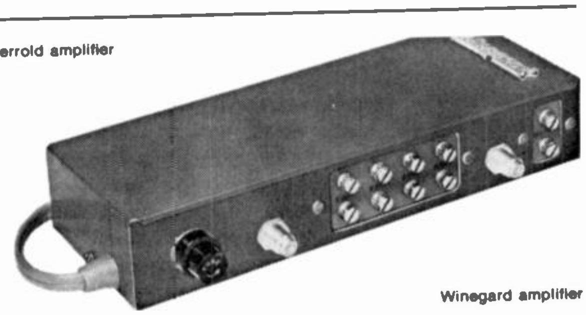
Tapoffs and downleads are different for commercial systems, too, and setting up something like this calls for some preliminary engineering before even starting.

But in the home MATV areas, much sophisticated technology, developed specifically for the commercial setups, is available at a nominal cost today. And while you're keeping costs in mind, here are a few factors that affect the total: number of antennas installed; number of preamplifiers used; the use of a broadband amplifier or several single-channel units; the type and number of TV and FM outlets; the antenna location; type and amount of downlead and connecting cable; cable and outlet installation. **R-E**



Channel Master amplifier

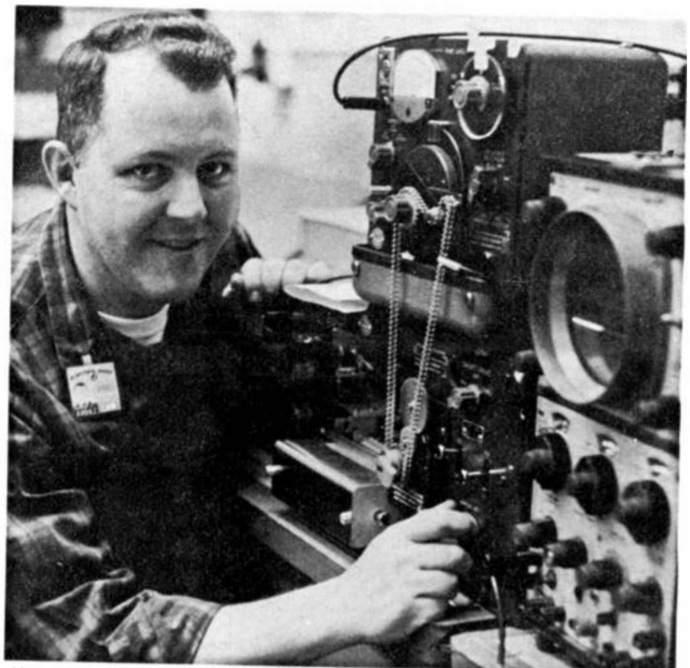

Jerrold amplifier



Winegard amplifier

# One of our most successful students wrote this ad!

**Harry Remmert decided he needed more electronics training to get ahead. He carefully "shopped around" for the best training he could find. His detailed report on why he chose CIE and how it worked out makes a better "ad" than anything we could tell you. Here's his story, as he wrote it to us in his own words.**



Harry Remmert gives his CIE Electronics course much of the credit for starting him on a rewarding career. He tells his own story on these pages.

## By Harry Remmert

"AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

"Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

### The Advantages of Home Study

"Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because it is right there in print for as many re-readings as I find neccessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

"Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

### FCC License Warranty Important

"The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams, and the material had always seemed just a little beyond my grasp. Score another point for CIE.

*CIE backs its courses with this famous Money-Back Warranty: when you complete a CIE license preparation course, you'll be able to pass your FCC exam or be entitled to a full refund of all tuition paid. Warranty is valid during completion time allowed for your course.

"Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

"When a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. I wanted to be a full-fledged student instead of just a tag-a-long, so CIE's exclusive home-study program naturally attracted me.

"Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

"From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

**Two Pay Raises in Less Than a Year**

"Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later.

"These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

**Praise for Student Service**

"In closing, I'd like to get in a compliment for my Correspondent Counselor who has faithfully seen to it that my supervisor knows I'm studying. I think the monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. My Counselor has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

"And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

"I'm very, very satisfied with the whole CIE experience. Every penny I spent for my course was returned many times over, both in increased wages and in personal satisfaction."

For men with prior electronics training . . .

**Electronics Engineering Course**

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

---

Perhaps you too, like Harry Remmert, have realized that to get ahead in Electronics today, you need to know much more than the "screwdriver mechanics." They're limited to "thinking with their hands" . . . learning by taking things apart and putting them back together . . . soldering connections, testing circuits, and replacing components. Understandably, their pay is limited—and their future, too.

But for men like Harry Remmert, who have gotten the training they need in the fundamentals of Electronics, there are no such limitations. He was recently promoted, with a good increase in income, to the salaried position of Senior Engineering Assistant working in the design of systems to silence submarines. For trained technicians, the future is bright. Thousands of men will be needed in virtually every field of Electronics from two-way mobile radio to computer testing and troubleshooting.

**Send for Complete Information — FREE**

Many men who are advancing their Electronics career started by reading our illustrated school catalog, "Succeed in Electronics." It tells of the many electronics careers open to men with the proper training. And it tells which courses of study best prepare you for the work you want.

If you're "shopping around" for the training you need to move up in Electronics, this interesting book may have the answers you want. We'll send it to you FREE. With it, we'll also include our other helpful book, "How To Get A Commercial FCC License."

To get both FREE books, just fill out and mail the reply card. For your convenience, we will try to have a representative call. If card is missing, use coupon below.

**APPROVED UNDER G.I. BILL**

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

**CIE Cleveland Institute of Electronics, Inc.**

1776 East 17th Street, Cleveland, Ohio 44114

Accredited Member National Home Study Council

**Cleveland Institute of Electronics, Inc.**

1776 East 17th Street, Cleveland, Ohio 44114

Please send me your two FREE books:
1. Your school catalog, "Succeed in Electronics."
2. Your book on "How To Get A Commercial FCC License."

I am especially interested in:

☐ Electronics Technology ☐ Electronic Communications
☐ Broadcast Engineering ☐ Industrial Electronics
☐ First Class FCC License ☐ Electronics Engineering
☐ Electronics Technology with Laboratory

Name____________________ (Please Print)

Address____________________

City____________________

State__________ Zip______ Age_____

☐ Veterans & Servicemen: Check here for G. I. Bill information RE 22

*Circle 15 on reader service card*

# *INSIDE* STORY ON

*An unexpurgated report of what it takes to television or FM multiplex.*

**by FOREST H. BELT**

DEALERS AND TECHNICIANS WHO HAVE to guarantee an acceptable color television picture for customers almost unanimously agree: the set must be fed a reasonably strong, ghost-free signal. They also know the monopole or dipole on the back of the set just can't hack it. Nor can those little uhf loops and bows. Even if signals from all the local stations are strong, rare is the location where a built-in TV antenna accepts every station without reflection or lead-in pickup.

But why such a big antenna? What is it about all those rods, bars, and booms that enables them to select just what the viewer wants sent down the lead-in cable to the receiver? You probably know vaguely that dimensions and spacing are major factors. Some technicians and set-owners feel sure that additional rods and bars always bring greater sensitivity. There's more to it than that. Too, most localities nowadays have both uhf and vhf TV stations; that adds another antenna complication.

Major antenna makers spend a lot of dollars on engineering to come up with something "different" as well as effective. That's why you see so many shapes and sizes. Each year, at least one or two manufacturers bring out improvements of some sort. The next year, it's some other brands. But the changes accumulate. There's now an antenna for just about every conceivable reception situation. In choosing the right one, it helps to know what each detail of antenna design accomplishes.

## Advanced, but basic

The fundamental antenna for TV or FM reception has always been the *Yagi*. A dipole, cut precisely to resonate at one-half wavelength of the desired reception frequency, forms the "driven" element. In front of the active element, and cut slightly shorter, are *directors*. Behind, and a bit longer than a half-wavelength, are *reflectors*.

Directors and reflectors are "parasitic" elements; they do not feed the lead-in cable directly. Sometimes they're termed passive, as opposed to active elements. The more directors and reflectors, the narrower the frontal capture pattern—and the greater the array's sensitivity. Yagi antennas cut for single-frequency operation and augmented by many directors and reflectors offer extremely high gain over a simple resonant dipole.

Color television introduces a need for broadband reception. It's fairly important that the entire color television signal be picked up without attenuation of any portion. A Yagi must be treated to broaden its frequency response.

Most reception situations impose an even more stringent need: to pick up several TV channels with one antenna. Here, the plain Yagi fails. Its design is practical for one station only. One alternative lies in stacking several Yagis, one for each desired station. For the ordinary color-TV owner, that's impractical. The accepted approach is through a collection of driven and parsitic elements on one boom. The array resembles Yagi operation but elements combine broadly to pick up all television channels about equally. Most important for color reception, there should be no "dips" or "dropouts" in the overall frequency pickup characteristic.

One antenna that answers to these criteria is illustrated in Fig. 1, the top model in RCA's *Permacolor* series. You may wonder how so complex a design stems from the simple Yagi. First realize that what you see comprises three arrays. Two are broadband vhf antennas, stacked in a forward-tapered formation. The third is a uhf array consisting of special bowtie driven element, corner reflector, and a set of directors. The bends at the front of the two vhf arrays extend the uhf reflector into a near-parabolic dish that focuses incoming uhf energy on the bowtie.

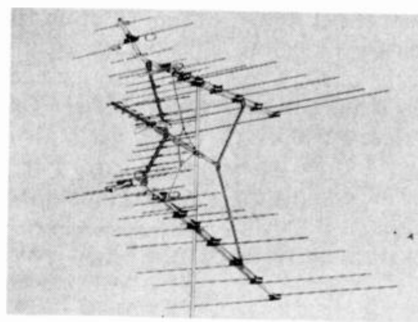


**FIG. 1.—FAR-FRINGE RCA PERMACOLOR antenna incorporates Yagi characteristic of lower-gain models.**

Consider one of the vhf arrays first. The hindmost element, despite looking like a dipole, is a parasitic reflector. The two rods connect together electrically at the center. It is reflector to all the other elements.

The next element forward is a dipole cut approximately for a half-wavelength at channel 2. The centermost ends of the rods are separated. The left-pointing rod connects to the top phasing bar, the right-pointing one to the bottom bar. (Neither connects to the main boom as the rear reflector does.)

The next element forward is another dipole, this one cut for TV channel 3. Note particularly the center connections, which have been transposed on the phasing bars: right one to the top, left to the bottom. This phase-transposition is necessary when driven elements for different channels are close together and must feed a common downlead. Another interesting phenomenon contributes to operation. The elements behind, being slightly longer than this driven element, act as reflectors for channel-3 signals. Elements toward the front act as directors, being slightly shorter than the channel-3 dipole. This ability of driven dipoles to resonate at one frequency yet function as parasitics at other frequencies vastly increases the sensitivity and, therefore, the performance of the antenna array.

## Adding uhf

If only one vhf array were involved, the uhf antenna would stack right on the front of it. The RCA uhf design consists of a corner reflector with rods long enough and spaced to act as a "sheet reflector"; a bowtie spatially bent to favor the low end of the uhf TV spectrum; and a set of directors to improve response to high uhf channels.

In the front-stacked configuration, the corner-reflector rods add pickup for high vhf channels. The tapered design offers an opportunity to enhance uhf pickup as well as vhf. The forward reflectors and boom of each vhf array are bent—one upward, one downward. The angle creates the effect of a parabolic dish for the uhf bowtie. Placement becomes critical in a design like this; the bowtie must be at the exact focal center of the reflector.

A dropoff of frequencies above channel 70 is considered normal in this model. Those channels cover translators. But, for that reception situation, little tabs on the uhf directors can be snapped off easily. The shorter directors force the uhf antenna then to favor the high end of the uhf TV spectrum, with some sacrifice in the response for channels 50-70.

The antenna in Fig. 1 shuts out FM signals rather abruptly. That's to eliminate interference if a strong FM station operates nearby. But, the installer who wishes to include FM in the pickup band of this antenna can modify it.

The "bugle" directors hold the key. Each one is scored just beyond the loop. The scoring makes it easy to break off the end of each bugle director. The new length extends the low-band spectrum right on up through the FM band. The antenna then responds smoothly to both vhf TV bands, to multiplex FM, and to uhf television.

A network of capacitances and inductances you can't even see isolates the vhf array from the uhf. The FM signals join vhf TV in its trip down the common lead-in. At the set, or at the distribution amplifier, a three-function splitter siphons off

# *OUTSIDE* ANTENNAS

*pick up good color*

FM and separates vhf from uhf television.

### From Yagi to wedge

Other manufacturers produce wide-band color-TV and FM antennas based on the Yagi. Variations abound. Full-fledged Yagi designs flourish most where specific reception problems exist. For example, Winegard offers an "Indianapolis special" to suit the peculiar arrangement of television stations around that city. Channels 6, 13, and 20 are north of town, and a special u/v array points in that direction. A three-element Yagi points east for channel 8. A more sensitive Yagi aims south toward channel 4, about 35 miles away. All three arrays are phased together by a harness and feed a single downlead.

An older broadband Winegard series, the *Super Colortron*, carries the Yagi prin-

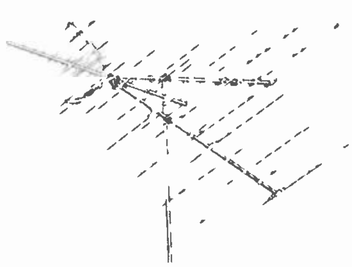
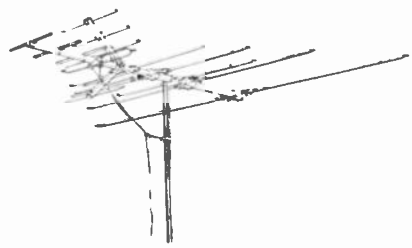


**FIG. 2.—UNUSUAL COLOR WEDGE from Winegard departs from Yagi array in several ways, yet adheres to some of the principles.**

ciple through the uhf and vhf bands. FM is included. A more recent introduction, the *Color Wedge* (Fig. 2), abandons the in-line dipole arrangement. In fact, this model incorporates several departures from "standard" design.

Possibly the most noticeable variance lies in the off-center and staggered elements. All the dipoles you see in Fig. 2 are active. Each rod connects to a phasing bar. But the phasing bars are not at all typical. The lengths of the elements grow shorter from back to front of the array, just as with Yagi designs, to cover the whole vhf TV band. Dipoles perform as resonant active elements at one frequency, and as passive parasitic elements for other channels.

Here's the kicker: The booms themselves are the phasing bars. They are formed as elliptical rods, dimensions 1¼ by ¾ inches. The elements connect to them electrically and mechanically (making construction inordinately sturdy). The phasing-bar booms are kept apart at the apex of the wedge by an insulator. The arrangement, spacing, and lengths of the elements, with the low Q of the phasing booms, present a 75-ohm impedance at the point of the wedge. Staggering elements on the booms, one to the left and the next to the right, introduces the necessary cross-phasing without a criss-cross wiring harness.



**THIS 83-CHANNEL ANTENNA from Antenna Corporation of America holds to in-line design for passive elements, but uses now-uncommon folded dipole for driven element. Uhf array front operates mainly in three-half-wave mode, with corner reflector that doubles as vhf high-band director.**

The obvious overlapping develops the "cells" that permit the elements to double for both low and high vhf bands. Rods that are part of the semi-parabolic reflector for uhf aid somewhat in this "breakup."

The uhf antenna itself trends more toward a yagi design; but directors of various sizes broaden its bandwidth to accommodate the entire uhf spectrum. The unusual curved reflector concentrates uhf energy efficiently on a special driven element. The latter is longer than you'd expect for a uhf yagi, and its two dipoles are connected in the center by an oddly shaped frequency/impedance correlator.

One other quality of this Winegard series seems worth noting: the close spacing of the elements. This is characteristic of the earlier *Super Colortron* series too. In those models, the short spacing was made pos-

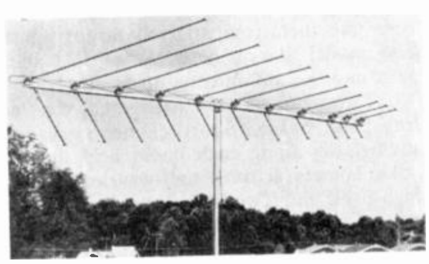


**FIG. 3.—THIS JFD ELECTRONICS DESIGN was the first to include the log-periodic principle of element size and spacing.**

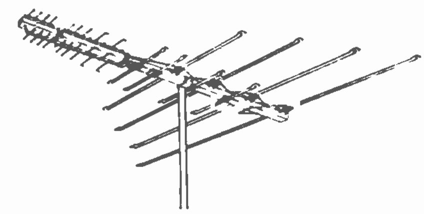
sible by "corrugated" phasing strips.

As is common with antennas that don't block out FM frequencies, a three-way splitter at the set end of the downlead separates uhf, vhf, and FM.

### Log-periodic designs

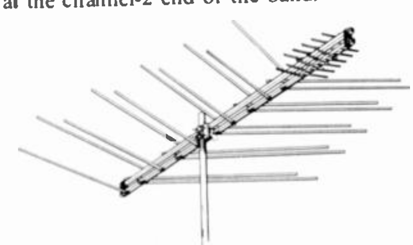
This description, which has been around several years, refers to a particular length-and-spacing relationship among elements. The concept was pioneered by JFD Electronics. Several manufacturers have since borrowed the idea. JFD put the design into a configuration called *log-periodic vee* or just *LPV*. An example appears in Fig. 3

The lengths of dipoles follows a principle similar to that already described for Yagis. That is, the longest, at the rear, resonates to a half-wavelength of the lowest vhf television channel frequency. Successively shorter elements, proceeding toward the front, resonate at correspondingly higher



**ANTENNACRAFT CDX-SERIES of antennas combine some characteristics of Yagi, some of log-periodic. In-line dipoles work at half-wave for low band, at full-wave for high. Channel-2 droop is alleviated by close phasing loop at rear. Transposed phasing harness smooths response across band. Uhf array in front uses twin-boom staggered phasing for dipoles, and in-line directors for response at high end of uhf.**

channel frequencies. Phasing is taken care of by a crossed harness, leading from element to element. Dipole length and spacing follow a formula that includes a logarithmic relationship to frequency. A closed stub at the rear helps overcome response "droop" at the channel-2 end of the band.



**THE BLONDER-TONGUE PRISMATIC series combines several principles discussed in text. Twin booms with staggered elements at log-periodic spacing contribute smooth channel-to-channel response across vhf band. Forward sweep improves front/back ratio and forward gain. Uhf array is merely continuation of design for vhf, except that dipole elements are not swept forward into vee.**

The log-periodic relationship, with the transposed phasing, makes the antenna resemble a helical spiral—a principle incorporated in low-noise broadband antennas for satellite reception. For each television channel, elements toward the rear act as reflectors to the resonant element. Those to the front act as directors. Dipoles that are basically half-wave at low-band vhf break up into three half-waves for high-band. For vhf television and FM, this "helix" boasts smooth sensitivity across the entire band.

Sloping the dipoles forward into the vee formation narrows the frontal pickup lobe. That raises gain, especially at the higher end of the TV band, and improves front-to-back ratio. Recent versions (Fig. 4) use the twin-boom means of transposing dipole phasing. Two booms hold the dipole rods in a staggered pattern that accomplishes phase transposition. Also, capacitive buttons have been interjected in forward elements to smooth the breakup for high-band reception.

**FIG. 4.—MORE ADVANCED LPV ANTENNA for uhf and vhf brings new innovations to the basic log-periodic design.**

The uhf antenna appended at the front of the antenna in Fig. 4 uses flat-plane log-periodic driven elements in a wedge formation. The wedge, as for vhf, helps narrow the vertical capture angle in front and combats ghosts that plague uhf reception. A rod-and-disc director system offers very broadband gain to the uhf array.

## Uniform periodic

The log-periodic approach nowadays outstrips the Yagi in popularity for all-channel TV and FM antennas. But not all designers adhere to the logarithmic pattern faithfully. For the *Super VU-Finder* line of antennas (Fig. 5), Jerrold Electronics has adopted "uniform periodic" spacing. Whereas the log-periodic arrangement theoretically gives even sensitivity across the whole TV band, this slightly altered spacing imparts a rising curve. The antenna shows progressively greater gain as channel frequencies go higher. This partially overcomes the increase in propagation loss from low to high channels.

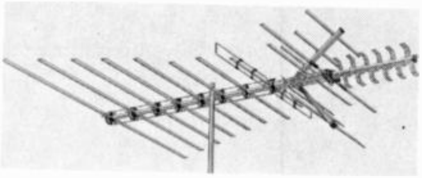


**FIG. 5—ANOTHER MODIFICATION of log-periodic principle, known as uniform-periodic, is typified in this Jerrold all-channel *Super-VU-Finder*.**

The new series advances the *Paralog* design that Jerrold offered for several years. Basically a channel-2-through-FM half-wave array, the vhf section converts to full-wave operation for high-band channels. The chief trigger for this dual-mode operation is the trombone-shaped folded-dipole parasitic element up near the front.

Phase transposition takes place in an interesting manner. The dipoles are in-line, separated by disc-shaped insulators. Notice the two straight-line phasing strips, one above and one below the insulators. Phasing connections are imbedded inside each insulator. One carries its right-pointing dipole-half to the top phase strip and its left-pointing dipole-half to the bottom one. The next insulator reverses that order. The third goes the same as the first, and the fourth the same as the second. And so on throughout the array. Phasing is thus criss-crossed without worry of phase-wire interaction and without staggering the dipole elements.

The uhf array sports a special low-Q three-quarter-wave dipole. A corner reflector focuses incoming uhf energy on the driven element. The unusual quarter-wave X-type directors are Yagi-spaced and offer a very narrow, circular horizontal/vertical reception lobe to uhf signals. Their width-versus-length make them broadband across the upper end of the uhf TV band.

## "Reverse" spacing

Even with antennas that don't follow the log-periodic formula for spacing, elements at the rear ordinarily spread farther apart than those up front. The antenna in Fig. 6 breaks that tradition. All models in The Finney Co.'s new *80 Series Color Spectrum* line follow a patented spacing principle that the firm tags "frequency Dependent Principle."

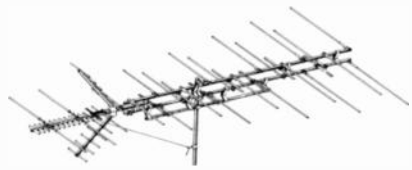


**FIG. 6.—LATEST FINCO ANTENNA, the 80 Series Color Spectrum, takes an opposite approach to element spacing—almost log-periodic in reverse.**

The prime object of the "FDP" is to stagger the gain of the antenna to match and counter propagation loss exhibited by television signals at higher channel numbers. Instead of decreasing dipole separation toward the higher-frequency front of the array, the frequency dependent principle puts them comparatively farther apart. The model shown here carries that idea even into the uhf antenna up front.

Twin booms and staggered dipoles transpose phase. Short elements spaced strategically along each boom help the dipoles operate at three half-wavelengths for high-band vhf. Two high-band directors are part of the corner reflector in the uhf array. They're broken up by insulators so they don't upset the uhf capture pattern. These directors also help isolate uhf from vhf. The uhf driven element is channel-shaped, which Finco engineers find rather broadband, almost like a folded dipole. Channel-aluminum strips make up the uhf directors. As with similar uhf arrays, the directors provide high-end gain and the reflector low-end.

## Folded dipole with IC

Adding an amplifier to an outdoor antenna certainly is nothing new. Nor is the folded dipole new, although it doesn't figure in many antenna designs these days. You might also shrug "so what's new?" about integrated circuits. But Kay-Townes, Inc. has brought these not-so-usual ingredients together in a lone of antennas called the *ICA* series.

The antenna design shows in Fig. 7. Folded dipoles, cut for half-wave operation at low-band vhf, mount on a twin boom. Folded dipoles are somewhat broadband in normal operation, so not many are needed to give reasonably smooth coverage of the low vhf band. High-band passive elements, staggered along the two booms, assure full-wave dipole operation for high-band vhf. A director far up front aids low-band gain, and the uhf corner reflector aids high-band vhf.

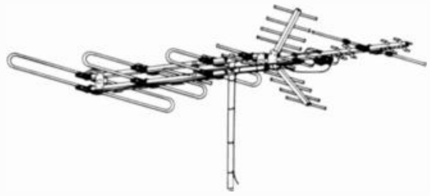


**FIG. 7.—INTEGRATED-CIRCUIT AMPLIFIER is standard part of this Kay-Townes model ICA-500.**

The uhf portion contains two folded dipoles as broadband driven elements. An array of X-type directors assures response to high uhf channels.

What justifies the Kay-Townes claim to high antenna sensitivity is an integrated-circuit signal amplifier. The usual drawback to antenna amplifiers is noise. The antenna picking up a weak television signal often can't make the signal override the noise level in the amplifier. Hence, no matter how high the amplifier gain, all you see is more snow on the screen. The gimmick here is a low-noise, wideband integrated circuit. Company spokesmen offer no clue to where this special IC comes from, but here are some claimed specs: 20 dB gain, absolutely flat from 50 to 1000 MHz. Most important of all, the noise figure is no more than 4 dB, across the whole spectrum. Compare that with the usual 6 dB for vhf and 8 dB or more for uhf, and you get the notion that this amplification might mean something—given a halfway reasonable signal from the antenna.

Beware of one antenna-preamp problem. Close to stations, the IC amp overloads easily. A gain adjustment on the newest K-T version, labeled "Zoom control," adapts the system to exact signal conditions.

## Summing up

So, what does all this technical data on antennas mean to you when you go to choose one? Only that you can evaluate sales literature a bit more intelligently. Some antenna makers still compare "gain" figures or "this many dB's" more signal. Unless you know the specific conditions of measurement, such figures don't mean much.

Study the configurations you think best fit your locality. Need high sensitivity on uhf but ordinary operation on vhf? Pick a model that offers that combination. Need just the opposite? Choose accordingly. At the very least, when a customer asks why a particular antenna does the job it does, you can explain. **R-E**

# TV TYPEWRITER

***This character generator and your TV set form a computer terminal, educational toy or display device. Basic details are here. Full and complete data is yours when you need it.***

by DON LANCASTER

This construction project started out as a very low-cost computer terminal for home use, but as it went together, we became aware of the many possible noncomputer uses for such a device, particularly since it is priced right. What can you do with a machine that puts letters and numbers on an ordinary unmodified TV set?

Obviously, it's a computer terminal for timesharing services, schools, and experimental uses. It's a ham radio teletype terminal. Coupled to the right services, it can also display news, stock quotations, time, and weather. It's a communications aide for the deaf. It's a teaching machine, particularly good for helping preschoolers learn the alphabet and words. It also keeps them busy for hours as an educational toy.

## GET THE COMPLETE STORY

**The TV Typewriter is a very special story. Complete construction information, including full-size circuit-board patterns would require a long, multi-part article in Radio-Electronics.**

**To make it possible for interested readers to get full details of the unit and to immediately start construction, we are making available a special package of additional data, including complete construction details, more data on how it works, troubleshooting tables, connections and other important information. The cost of this 16-page package is $2.00.**

**To order your construction details, send $2.00 to:**

**TV TYPEWRITER**
**Radio-Electronics**
**45 E. 17 St.**
**New York, N.Y. 10003**

**This is the first time that Radio-Electronics has presented a construction article in this fashion. We would appreciate your comments on this approach. Remember, by doing this we can offer readers many more construction articles in Radio-Electronics without the need to wait for more details in the next issue. Also we can provide full-size printed circuit patterns and overlays.**

**Use the reader service card in this issue to tell us what you think. If you like this approach, and want to see us use it more often, circle number 132. If you *do not* like this approach and *do not* want us to use it again circle 130.**

**If you don't use the reader service card to register your feelings address your letters and cards to the Editor, Radio-Electronics, 200 Park Ave South, New York, N.Y. 1003.**

It's a super sales promoter, either locally or on a store-wide basis. It's easily converted to a title machine for a video recorder. It's a message generator or "answer back" unit for advanced two-way cable TV systems. Tied to a cassette recorder, it's an electronic notebook and study aid, or a custom catalog. It's an annunciator for plant, schools, and hospitals that tells not only that someone is needed, but why and where.

And, if all that isn't enough, it's easy to convert into a 12- or 16-place electronic calculator. You can also make a clock out of it, and, with extensive modification, you can even make a 32-register, 16-place serial digital computer out of the beast!

Cost of the project? Around $120 for the basic unit. This is slightly under two month's normal *rental* of commercial units that don't do nearly as much, and less than 1/10 the cost of anything commercial you could buy to do the same job. And we feel that this cost is finally low enough that a lot of new uses are now not only possible, but reasonable as well.

The low cost comes about by using the latest available semiconductors, leaving the keyboard and case as flexible options, and working in kit form.

Printed-circuit boards and complete kits are readily available as are any special or hard-to-get-normally parts. A limited quantity of high-quality keyboards are also available from the same source. This is not the sort of thing you'd want to try as a first electronic project, but if you are willing to slowly and methodically work things out and carefully reason out any debugging problems, you shouldn't have an unreasonable amount of trouble getting the thing to work. Once you're past a certain stage early in the construction, the TV set itself becomes a self-testing display that greatly simplifies debugging.

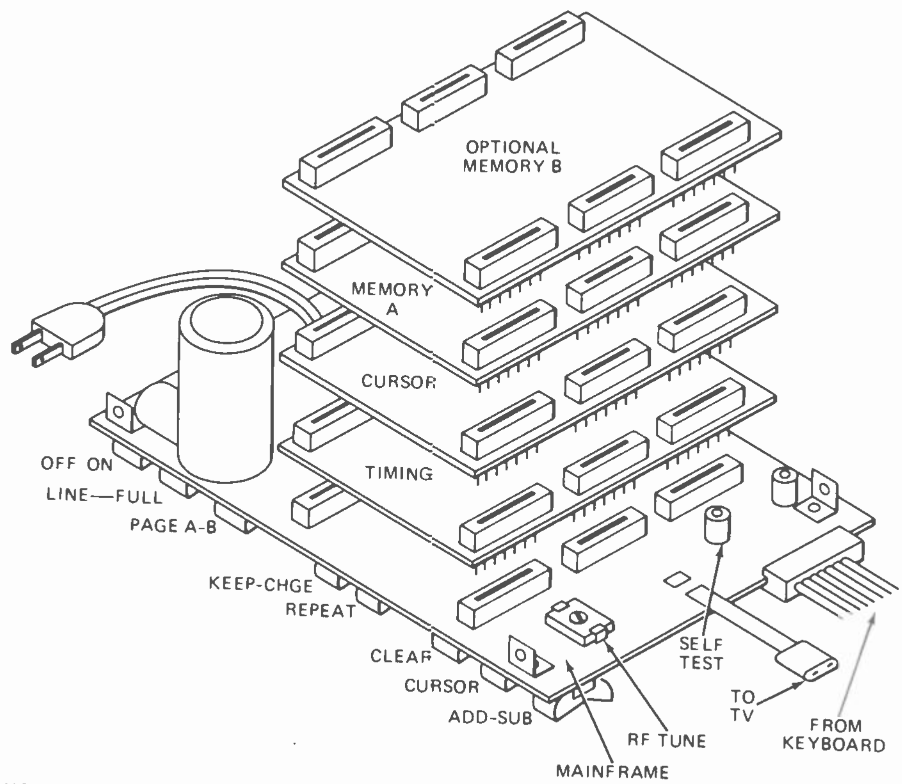
To make things easier, you can get a complete copy of the *entire* story that includes additional design information, how it works, PC patterns, construction details, etc. *DO NOT ATTEMPT CONSTRUCTION WITHOUT THIS ADDITIONAL INFORMATION!*

Construction is done in stages. Once each stage is tested, it is safe to go into the next, progressively working up to a complete unit. The basic machine we'll show you works from a keyboard or a set of six switches and a pushbutton. Thanks to the plug-in construction, low-cost add-on circuit boards can let you talk to a computer or a cassette recorder, or adapt the unit for 12-place calculation. These add-ons will be picked up later if enough readers seem interested. They're not needed for most of the possible applications of this TV Typewriter.

### Specs of the unit

Complete specs appear in Table 1. The basic device generates and stores 512 characters, arranged as sixteen lines of 32 characters each. A second page of characters is easily added internally to bring the total up to 1024 characters. For more storage, a C90 cassette can store well over a hundred pages, so the total capability is quite large. The characters available are standard ASCII ones that include the capital letters, numerals, and most punctuation.

The TV Typewriter is self-powered and contains its own miniature TV transmitter which simply clips onto the antenna terminals of an unmodified TV tuned to an unused channel. Several TV's may be driven simultaneously, and a direct video output is also available for industrial and experimental uses. While any TV can be "borrowed" and used with the typewriter, small, high-quality portables give the nicest presentation, and slight size and position




**HOW TYPEWRITER ELECTRONICS IS ASSEMBLED within the case. The timing, cursor and memory boards plug into the mainframe and each other, cordwood fashion.**

**A SURPLUS KEYBOARD is used in this version of the TV typewriter. Unit on cover has a homemade keyboard based on the article in the February issue.**

**TABLE I**

COMPLETE SPECIFICATIONS—TV TYPEWRITER

| | |
|---|---|
| STORAGE: | 1024 Characters arranged as 2 pages of 16 lines of 32 characters each. |
| OUTPUTS: | Rf Output tuneable from channel 2 through 5; clips directly to the antenna terminals of one or more unmodified television sets. Optional positive-white video output. |
| INPUTS: | Parallel, TTL compatible, ASCII character code (Table II) is input with positive logic on six lines; a seventh *keypressed* line is suddenly brought to ground to input character, Internal debouncing. The full 8-bit ASCII code may also be used as an input. If done, *any* CTRL input will be interpreted as a combined CARRIAGE RETURN and LINE FEED, CTRL output available for code extension. |
| FORMAT: | Begins in upper left HOME position and proceeds as in normal typing. Carriage return and linefeed automatic at end of line. At bottom of screen, jumps to upper left HOME position and rewrites over old text. |
| EDITING: | Winking cursor indicates next character position. Cursor may be blanked and may be independently moved in any direction with or without changing text. One or more letters may be easily changed at any time. |
| TIMEBASE: | Internal, crystal controlled TTL divider. Basic video clocking rate = 4.562 MHz. 15,840 kHz noninterlaced horizontal scan rate; 60-Hz vertical scan rate. Easily converted to full interlace for Video Recorder titling applications. |
| MEMORY: | 512 word by 6 bit MOS dynamic storage, bus oriented for easy page conversion, optional memory output, and optional extension to calculator, computer, and other functions. |
| CONTROLS: | Internal: Rf frequency (trimmer capacitor)<br>Position—(Jumpers—4 horiz; 3 vert for 12 possible locations.)<br>EXTERNAL: ON-OFF<br>PAGE OR LINE SCAN<br>KEEP-CHANGE memory protect<br>A or B page select<br>REPEAT or SINGLE character<br>HOME or RUN cursor location<br>CURSOR ON-OFF<br>ADD-SUBTRACT cursor direction |
| CONSTRUCTION: | Modular mother-daughter boards. Mother board contains power supply, rf modulator, and control switches. Timing board, cursor board and one or two memory boards snap on as a stack. Add-ons such as calculator and MODEM FSK unit snap onto same stack; not included in basic unit. 33 integrated circuits, of which 8 are MOS LS1. |
| SIZE: | 7"x8½"x3", not including keyboard or case. |

adjustments can further help the appearance, although they are not needed.

The characters are added one at a time and normally go on the screen just like you were typing. This is done by providing the proper ASCII character code on seven input lines and tripping an eighth "key pressed" line to enter the character. A winking cursor tells you where the next character is to go, but you can turn this off if you want to. Should the screen get filled, the machine starts over again on the top, rewriting over the old message.

Besides the normal operation, you have a complete editing capability. You can move the cursor either direction anywhere you want and then change only the characters or words you wish to, thus editing something you already have on the screen. This nicely handles mistakes without having to start over again. A REPEAT key is available for putting down a group of identical characters or getting to a given position in a hurry. There's a KEEP-CHANGE switch to protect what you have written while you are moving around, and you can home the cursor to the upper left either by itself or erasing the whole picture on the way. Other switches control the direction the cursor goes, which page is being displayed, and optionally whether the mode will be a full screen one for typewriter use or a line scan one for calculator use.

Computer people would call this a parallel input system with off-line editing. A single machine command is available; this is the LINE FEED. Thus, any CTRL key moves you down a line. Other remote commands are easily added, but were left off to hold the cost down. The contents of the memory can be retransmitted with simple circuit modifications, and the whole system is bus-oriented to allow all sorts of add-ons without major circuit rework.

Character input rate is asynchronous and up to 30 characters per second, thus making the beast three times faster and compatible with the industry standard ASR-33 teletype. Hard copy is via cassette recorder or Poloroid[r] photos.

## Organization of the instrument

To keep things as simple as possible, the circuit is arranged like a set of snap-together blocks. This way, the only interconnect wiring consists of the line cord and the 300-ohm twinlead output. Since the interconnect wiring is locked into the board and 60-pin connector system, the biggest single headache and potential error source is eliminated.

Fig. 1 shows the basic blocks. The MAINFRAME contains a power supply of +12, +5, -5, and -12 volts; the control switches; the rf modulator; the internal test system; and connectors for both the keyboard and the other boards in the stack.

There are three other essential boards. The MEMORY board is the most important and the most complex. It contains a dynamic MOS (Metal Oxide Semiconductor) shift register that stores 512 words of 6 bits each. It also holds a single-line memory; a character generator; and an output video register. We'll see later that the single-line memory is needed to get each character back eight times in sequence for eight successive TV scans.

For a page-A memory, you need all of *(continued on page 50)*

# BUILD YOUR OWN BELL & HOWELL SOLID-STATE 25-INCH DIAGONAL COLOR TV!

## It's an enjoyable way to learn new skills that could launch you on a brand-new career in electronics!

## For free information, mail postage-free card today!

this board. The additional page-B memory does not need a new single-line memory, character generator, and output video register, as it can borrow the one in the page-A memory when the second page is in use. This is called *bus organization*. The character generator will respond to anything that is enabled on the bus, be it page-A memory, page-B memory, a calculator add-on, or whatever. Of course, we have to be careful to only enable *one* possible source of characters at a time, but this is easy. We can also use the bus optionally to *output* characters to the outside world.

The output of the memory board also contains a video combiner that assembles the character video, sync signals, and the internal test signal into one composite video output. This output may either be used directly or routed to the rf modulator for clip-on operation of an unmodified TV. It can be optionally flashed or blinked.

The TIMING board contains a crystal divider and TTL (Transistor Transistor Logic) countdown chain that generates all the needed signals to run the typewriter in proper sequence. It does not normally use interlace, but the timing chain is split so that the somewhat more complex TV full-interlace system can be added if you need this sort of thing for video titling. There are two principal areas to the timing board, the MAIN timing, and the DERIVED timing. The main timing is the continuous waveforms obtained off the crystal divider, while the derived outputs combine portions of the main timing signals into properly coded signals needed to run the rest of the typewriter. Two examples are the composite sync signal and a blinker used for flashing, cursor winking, and repeat functions.

The third essential board is a CURSOR board. Anyone who ever tried to design and debug a simple one of these will easily understand why it is called a cursor board. Anyway, the cursor keeps track of where the next character is to go; runs the winking line that shows the character position; controls entry of the character; and optionally sets up characters for output. It also contains an input conditioner, and debouncer and a detector for CTRL commands that tells the typewriter to carriage return rather than enter a character.

Many cursor systems are extremely complex. This one is relatively simple in that it uses a *phase-shift counting technique*. The cursor has a *continuously running* counter just like the main timing chain does. Its output drops suddenly in some *relative* position, indicating where the next character is to go.

To back the cursor up, we throw in another count pulse. To run it forward, we hold back one normal count pulse. Thus, the *relative* position or phase of the cursor counter advances or backs up with respect to the system timing. Actually, to go forward, we hold back *two* normal system timing pulses and throw in a new one. This buys us a simplification of circuitry, but still ends up with the same result.

An ADD-SUBTRACT switch on the mainframe controls the cursor direction for editing. LINEFEED is handled by adding and removing the proper number of counts in the proper position in the cursor counter so that the new position is reached. Just like most typewriters, the linefeed always returns to the lefthand side.

In normal operation, each character entry moves the cursor over one character. When it gets to the end of the line, it starts again on the next line. When it gets to the bottom of the page, it starts again at the top. A CLEAR or HOME override also moves the cursor to the upper lefthand position.

And, this is about all you need for a normal parallel entry type of TV typewriter. One possible optional board is a MODEM or frequency-shift-keying interface. This would use a MOS chip and some TTL to convert to or from a serial tone input, suitable for computer or telephone line communication. A cassette recorder will work just as well with the modem for electronic notebook use.

Another possible add-on makes the typewriter into a calculator. This is done by converting the scan from a complete frame to a single line of numerals and would use a surplus calculator chip to provide the familiar calculator functions. If you already have or need the TV typewriter for something else, this add-on is far cheaper than a conventional calculator would be, and its display would be obviously larger and more readible.

Or, you can add most anything else you want onto the machine by tieing into the bus-oriented lines (b1 through b6). For instance you can think of the memory as sixteen registers of 32 numbers each, and those numbers are decimal numbers plus, not bits! With six bits per word, you can store 10 possible numerals and 54 machine commands in any word! Or, you can split the registers into 32 registers of 16 decimal numbers each, building your own computer or programmable calculator.

Of course, this computer-add-on is very much an advanced experimenter project, but it really doesn't take much more than a double handful of TTL to pull it off. While such a computer will be relatively slow (around a 33-ms cycle time), it does provide an extremely accurate and very low cost computer approach, particularly when you are working directly with BCD numbers instead of binary.

## Some basics

Before we turn to the actual circuitry, some basics of what a character is and how it can get on a TV screen is in order. Lets start with the characters:

If we had six possible binary bits of either 1 or 0, we would have sixty-four different possible combinations ranging from 000000, 000001, 000010, . . . through to 111110 and finally 111111. These 64 different states can represent all the capital letters, all the numbers, a blank, and most punctuation, following the standard ASCII code. In the TV Typewriter, all of the six bits of this code must be presented at once or in *parallel* form, and this is the *only* code the circuitry shown can use. Other codes can be converted to ASCII before going into the TV Typewriter. A seventh bit is used to separate characters from internal commands.

Our final presented character consists of an array of 5 × 7 dots. Since it only takes 6 bits to store a coded character and at least 35 bits to store a generated one, its obviously much better and cheaper to generate the characters *after* they are stored, rather than before.

For other keyboards and encoders, the

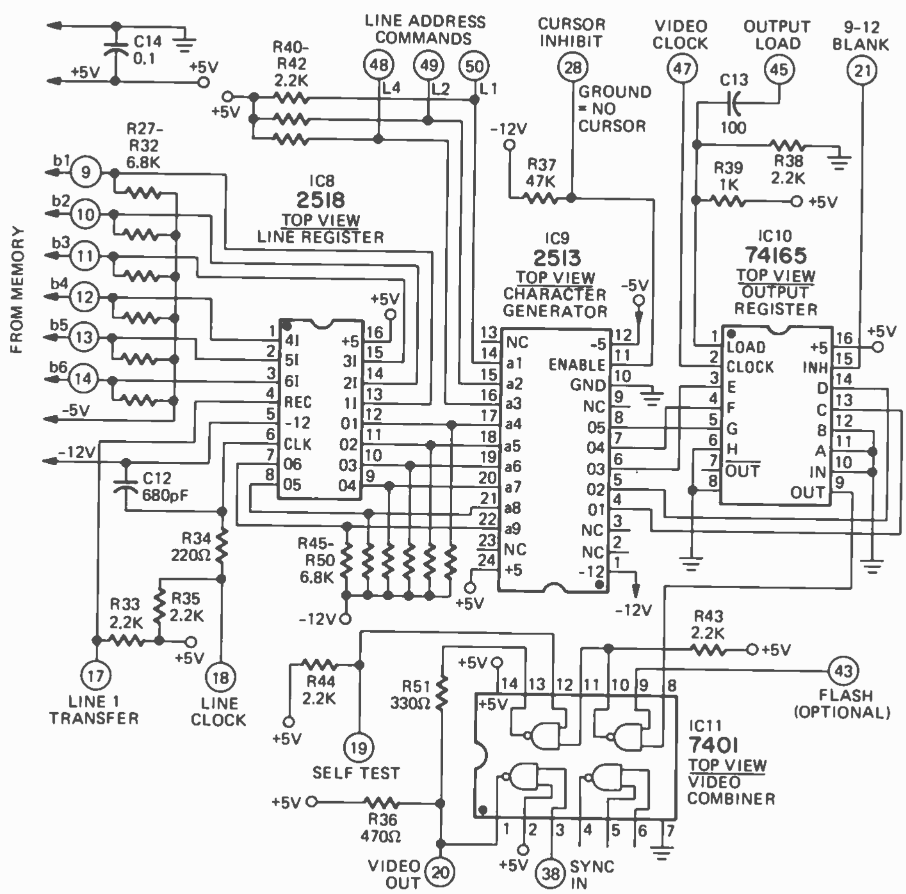
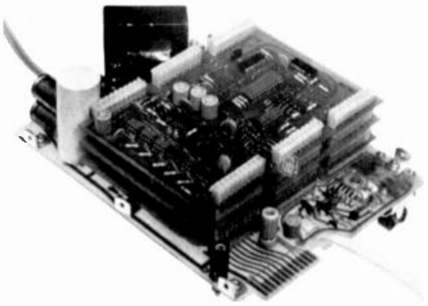



**FIG. 2—SCHEMATIC OF THE CHARACTER GENERATOR. the use of integrated circuits greatly reduces circuit complexity and makes possible a very compact device.**



**INSIDE VIEW SHOWS STACKED BOARDS containing the electronic circuits in the TV typewriter.**

typewriter gives you lots of +5 and a choice of +12 or -12 volts at relatively low current. The original **Radio-Electronics** ASCII encoder needs the +12; a mechanically encoded keyboard will only need +5, while a MOS encoded keyboard probably will need +5 and -12 volts.

A limited quantity of suitable keyboards is presently available from the kit source. Other sources of input material include computers, calculators, the phone line, or a cassette recorder. Many of these signals will be in serial or one-bit-at-a-time form and have to be changed to the parallel ASCII code. This takes an add-on board using a MOS terminal-receiver chip. Regardless of the source, your input must be in parallel form when presented to the typewriter, with a "1" near but not exceeding the internal +5 and a "0" near but not going below ground. Internal debouncing is provided on the cursor board for manual keyboard entry.

### Interfacing with the TV

To use an unmodified TV, we have to build a miniature transmitter and arrange the signals so they compare as closely as possible to a normal broadcast set of scanning standards. This way, any TV can be driven by the typewriter simply by clipping onto the antenna terminals and tuning to an unused low channel.

A TV starts in the upper lefthand corner and sweeps a dot rapidly to the right and slowly downward, taking around 62 μs to get across the screen and 33 ms to get to the bottom. It then repeats the process again and again, presenting a series of dots that assemble into a series of still pictures that the tube phosphor and your eye integrate to get the effect of a complete and usually moving picture.

Brightness is changed on each dot by controlling the picture tube's cathode current, which in turn follows the input rf signal seen at the antenna terminals. Very low signal is seen as white. The stronger the signal, the blacker the picture. The sync signals are the strongest of all, or "blacker than black", and are used to synchronize the scanning of the television set to the transmitted signal.

To provide sync, we need one horizontal sync pulse at the beginning of each scan line, and one vertical sync pulse for the beginning of each frame. To keep things simple, we make all the frames identical in the TV Typewriter instead of using interlace. Interlace has no advantage on a stationary message presentation and simply adds parts. If you have to you can easily add it for video titling or other places where you must superimpose the TV Typewriter's output onto an existing program.

We assign 48 possible character positions across the TV screen, but we only use 32 of them. The remaining 16 allow for retrace and the extreme overscan used on economy TV's. We assign 12 scan lines per row of characters. The uppermost scan line is blank except possibly for a winking cursor that appears as a bar above the next character to get input. The next 7 lines form the character as a series of dots 5 dots wide by 7 dots high, and the final 4 lines are blank. These allow for the space between character lines.

We likewise assign 22 possible character lines but only use 16 of them, this time saving 7 for vertical retrace and overscan. By picking the right timing frequencies, we obtain a horizontal rate thats so close to the normal rate the TV doesn't know the difference, and a vertical rate of exactly 60 Hz. The latter is especially important to keep hum bars out of the display. Since each frame is stationary and ends with a bunch of blanks, Equalizing pulses are neither needed nor used.

Each character takes six bits of storage, arranged as one parallel 6-bit word. The storage is used to hold the character from time of entry until it is no longer needed, which can range from seconds to days. For a single-page memory of 512 characters, we use six 512-bit recirculating MOS shift registers. These go around once each TV frame. The timing and cursor boards together decide *where* in each of the six registers a new character is to go. Once in memory, the character stays in the same relative slot until it is cleared or replaced. The memory is violatile, meaning that you lose the message if power drops for more than a half a second or so.

Note that an ASCII blank is 100000. All 1's is a "?" and all 0's is an "@". This is helpful when troubleshooting, for its rather difficult to get a totally blank screen by accident. On the other hand, this means we have to be careful when we clear our memory to erase the screen. Here, we purposely have to set up the 100000 code. One way to do this, is to hold down the keyboard's space bar during the clearing process. A better way is to remove the keyboard encoder power (via the UNCLEAR or not-clear line from HOME switch S6) from the encoder to get all 0's out. Then a "1" can be force-fed to the a6 input line to set up the proper code. This gives us a one-button clearing operation. Other schemes can easily be worked out, but the essential thing is that the 100000 code gets set up during the time you want to erase what you have.

We normally put a character into memory and leave it there for a relatively long time. The memory usually is in a *recirculate* mode where its own output is connected internally back to its input. The memory is a *serial* device—the bits take turns coming out one at a time, and 512 pairs of clock pulses are needed to turn the memory over exactly once.

The memory is normally in the recirculate mode. We keep it there if we are using the other page or if we have our KEEP-CHANGE switch in the KEEP position. We also force it to recirculate if a CARRIAGE RETURN command (a6 *and* a7 = 0) arrives, for, just like a typewriter, we don't want to enter anything while the carriage goes back to the beginning of a line.

The only time we actually enter a character is once when the cursor board tells us it is the right time, then only if we are working on this page, want to change the character, and are not trying to return the carriage.

### About keyboards

So where do we get our characters? The simplest and far cheapest source is from six switches and a pushbutton, arranged to get us +5 for a "1" and ground for a "0" and set up so the pushbutton gives you a sudden +5 to ground "Key-pressed" output. This is handy (almost essential) for testing, and can be used for message generation, although it takes quite a bit of practice to get any speed.

A keyboard is the next best bet, such as the low-cost keyboard in the February 1973 issue of **Radio-Electronics**, and its low-cost companion ASCII encoder (April 1973). Many of the surplus keyboards offered in the back pages of **Radio-Electronics** can also be either used directly or readily adapted.

The input code *must* be in ASCII. Any keyboard that consists of one or two make contacts per key *must* be converted in a suitable encoder, again such as the low-cost ASCII encoder described in the March 1973 issue of **Radio-Electronics**. Further, the ASCII output *must never exceed* the internal +5 volt supply of the typewriter, nor should it go below ground, even by a small amount.

Jumpers on the timing band allow for selection of 12 possible display positions so that internal TV adjustments need not be changed.

### Character generation

We use raster-scan dot-matrix characters providing an array of 5 dots wide by 7 dots high for each character with one "undot" between characters for spacing. Seven passes of the TV raster are needed to generate each line of characters. This says we must borrow one line's worth of characters (32) from the memory and put it into a new *line register* memory, use it over again at least seven times, and then later on, go get a new line of characters. To do this, we need a line memory, a single IC consisting of six 32-bit recirculating shift registers.

Let's go through a typical scan and see what happens. Most of the circuitry is shown in Fig. 2.

Suppose we just retraced to the upper left hand corner. We're now on line 1 of the top of the characters. On line No. 1, our line register is connected to the memory and it samples the next 32 characters to be presented. The main memory thus fills the line register. For the next twelve scans, the memory is idle, but the line register brings the same characters back over and over again. On scans No. 2 through No. 8, the character is actually generated. The line register drives a character generator.

The character generator is also connected to logic that tells it which part of each character it is working on. The output of the character generator goes to an output register that converts the characters into actual video.

Since line No. 1 is supposed to be all blanks, the character generator is told this and we get all blanks, except possibly for a brief cursor winking bar.

On the second scan line, we again clock the line register 32 times, letting it go once around. The main memory just waits. This time, the character generator is told to work on line No. 2 and please put down the *top row* of dots on each character. For instance, if a "T" comes up, we get five "1's" in a row. An "S" would be 01110 and so on. As the TV scans across, each top row of dots for each following character is put down.

On the next pass, we again clock the line register 32 times. This time, the *second* row of dots gets output, with a "T" being a 00100 and an "S" being 10001, and so on. Lines No. 4, 5, 6, 7, and 8 are handled the same way, with the character generator working on the line it is told to and the line register going once around for each line. By the end of the eighth line we have put down all the dots we need for a line of 32 complete dot-matrix characters. The circuitry is blanked for the next four scan lines, providing us with a space between character lines.

On line No. 13 (a new line "1"), our main character memory is once again clocked 32 times and the line register is simultaneously clocked. This fills up the line register with a new set of 32 characters. The same operation repeats for each of the sixteen rows of characters that we want to put down.

Notice that the timing runs in bursts and is not continuous. Thus, the line register runs for 32 counts and waits 16 for retrace and so on. The memory does the same thing, but only on every twelfth line during the active scan. Carefully established internal timing delays take care of settling times between memory, line register, character generator, and the final video generating output register. The output register converts the five parallel outputs of the character generator into serial, high speed video.

## About the memory bus

So far, we've assumed that we were using the page-A memory with the page-A character generator. Thanks to the memory bus (b1 through b6) we can connect anything we like to the character generator, including the page-A memory, the page-B memory, or anything else we want to hang on these lines.

To run page-B, we simply disable the page-A memory and enable the page-B memory's output. The handy thing about bus organization is that no complex switching is involved. Whatever is enabled gets connected to the character generator; other things tacked on just sit there. The only restriction is that *we have to enable only one character source at a time.* We can also use the same memory bus optionally to output characters to a computer, a cassette recorder, or a phone line.

This way, with suitable add-ons we have a choice. We can send one character at a time directly from the keyboard, or we can send an entire page at a time from the memory. The latter is faster and more complex but has the advantages that you can fix all the mistakes first and don't tie up nearly as much outside equipment. R-E

## PARTS LIST

**MAINFRAME**

C1—5000-μF 10-V electrolytic
C2, C3—1000-μF 25-V electrolytic
C4—100-μF 6-V electrolytic
C5, C7—470-pF disc for vhf bypassing
C6—3-30 pF trimmer
C8—27-pF mica
C9—47-pF mica
C10—Gimmick attenuator made of twin lead
D1 to D6—1N401 or equal
D7—12-V, 1-W Zener, 1N4742 or equal
D8—6.8-V, 1-W Zener, 1N4736 or equal
D9—5.1-V, 1-W Zener, 1N4734 or equal
D10 to D14—1N914 or equal
F1—1-A fuse and fuseholder
IC1—7805 regulator (Fairchild or Motorola)
J1, J2—Binding posts, one yellow, one black (5 way)
L1—Coil made from 4" of No. 14 solid wire
Q1—2N918 transistor in metal can, **do not substitute!**
R1, R2—47 ohms, ½-W
R3—22 ohms, ¼-W
R4, R9, R10—2200 ohms, ¼-W
R7—4700 ohms, ¼-W
R8—470 ohms, ¼-W
S1, S2, S3, S4, S7, S8—dpdt rocker switch
S5 to S6—dpdt rocker switch, momentary spring return
SO1 to SO6—connector, Molex 09-52-3103
SO7—TV lead-in connector
T1—Power transformer, dual 12-V center tapped secondaries, 1.5-A. Signal 24-1A or equal
MISC:—PC Board, 8¾ x 6¾; mounting brackets and hardware (6); switch mounting hardware (8 sets); line cord and cable clamp; hardware for T1; vertical heat sink for IC1; No. 24 jumper wire; sleeving; No. 14 wire for L1; fuse clips and hardware, 300-ohm twin-lead, 18"; PC terminals, optional-2; solder.

**MEMORY BOARD**

Note: Each system needs one "Memory A" board. Memory "B" boards are optional. These parts are needed for *either* a Page A or a Page B memory:
C1, C3, C5, C7—100-μF 15-V electrolytic
C2, C4, C6, C8, C9, C10, C11—0.1-μF disc ceramic
D1, D4, D5, D6—1N914 or equal
D2, D3, D7—1R4001 or equal
IC1 to IC 6—2524 MOS 512-bit recirculating shift register (Signetics)
IC7—7406 hex driver, TTL
P1 to P60—Connector pins to fit Molex 09-52-3103 connectors
Q1, Q2—2N5139
**All resistors ¼-W carbon**
R1 to R6, R25—2200 ohms
R7, R8, R15—2.7 ohms
R9, R23—10,000 ohms
R10, R12—22 ohms
R11, R13—4700 ohms
R14, R18, R19, R20—150 ohms
R16, R17—100 ohms
R21, R22—1000 ohms
R24—330 ohms
R26—470 ohms
**These parts are needed ONLY for a page A memory:**
C12—680-pF mica
C13—100-pF mica
C14—0.1-μF disc ceramic
IC8—2518 MOS hex 32-bit recirculating register (Signetics)
IC9—2513 character generator, MOS (Signetics)
IC10—74165 TTL 8-bit PISO register
IC11—7401 TTL open collector NAND gate
R34—220 ohms
R33, R35, R38, R40 to R42, R43, R44—2200 ohms
R27 to R32, R45 to R50—6800 ohms
R36—470 ohms
R37—47,000 ohms
R51—330 ohms
MISC: PC Board, 4½" x 6½"; #24 wire jumpers; Sleeving; PC Terminals (Optional-2), Solder.

**TIMING BOARD**

C1 to C4—01-μF 10-V disc ceramic
C5, C6—160-pF mica
C7—0.001-μF disc ceramic
C8—100-μF 6-V electrolytic
C9—33-μF 6-V electrolytic
IC1—MC4024 dual astable (Motorola)
IC2, IC3,IC5—8288 divide by 12 (Signetics)
IC4—7473 dual JK, TTL
IC6—8288
IC7, IC8—7432 quad OR gate, TTL
IC9, IC12—7402 quad NOR gate, TTL
IC10, IC11—7410
P1 to P60—Pins to fit Molex 09-52-3103 connector
R1—330 ohms ¼-W
R2, R3—220 ohms, ¼-W
R4—2200 ohms, ¼-W
SO1 to SO6—Molex 09-52-3103 socket
XTAL 1—4561, 920-kHz series-resonant crystal
MISC: PC Board, 4½" x 6½"; #24 solid wire jumpers; Sleeving; PC Terminals (optional-21); solder.

**CURSOR**

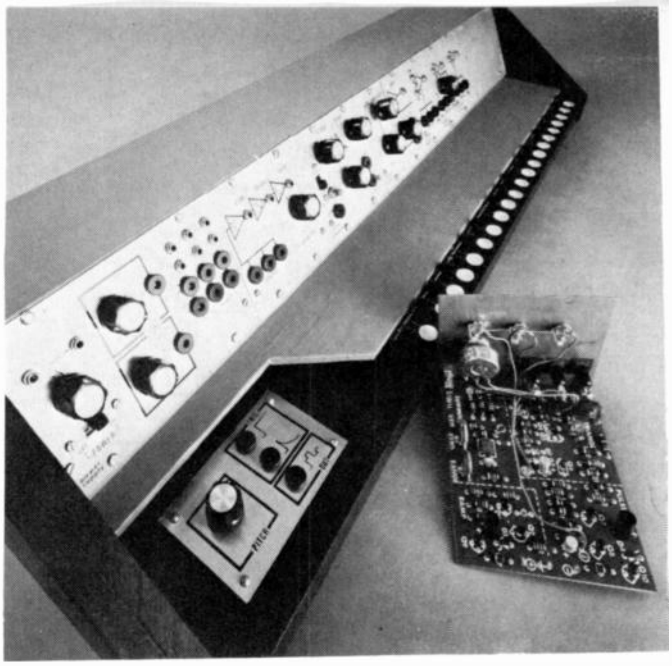
C1—1200-pF mica
C2—4300-pF mica
C3—620-pF mica
C4—6200-pF mica
C5—1000-pF mica
C6 to C9, C12 to C15—0.1-μF disc ceramic
C10—100-μF 6-V electrolytic
C11, 16—10-μF 6-V electrolytic
IC1—7408 quad AND gate, TTL
IC2, IC4—74197 or 74177 or 8281 or 8291 divide by 16 TTL
IC3—7473 dual JK TTL
IC5, IC6—7402 quad NOR gate TTL
IC7—7474 dual D flip-flop, TTL
IC8—7400 quad NAND gate, TTL
IC9—555 timer, Signetics
P1 to P60—pins to fit Molex 09-52-3103 connector
Q1—2N5129
R1, R5, R8, R13, R16, R21—1000 ohms, ¼-W
R2, R3, R4, R6, R7, R9, R11, R14, R17, R18, R22—2200 ohms, ¼-W
R10, R19—330 ohms, ¼-W
R12—100 ohms, ¼-W
R15—100,000 ohms, ¼-W
R20—150 ohms, ¼-W
SO1 to SO6—Molex 09-52-3103 connector
MISC: PC Board, 4½" x 6½"; No 24 wire jumpers; sleeving; PC terminals (optional-8); solder.

**The following items are avilable from Southwest Technical Products, 219 West Rhapsody, San Antonio, Texas, 78216.**

***All circuit boards are etched and drilled***

| | |
|---|---|
| **Mainframe board:** | **No. TVT-1, $9.75** |
| **Timing board:** | **No. TVT-2, $5.75** |
| **Cursor board:** | **No. TVT-3, $5.75** |
| **Page A or B board** | **No. TVT-4, $5.75** |
| **High-quality keyboard, custom remanufactured for TV typewriter use (less encoder)** | **No. TVT-5, $18.75** |

**A complete or nearly complete kit of parts will also be offered, but pricing depends on semiconductor availability at time of publication. Write for a complete list of available parts and prices for assembled units.**



# more SYNTHESIZER modules

*Part IV: You've built the keyboard and the basic electronic circuits. Here are four modules to enhance your instrument.*

**by JOHN S. SIMONTON, JR.***

BY NOW YOU SHOULD HAVE A GOOD START on your synthesizer. You've built the VCO, keyboard controller and power supply from articles in May, June and July issues. Now we will finish the basic package by assembling a voltage-controlled amplifier, two types of voltage-controlled filters, a noise source, envelope generator and low-frequency control oscillator.

Rather than go through the same tired old warnings about soldering and component polarity for each module, let's just get them all out of the way at once. These same precautions and assembly details apply to all the modules.

As you might expect, there is nothing really critical about the assembly of any of the modules we will look at. There are no high frequencies involved so other than standard rules of good practice for audio assembly work lead dress and component arrangement are not critical. Keep outputs and inputs separated as much as possible and avoid outrageously long input and output lines.

Any of the standard assembly techniques from perf-board to etched circuits may be used with extra points for professional appearance and ease of assembly going to the etched circuit boards. Boards may be etched at home using the layouts shown or are available commercially.

As with any semiconductor circuit, heat is a major enemy so stick to as small a soldering iron as possible (no larger than 35 watts in any case) and wherever possible heat sink semiconductor leads while soldering. Do not use a soldering gun. The induced EMF generated when they're turned on and off has crunched more than one previously healthy transistor.

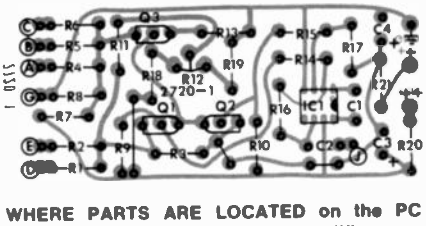
Like electrical assembly, the mechanical assembly techniques used can be adapted from whatever you have available. Our standard module is 2 inches wide by 4 inches high with double and triple modules being 4 and 6 inches wide respectively. Front panels may be made of whatever materials you have handy from sheet aluminum to scrap copper-clad. Paint and mark the panels before installing any controls, jacks, etc. In prototypes the front panels are attached to the circuit boards with 4-40 hardware and small "L" brackets.

## voltage-controlled amplifier

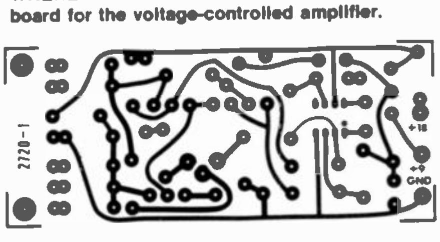
The two most important characteristics of natural or synthesized sounds are their attack and decay times—how fast they build up and die away. Taken together, these two parameters are ordinarily referred to as loudness contour or dynamics. In a synthesizer they are produced by an amplifier which has its gain determined by one or more control voltages. Ordinarily the control voltages are added together and the gain is proportional to the sum so that any control input that is not connected represents zero voltage and does not contribute to the sum.

Since many sounds require that the amplifier be switched from an essentially isolating condition to full gain in 2 ms or less, the primary concern in designing a VCA is that none of the control voltage appear as part of the audio output. If it does, the result is at best annoying "pops" and "clicks" and at worst blown loudspeakers. In my VCA (Voltage Controlled Amplifier) this problem is eliminated by using the control voltage to set constant current source (Q3) common to both emitters of a differential pair Q1 and Q2. Since the gain of a transistor is proportional to its collector current, increasing the current increases the gain of the pair.

Increasing the collector current also increases the voltage drop across load resistors R9 and R10. Since these two voltages are equal for matched transistors they appear as a common mode voltage at the inverting and noninverting inputs of the operational amplifier IC1 and are rejected at the common mode rejection ratio of the amplifier (about 90 dB for the 748 op-amp). The audio signal on the other hand is applied to the base of Q1 and appears 180° out of phase between the two collectors of Q1 and Q2. When these out of phase signals are applied to the inputs of the op-amp they are slightly amplified and appear at the output.




**WHERE PARTS ARE LOCATED on the PC board for the voltage-controlled amplifier.**




**PC BOARD PATTERN for the voltage-controlled amplifier is half-size.**

Control voltages are summed using a simple passive summing network (R4, R5 and R6). R1 and R2 allow the VCA to be used as a two-input audio mixer. Circuit values are selected so that when the inputs add up to 5V there is unity gain between the "0 dB" input and the output while there is a 3 dB power gain between the "3 dB" input and the output.

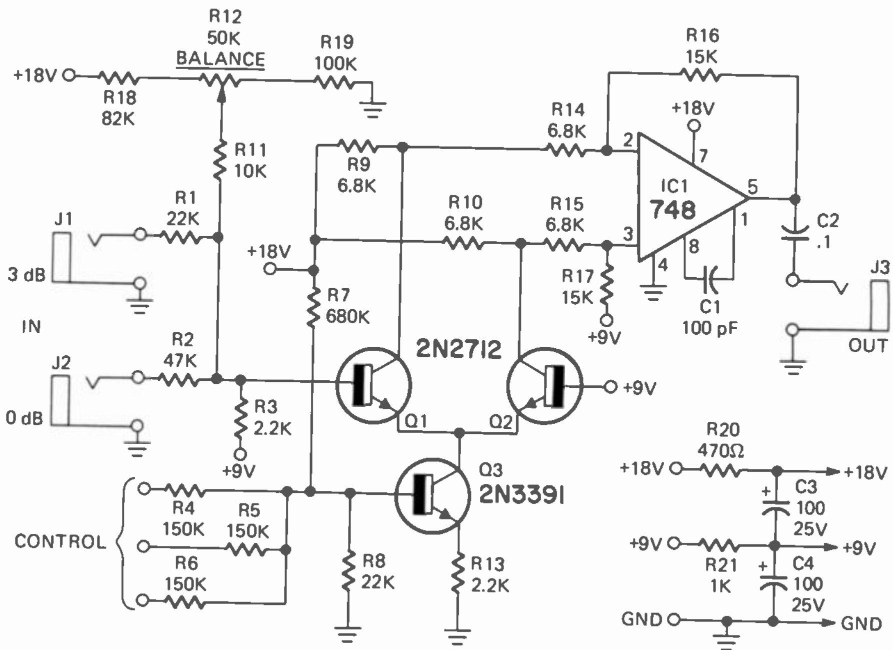
Test the completed module by connecting an audio signal source to one of the inputs and jumpering the output to an amplifier. Apply a variable 0 to 5V supply (such as one of the power supply's bias outputs) to one of the control voltage inputs and observe that varying the control voltage varies the gain. Note that there is no provision for dc isolation of the audio inputs so if a signal source other than the VCO is used in this test, an external isolation capacitor must be provided.

Of the modules described in this article, the VCA is the only one that requires any sort of calibration. Potentiometer R12 must be adjusted so that the characteristics of the differential pair Q1 and Q2 are as nearly identical as possible. The quickest and easiest way to perform this adjustment is to use the output of the control oscillator (described later) as a control voltage input source. With both audio inputs to the VCA open, jumper the 5V peak-to-peak output of the control oscillator to one of the VCA

*President, PAIA Electronics.

control voltage inputs. Jumper the output of the VCA to the input of an amplifier and set the control oscillator for it's maximum frequency. At this point you will probably hear a "popping" from the amplifier at the same frequency as the control oscillator signal. This is the control voltage being coupled into the audio channel. Simply adjust R12 for minimum pop, indicating that the two transistors are matched.

*All resistors are ½W 10% unless noted*
R1, R8—22,000 ohms
R2—47,000 ohms
R3, R13—2,200 ohms
R4, R5, R6—150,000 ohms
R7—680,000 ohms
R9, R10, R14, R15—6,800 ohms
R11—10,000 ohms
R16, R17—15,000 ohms
R18—82,000 ohms
R19—100,000 ohms
R20—470 ohms
R21—1,000 ohms
R12—50,000 ohms, trimmer potentiometer
C1—100-pF ceramic
C2—.1-μF disc or mylar
C3, C4—100-μF 25V electrolytic
IC-1—748 op-amp
Q1, Q2—2N2712
Q3—2N3391




**VOLTAGE-CONTROLLED AMPLIFIER uses a differential-pair fed from a constant-current source to drive the IC op-amp. Control voltages are summed in Q3's base circuit.**

# band-pass filter

Next to dynamics, a sound's most important property is timbre. Everybody has a feeling that timbre in some way relates to the body that a sound has, but in technical discussions this term refers to the constant or time-varying harmonic content of the signal.

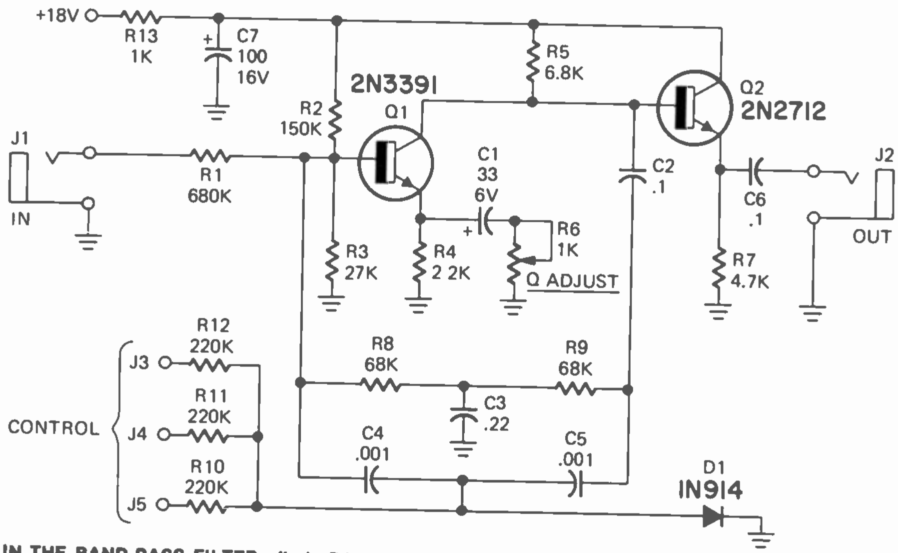
Synthesizers produce various timbral properties using formant synthesist techniques. This is a fancy way of saying that instead of summing together a bunch of sine waves to arrive at a desired sound you start out with a waveform that has more harmonics than you need and use filters to eliminate the ones you don't want.

If the timbre is to be time-varying, as it should be to produce musically interesting sounds, there must be some convenient way to change the characteristics of the filter being used. Once again, voltage control comes to the rescue by allowing us to turn the job of varying the filter parameters over to automatic function generating circuitry.

In our band-pass filter, resistors R8 and R9 in combination with capacitors C3, C4 and C5 and the equivalent impedance of diode D1 form a parallel-T notch filter in the feed-back loop of the common emitter gain stage Q1. The combination of a gain block with a notch filter for negative feed-back produces a band-pass circuit.

Voltages applied to the three control voltage inputs are summed by resistors R10, R11 and R12 and cause a current to flow through diode D1. As the current flow through the diode increases, the diode's equivalent ac impedance decreases (because of the slope of the diode curve) and causes the center frequency of the notch filter to be raised.

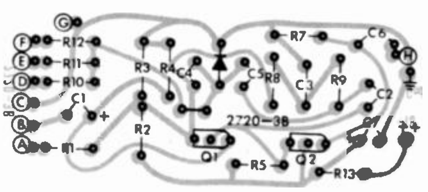
Potentiometer R6 varies Q1's gain by decreasing or increasing the emitter by-pass. As the amplification provided by the gain stage is increased it tends to overcome



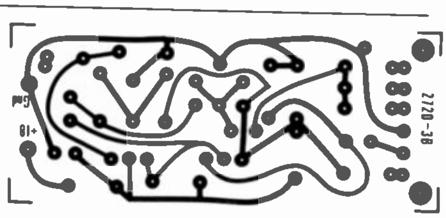

**IN THE BAND-PASS FILTER, diode D1 replaces the shunt resistor in the parallel-T filter. Control voltages vary D1's impedance and modify the filter's center frequency.**

*All resistors ½W 10% unless noted*

R1—680,000 ohms
R2—150,000 ohms
R3—27,000 ohms
R4—2,200 ohms
R5—6,800 ohms
R7—4,700 ohms
R8, R9—68,000 ohms
R10, R11, R12—220,000 ohms
R13—1,000 ohms
R6—1,000 ohms, linear taper potentiometer
C1—33-μF 6V electrolytic
C2, C6—.1-μF Mylar or ceramic
C3—.22-μF Mylar
C4, C5—.001-μF disc
C7—100-μF 16V electrolytic
D1—1N914
Q1—2N3391
Q2—2N2712




**WATCH TRANSISTOR LEAD PLACEMENT when wiring the band-pass amplifier board.**




**HALF-SIZE FOIL PATTERN for the active band-pass filter. Direct wiring is OK too.**

more of the losses in the notch filter which has the overall effect of increasing the "Q" of the filter.

The filter is tested by supplying its input with a harmonic rich waveform—the pulse output of the VCO with the duration control at minimum is ideal—and listening to the output as a control voltage variable between 0 and 5 volts is applied to one of the control inputs. As the control voltage increases you should hear the unmistakable waa-waa of a band-pass filter being swept up and down. Advancing the Q control should make the effect more pronounced. It is one of the peculiarities of this type of filter that as the Q control is advanced the overall gain of the module is also increased but this is not particularly objectionable in a low-priced unit.

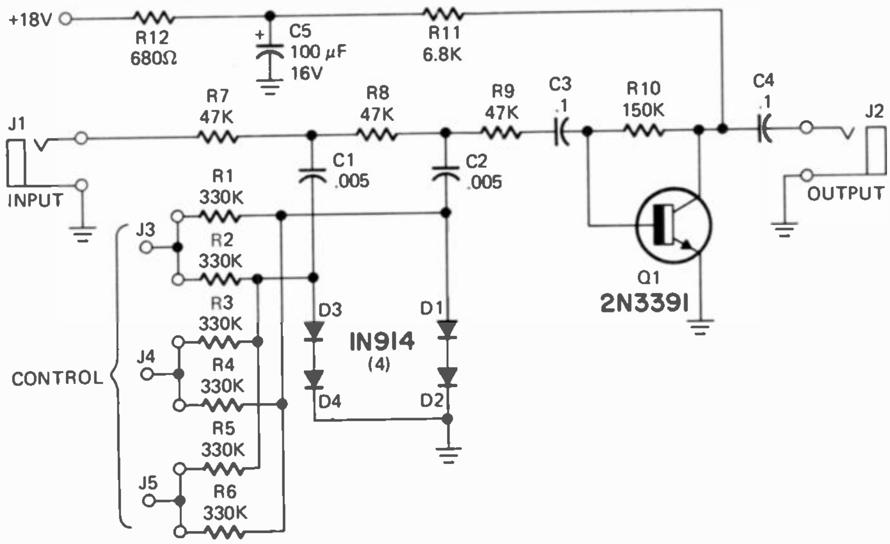
The biggest drawback of this filter is that it will "pop" if the control voltage is stepped very rapidly but you can rationalize this drawback away by reasoning that you really don't ever need to step the control voltage anyway. The nicest thing about the filter is that it's cheap. Several can be built for the cost of the next best design.

# low-pass filter

Here we have a rather un-elegant, but low-priced, solution to the filter problem. While the bandpass filter is used to select a particular frequency from a harmonic rich source, the low-pass filter is used to eliminate all frequencies above some cutoff frequency.

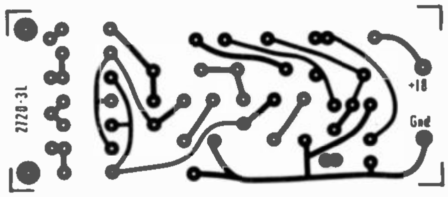
The actual filter part of this circuit is the pi-section composed of resistors R7, R8 and R9, capacitors C1 and C2 and diodes D1 through D4. As with the bandpass filter, the equivalent impedance of the diodes is decreased by increasing the current flow through them. As the impedance of the diodes decreases the cutoff frequency of the filter rolls back. The gain stage Q1 is used to compensate for losses in the filter section.

Like the bandpass filter this module may be tested by supplying it with a harmonic-rich source and listening to the results as the voltage applied to one of the control inputs is increased from 0 to 5V. Unlike the band-pass the sound of this filter will lack the "resonant" quality and be more like the operation of a tone control turned toward accentuated bass.

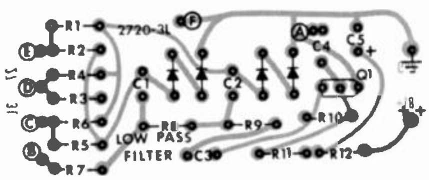



**THE LOW-PASS FILTER IS A PI NETWORK feeding the base of Q1. Series diodes tune the filter by varying the impedance of the shunt (capacitive) legs.**

*All resistors ½W 10%*
R1 thru R6—330,000 ohms
R7, R8, R9—47,000 ohms
R10—150,000 ohms
R11—6,800 ohms
R12—680 ohms
C1, C2—.005-μF disc
C3, C4—.1-μF ceramic or Mylar
C5—100-μF 16V electrolytic
D1-D4—1N914
Q1—2N3391



**FOIL PATTERN for the low-pass filter. It should be copied twice the size shown.**



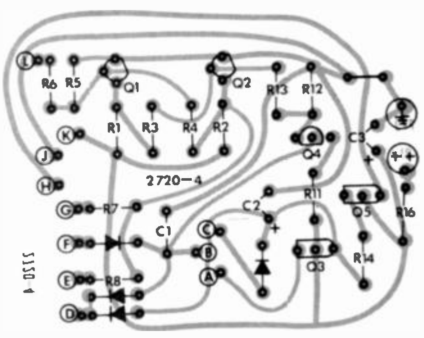
**DIODE POLARITY IS IMPORTANT in the low-pass filter. Follow layout carefully.**

# envelope (function) generator

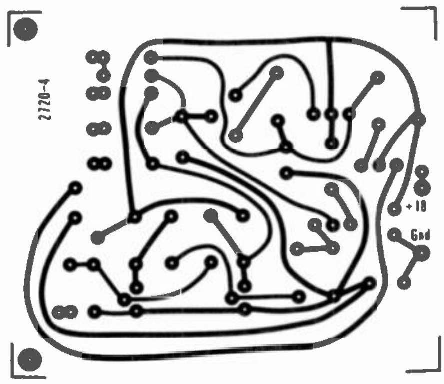
Now that we have built up a few of the basic synthesizer processing modules we need some way to perform all these automatic control functions we have been talking about.

The primary controller is of course the manual one, the keyboard controlled voltage source that we built last month. But that controller will most often be used to set the pitch of the VCO and what we're after now is producing desired loudness contours and all those terrific time-varying timbrel changes.

The most important automatic control voltage source is the envelope generator. Essentially this is a module that, on command, produces a voltage that rises to a pre-set level in a pre-determined time, sustains that level for a controllable length of time and then takes a pre-set length of time to decay back to zero. Obviously, this module will generate the attack and decay times required by the VCA to produce dynamics



**ENVELOPE GENERATOR parts layout is above. It's half-size foil pattern is at right.**

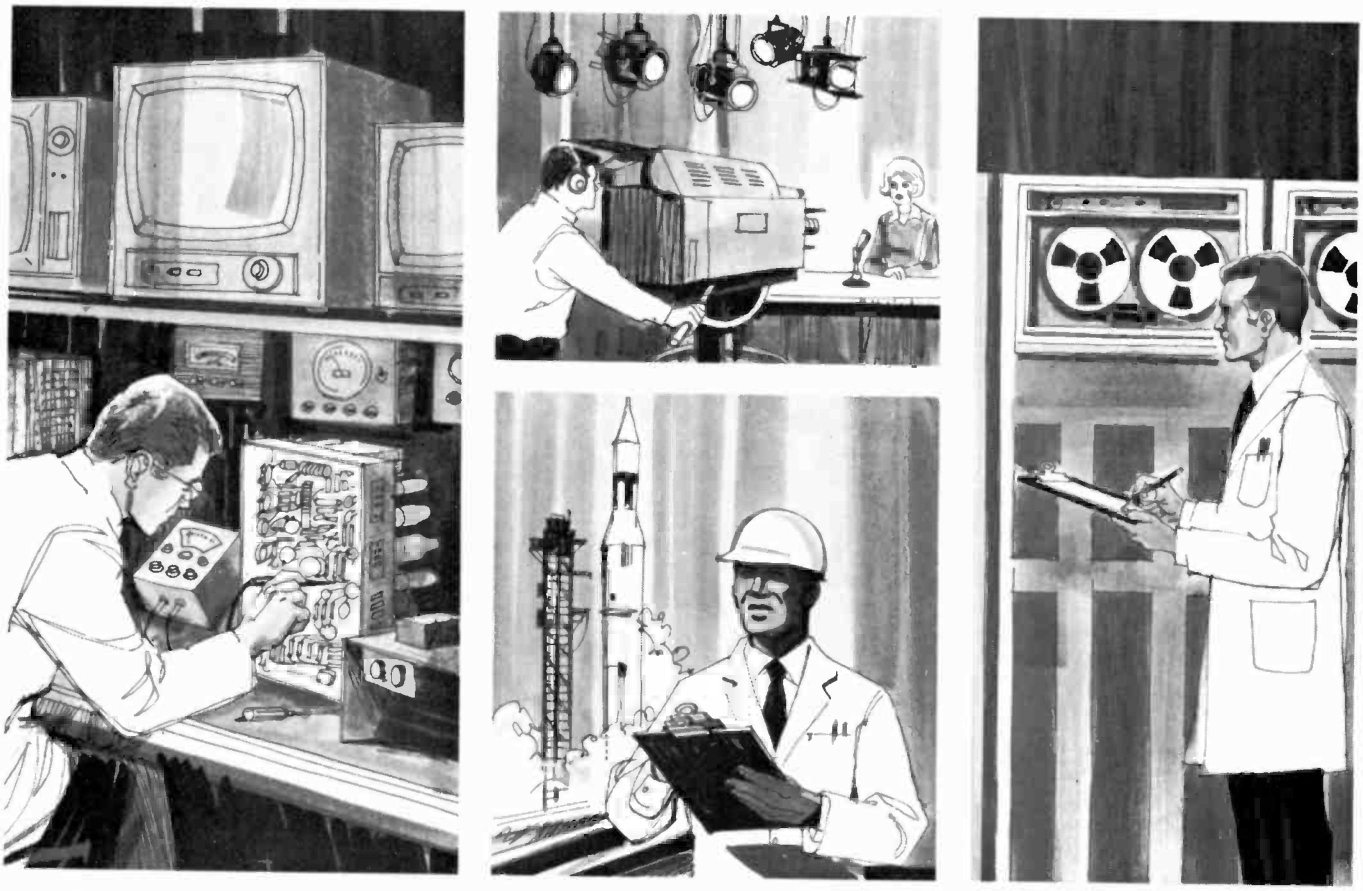


but as we will see it also meets innumerable other needs.

When a short-duration pulse is applied to the input of the circuit shown, it causes bistable Q1 and Q2 to switch so that the collector of Q2 goes high. In this condition capacitor C1 charges through the "attack" control and forward biases diode D1. When the voltage reaches the triggering threshold of UJT Q4, a pulse appears across R12 which resets the bistable so that C1 dis-

*(continued on page 102)*

# Great careers



## Join the high-paid electronics technicians who got their start through NTS Home Training.

*Your home can become your own private classroom-workshop. NTS sends you everything you need to learn valuable technical skills in electronics. You get easy-to-grasp lessons, comprehensive kit manuals, large fold-out charts, and more. Plus the finest professional equipment available today. It's all included in your tuition, yours to keep.*

*You'll work with commercially-designed equipment, and school training material. Cash in on the tremendous opportunities in the expanding, exciting world of electronics.*

*If your field is television, you might decide to join a first-class TV repair center. Or start a shop of your own. Or specialize in industrial applications of television. Once you master an area of electronics, the direction you take is really up to you. And you'll be able to use the test instruments you built yourself.*

*It all begins at home, with NTS Project Method Training. Check card or coupon today for free full-color NTS Catalog and complete details. No obligation. No salesman will call.*

### NTS COLOR AND B&W TV SERVICING

Build the largest most advanced color TV made! It's a Heath! Over-all solid-state design, 315 sq. in. ultra-rectangular screen, 24 channel detent UHF/VHF power tuning, matrix picture tube, built-in self-servicing features, "Instant On," A.F.T., solid-state VHF tuner, and much more! This is a commercial set, the kind you'll encounter in the field — and not for training purposes only. Also build and keep AM-SW Radio, Solid-State Radio, FET Volt-Ohmmeter, and Electronic Tube Tester. Learn trouble-shooting, stereo multiplex systems, radio, color and B&W TV servicing.

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

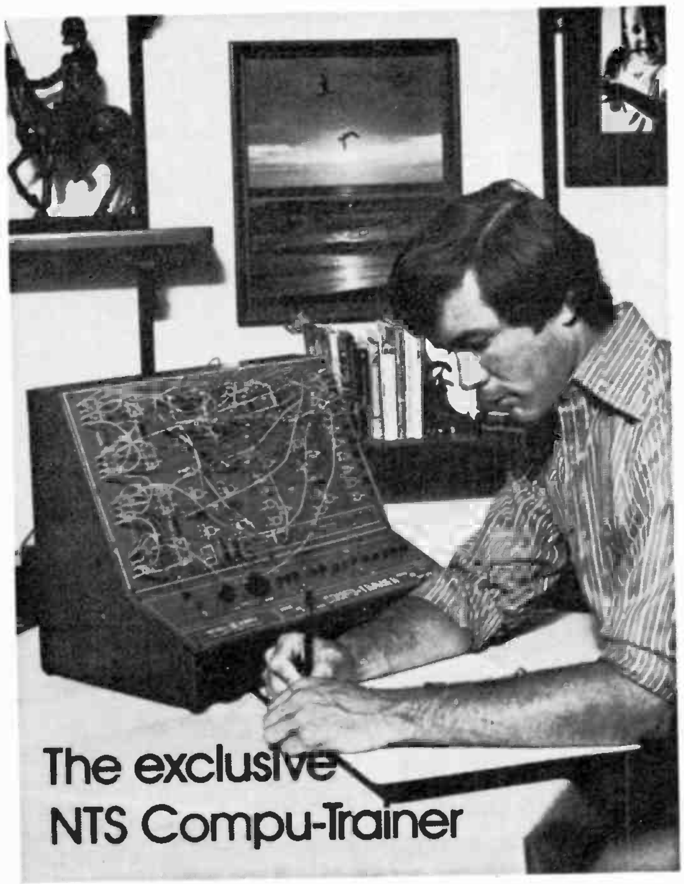
Learn advanced solid-state circuitry as you build this B&W TV receiver. Course covers the full range of home entertainment electronics.

### NTS AUDIO ELECTRONICS SERVICING

**Solid-state Heath Stereo Receiver and Speakers**

Learn sound theory — how it works in home radio, 4-channel, and more! Set up a spectacular music system. Learn about sound distortion, amplification and control, loud-speaker baffles, problems of system installation, etc. Included is Volt-Ohmmeter. In-Circuit Transistor Tester and solid-state Radio. Prepare yourself for great opportunities in the Home Entertainment Industry!

# begin at home.

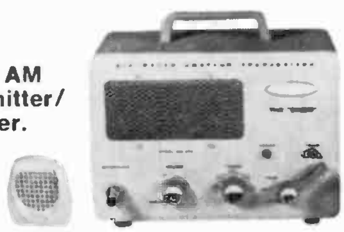

## NTS COMPUTER ELECTRONICS

Build and operate the exclusive NTS Compu-Trainer! Loaded with integrated circuits, it teaches you the how, what, and why of computers — faster, more thoroughly. You perform all wiring and patch-cording. No shortcuts! No pre-wired circuit boards. Also receive an FET Volt-Ohmmeter and a 5" wide-band Solid State Oscilloscope.

## NTS ELECTRONIC COMMUNICATIONS

Gain the prestige and earning power of owning an FCC First Class Radio Telephone License! Two exciting courses in the fields of transmitting and receiving. Experiment with an amateur phone 6-meter VHF transceiver, NTS exclusive 6-transistor solid-state radio and a fully transistorized volt-ohmmeter.

**5-watt AM transmitter/ receiver.**



## NTS AUTOMATION/ INDUSTRIAL ELECTRONICS

Systems automation is the future of the industry — and you can play an important role! Enter the age of electronic controls by training on the NTS Electro-Lab — a complete workshop. Also receive a Solid State 5" wide-band professionally rated Oscilloscope. Build five industrial controls to regulate motor speed, temperatures, pressure, liquid level and much more.

**5" Solid State Oscilloscope**

## 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 facilities devoted exclusively to technical training. Check box in coupon.

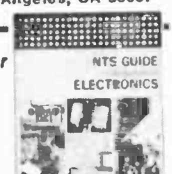
## APPROVED FOR VETERANS

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

**NATIONAL TECHNICAL SCHOOLS**

Resident & Home Study Schools
World-Wide Training Since 1905
4000 S. Figueroa St., Los Angeles, CA 90037

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




**National Technical Schools**
Resident & Home Study Schools
World-Wide Training Since 1905
4000 S. Figueroa St., Los Angeles, CA 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 Communications
- ☐ Practical Radio Servicing
- ☐ FCC License Course
- ☐ Master Course in Electronics Technology
- ☐ Automation & Industrial Electronics
- ☐ Computer Electronics
- ☐ Basic Electronics
- ☐ Audio Electronics Servicing

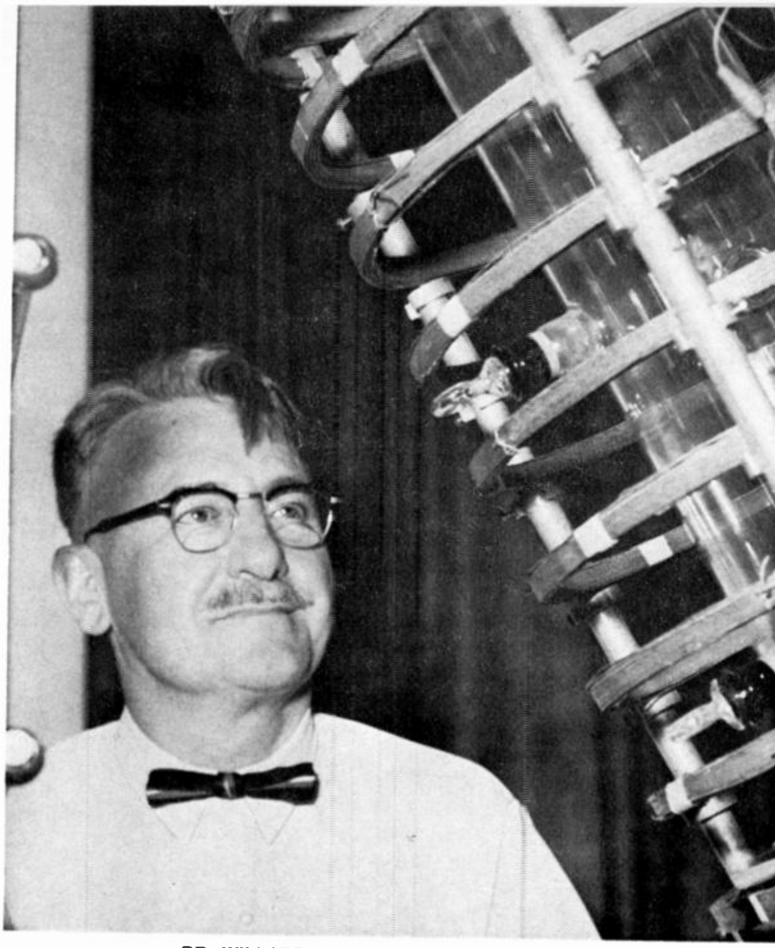
Dept. 206-093

Name ______ Age ______

Address ______

City ______ State ______ Zip ______

- ☐ Check if interested in Veteran Training under new G.I. bill.
- ☐ Check if interested ONLY in Classroom Training at Los Angeles.



DR. WILLARD H. BENNETT, PhD. with his experimental magnetic focusing ion plasma tube.

# SECRETS OF ION PLASMA TUBES

*The electrical conducting coating is "the" vital secret that makes the modern ion plasma tube possible*

**by JAMES A. GUPTON**

"THE GIANT TRANSPARENT TUBE glowed weirdly with angry light, as if the atoms of the gaseous mass were rebelling against the laws of nature. Slowly the plasma began to recede inward as Willard applied power to the multicolored bands ringing the tube. He watched as the plasma condensed into a narrow band of intense energy."

The fantastic potentials of electrical conducting (EC) coatings seem to come from a quotation out of science fiction. Only faint colored fringes give an indication of the presence of the EC coating on glass or quartz, yet this amazing coating provides a conducting path for current and a tough protective shield to the surface. So durable is this coating, once applied it can only be removed with extreme difficulty for it resists all acids.

Electrical conductive coatings have been used for many years. It is a simple process when applied to the surface of flat objects—you just spray it on. The spray process requires a controlled temperature environment to fuse the oxide into the surface. Other than heat, flat coating imposes no special problems. Inside wall coatings have been very difficult to coat with conductive oxides. Not only are uniform coatings virtually impossible to achieve, there is the hazard imposed by volatile mixtures and high temperature.

It was Dr. Willard H. Bennett, Ph.D., Head of Plasma Research at North Carolina State University, who developed a successful process for placing uniform electrical conductive coatings inside tubes. While more involved and complicated than the flat surface method, Dr. Bennett's process provides uniform conductivity throughout the tube and is virtually transparent. This process is especially suitable for cathode ray or plasma tubes since it eliminates the familiar dark gray aquadag coating used for internal conduction of high voltage. Not only do EC coatings provide cleaner tubes, they eliminate possible contamination from aquadag when the electron gun is inserted. By applying a high potential to the EC coating, it would repel plasma in ion laser tubes thus preventing erosion of the tube walls by the plasma. If the EC coating is sectionalized with individual anode connections, it will provide electrostatic focusing or shaping action for plasma or electron beams through the entire length of the tube.

You might have thought that the opening paragraph of this article was from a science-fiction story, instead it was an accurate description of the operation of Dr. Bennett's experimental plasma tube. In this experimental tube EC coatings reveal another feature of importance; they offer no opposition to magnetic fields or rf energy. Thus a gaseous laser could use EC coatings for beam shaping and still use rf excitation. It is conceivable that the EC coating could be etched into the configuration of an electromagnetic coil to produce magnetic fields but the etch process would destroy the protective shield effect in the etched areas.

In the normal EC coating process, the resistance of the coating is uniform throughout the length of the coating. The resistance can be varied from 20 ohms per square cm to as high as several megohms per square cm. It is possible to produce step-resistance patterns by using a telescoping section of glass to serve as a mask. The mask section is withdrawn during the coating process in gradual steps, depending on the length of step desired. The coating build-up gives each step a certain resistance governed by the number of steps. The last coated section having the higher resistance while the preceding steps run progressively lower in resistance.

To illustrate how EC coatings could be used in plasma control, Fig. 1 shows a cutaway diagram of a demountable plasma tube. The neck-down sections of the tube impose no special problem in applying the EC coating. The sectionalized bands may be masked before coating or etched free after coating. Each segment has a

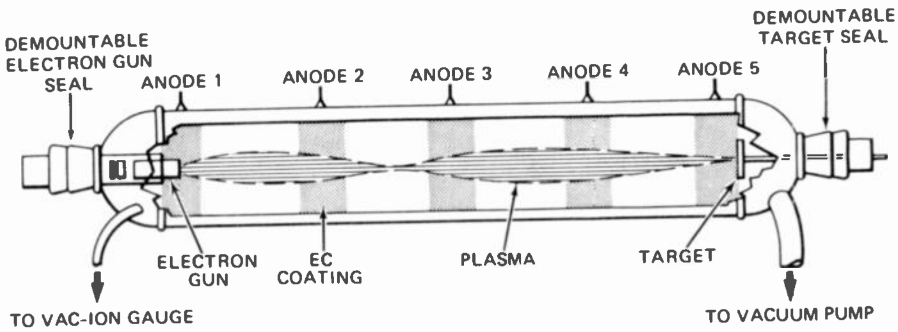
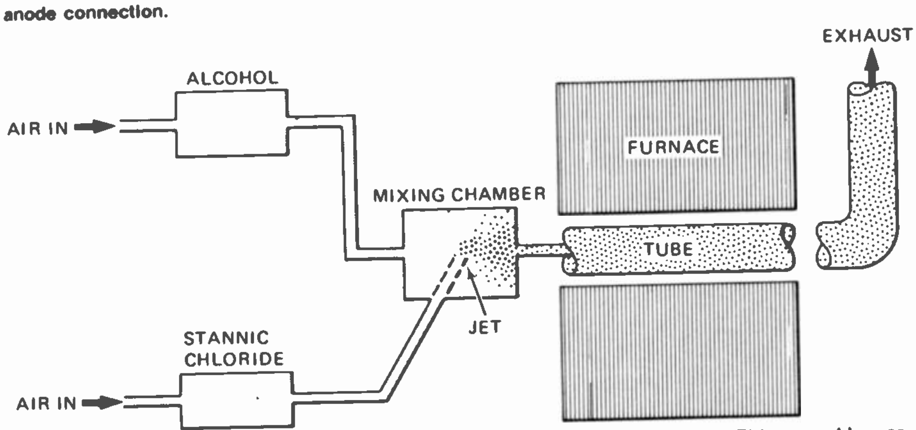



**FIG. 1—CUTAWAY VIEW of a demountable plasma tube. Note that each segment has a separate anode connection.**




**APPLYING EC COATINGS is performed with this kind of equipment setup. Either masking or etching is used to form the anode bands.**

separate anode connection to enable different potentials to be applied. The plasma tube, while under constant vacuum pumping, has a pressure of $10^{-3}$ torr and with an argon atmosphere. (Note: 1 torr = 1 mm mercury; a reference level used in high-vacuum technology.) The demountable electron gun provides the energy to produce argon ions forming the plasma.

Dr. Bennett theorized that it might be possible to increase the effective power of gaseous lasers by using EC coating fields to compress the field of excitement by rf energy. The EC coating could pull double duty by providing a static dc potential to shape the field of excitation while simultaneously serving as source of the rf excitation.

For those who detect an apparent discrepancy in the resistivity of the Transparent Electrical Conductive coatings to acid and the "etch" procedure for removing the TEC coating, I have been advised of a newly developed process which etches away the coating without attacking the glass underneath.

The TEC coated glass is placed in hot nitric acid to the point of removal and is slowly withdrawn while a low voltage current is applied to the TEC, as the cathode in an electrolysis process. The removal is so complete that one need only wash away the residue of nitric acid and the glass is ready for use. **R-E**

**ACKNOWLEDGMENTS**

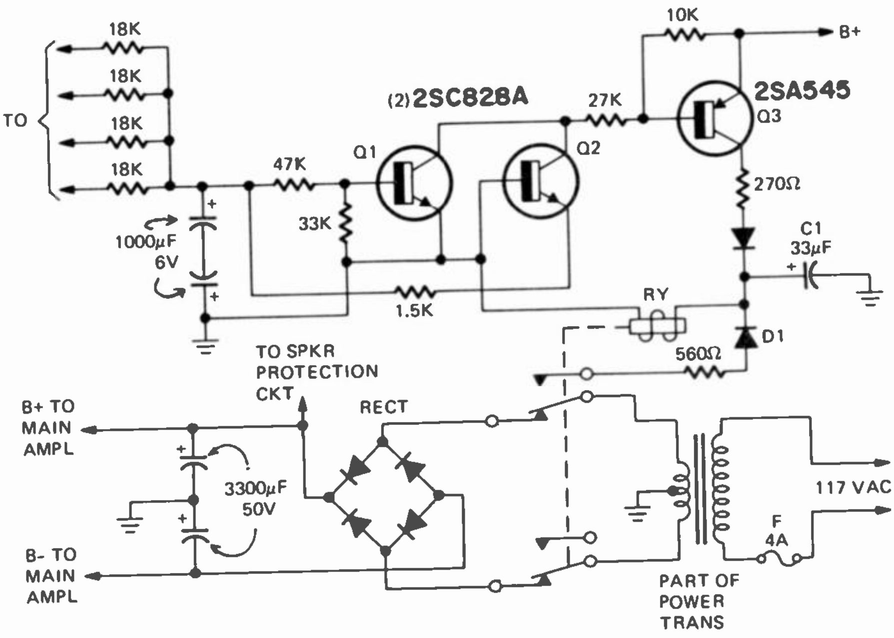
**The author wishes to acknowledge the assistance and cooperation of Dr. Bennett in providing the subject material for this article. Dr. Bennett is a Fellow of the American Physical Society, a Fellow of the Washington Academy of Sciences and a Consultant to the Los Alamos Scientific Laboratory. He has authored more than thirty-five major scientific publications and holds over fifty patents. He is listed in *World Who's Who in Science*, in *World Who's Who in Commerce and Industry*, and in *Who's Who in America*.**

# speaker protection

## Electronic circuit protects speakers from damage that might be caused by dc applied because of an amplifier component failure

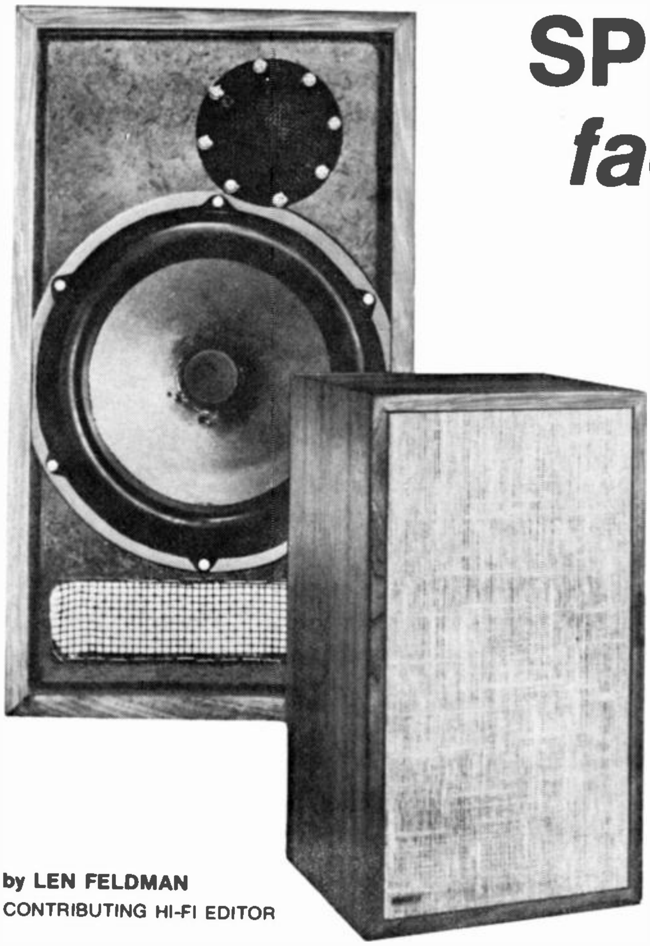
Loudspeaker protection in Panasonic's model SA-6800X FM/AM 4-channel receiver is provided by this electronic circuit that prevents the speakers from being damaged by dc that might be present at the speaker terminals due to a defect in the output amplifier circuitry. The input to Q1 is bridged across the output terminals of each of the four power amplifiers through 18K-ohm resistors.

A dc voltage present on any of the output terminals is integrated by the 18K-ohm series resistor and the two 1,000-μF electrolytic capacitors. Q1 turns on if the dc voltage is positive and Q2 turns on when the voltage is negative. Conduction in either Q1 or Q2 turns on Q3 and operates the relay. When the relay pulls in the rectifier bridge is disconnected from the power transformer so the dc supply voltages drop to zero. The relay is then held in by dc supplied by D1 and C1. **R-E**



# SPEAKER SPECS
# *facts and fallacies*

*Do speaker specs really tell you anything meaningful? Take a look at a spec sheet with Len Feldman and see what he thinks*



**by LEN FELDMAN**
CONTRIBUTING HI-FI EDITOR

THERE IS AN OLD TRUISM IN THE HIGH-FIDELITY BUSINESS about loudspeaker systems being the "weakest link" in the audio reproduction chain. A corollary to this generalization might well be that loudspeaker systems are the most poorly defined components in a high-fidelity system, in terms of their performance. It is virtually impossible to pick up two or more so-called specification sheets relating to speaker systems from as many manufacturers and make valid comparisons as to their relative quality or ability to reproduce musical programming accurately.

When you consider that the loudspeakers are, after all, the only component in the system that you *hear*, the more consistent and meaningful specifications relating to the electronic components of a system (tuners, preamplifiers, amplifiers, etc.) tend to assume less importance.

Of course, loudspeaker systems are electromechanical devices, and such devices are much more difficult to "pin down" in terms of performance. In addition, loudspeakers do not perform in a "vacuum" or even in an anechoic chamber when they are finally put to practical use. Their relationship to the room in which they are used, the amplifier which drives them and the listener who hears them form a complex physical and psychoacoustic interplay which is only now becoming the subject of much fundamental research and study.

Nevertheless, that does not justify the fact that many of the "specs" ascribed to consumer type home entertainment loudspeaker systems are totally meaningless and still others are quoted using such a great variety of references that the prospective purchaser usually ends up "trusting his ears" or relying upon specifications which have little or nothing to do with the sound he hears.

The Institute of High Fidelity (an organization composed of some fifty leading component high-fidelity manufacturers) has embarked upon a program of updating outdated measurement standards and formulating new ones for those high-fidelity components (notably speaker systems) which have never been previously standardized. Admittedly, the most difficult of these "standards" to create will be the one relating to loudspeaker measurements. Nevertheless, I'd like to offer a few thoughts on the subject which may be helpful to those engaged in this work and which may stimulate **Radio-Electronics** readers to make their opinions known to the IHF Standards Committee.

## Speaker specs we don't need

In trying to come to some conclusions regarding present-day "specmanship" of speaker manufacturers, I thumbed through the brochures of at least a dozen leading loudspeaker system manufacturers. Besides the lack of uniformity used in quoting what might be considered meaningful specs, I found a few that tell absolutely *nothing* about the sonic performance of the product. These include:

**Magnet structure**– The weight of the permanent magnet used in a given transducer is proudly quoted by some manufacturers. In some cases it's the weight of the magnet itself–in others, it's the combined weight of the actual magnet and its retaining structure. In *both* cases I fail to see a meaningful relationship between this spec and the sound you may expect to hear from the system. Heavier magnets may or may not result in "better bass", depending upon a great variety of other factors.

**Diameter Of Transducers**– I have heard very accurate bass from an 8-inch woofer and some pretty "muddy", one-note boom produced by massive 15-inch drivers. One of the best selling systems currently on the market uses a multiplicity of 4-inch elements to produce astoundingly good bass. Diameters of mid-range and tweeter elements tell even less about the ultimate sound quality in this region of the audio spectrum.

**Free Air Resonance**– An interesting parameter of a transducer as far as the speaker system engineer is concerned (it helps him to design enclosures that *minimize* the effects of this mechanical resonance), but absolutely meaningless as far as the end-user is concerned.

**Voice Coil Diameter**– Again, this dimension may be helpful to the designer but does not even suggest sonic performance qualities to the purchaser. An analogous spec in an amplifier might be the diameter of the output-transistor housings–interesting, but only very marginally related to the power output capability of the product!

**Crossover Frequencies**– While this specification may be of interest to the user who plans to use a bi-amp or tri-amp system (separate amplifiers driving the separate transducers in the system–thought by some to be superior to passive L-C crossover systems), most speaker manufacturers who proudly proclaim their various crossover frequencies make no provision for this type of operation.

Let's do away with specs that don't tell the consumer what he's trying to find out–and thereby leave some room on the spec sheet for some meaningful, properly stated specifications!

## Speaker specs we need clarified

Frequency response of a loudspeaker system is, of

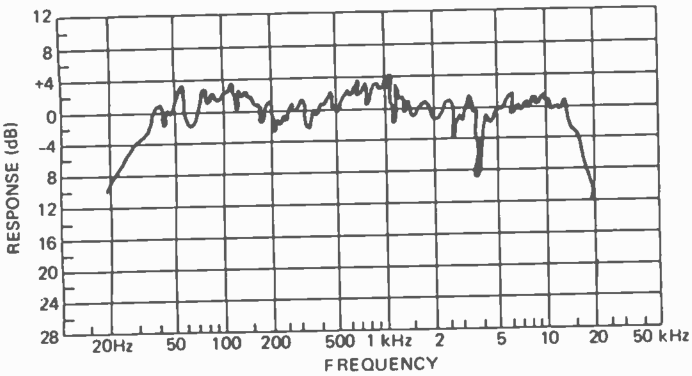


**FIG. 1—FREQUENCY RESPONCE CURVE of a typical speaker system. This is a point-to-point plot.**

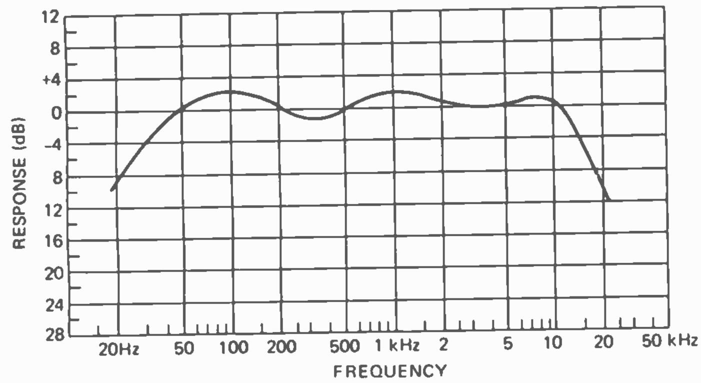


**FIG. 2—IT'S THE SAME SPEAKER SYSTEM as in Fig. 1, but the curve has been "smoothed".**

course, of paramount importance. The manufacturer who continues to quote frequency response without including a tolerance, or limits in decibels is, of course, guilty of gross misrepresentation. What does "Frequency Response from 30 Hz to 18,000 Hz" mean if the actual sound pressure level is down some 15 dB at 30 Hz and the output contains more harmonics than fundamental 30 Hz?

On the other hand, a statement of "30 Hz to 18,000 Hz ±3 dB" may be misleading, as well. Consider the frequency response curves shown in Figs. 1 and 2. (Only the very bravest speaker manufacturers publish frequency response curves of any sort, these days!) Given a choice, which system would you buy? The fact is that *both* curves were taken using the *same* speaker system. That of Fig. 1 is a point-for-point plot of a given speaker system, showing all the minor peaks and valleys typical of most speaker systems. The curve in Fig. 2 has been subjected to ⅓ octave "averaging"—a system whereby the output over each third of an octave has been averaged out to show a smoother response curve.

It has been suggested that human hearing cannot detect irregularities in amplitude response that are less than ⅓ octave wide and that therefore this "smoother" curve corresponds more nearly to the aural sensation we will get when listening to this particular system. The reasoning may well be valid—but if it is then *all* speaker system response curves should be plotted in this fashion. We have not, of course, dwelt upon where the response curve was taken (anechoic "dead" room, free air, or "typical listening room"), a parameter which is seldom specified by even those few manufacturers who *do* present response curves.

Dispersion is another characteristic of loudspeaker systems which is often referred to by manufacturers in the most general terms. Many mid- and high-frequency transducers have a tendency to "beam" sonic energy so that if the listener is "off-axis" from the speaker system, there is an apparent diminution in high-frequency response. Much work has gone into the design of tweeters which are capable of "wide angle dispersion," and the results are sometimes quoted in angular degrees—again, with no real reference to decibel limits. To say that a speaker system features "90° dispersion" without relating that number to *either* frequency or ±dB limits is all but meaningless.

Polar curves such as those shown in Fig. 3 are often plotted in engineering laboratories but hardly ever included in specification sheet presentations. Note, that in this graphic presentation, not one, but several high frequencies have been plotted and as the frequency increases, the angular dispersion is generally less. There remains, of course,

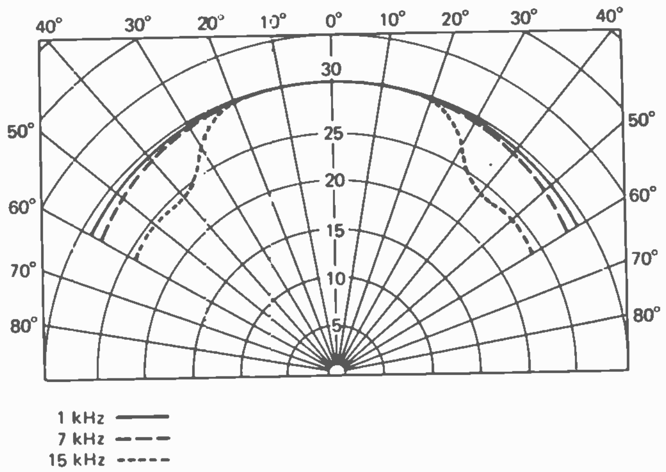


**FIG. 3—POLAR CURVES, like this one, hardly ever reach the spec sheet. They show speaker dispersion. Numerals down the center are in dB.**

the question of "how much dispersion *is* good", since it can be argued that an overabundance of this quality may actually tend to blur stereo (or quadraphonic) imaging, but that issue is best left to the psychoacousticians. But this quality must be stated in a consistent manner.

Efficiencies of loudspeaker systems vary over an enormous range. An electrical input of only a few watts of audio signal may produce ear-shattering loudness levels from very efficient speaker systems (large bass-reflex and folded- or corner-horn enclosures are relatively efficient systems), while the same input power fed to an inefficient system (generally, the book-shelf or "acoustic suspension" types) may produce no more than "background music" listening levels. The choice of a suitable power amplifier is, therefore, highly dependent upon this matter of efficiency. Of late, many manufacturers have begun to indicate the relative efficiency of their products in a variety of ways.

A statement as to "recommended power input" is the least definitive of these ways. The most definitive is a statement as to the sound-pressure level that will be produced at a given distance from the loudspeaker, for a given input wattage, at a given frequency. Unfortunately, those "givens" are not at all consistent from manufacturer to manufacturer. Sound intensity varies inversely with the square of the distance from the sound generating source. Thus, if 90 dB SPL (Sound Pressure Level) is measured at a distance of 1 meter from a speaker with 1 watt of electrical input, at 2 meters, the SPL will measure 84 dB (a change of 6 dB, or ¼ the *acoustic* power).

One meter seems to be the most popular reference distance, and 1 watt seems to be the most popular reference input, but since other distances are also being quoted, Table I offers a quick "translation service" from one reference to another and also quickly enables you to judge SPL's at a variety of listening positions other than the one referenced by the manufacturer.

It is important, too, that the manufacturer state the frequency or frequencies at which the SPL measurement was made. Obviously, if he has previously offered a response curve which, of itself varies ±3 dB or more and if he then selects the frequency at which his product is *most* efficient, there will be other frequencies at which sound output might be as much as 6 dB lower, requiring amplifier power which is *four times as great* for the same SPL.

It should be noted, too, that this inverse square-law relationship of SPL with distance is true only in "free-air". In an actual listening room (particularly one of large dimensions), the relationship holds for some distance, known as the "direct field", and falls apart in the "reverberant field" where sound intensity tends to remain constant regardless of further increase in distance from the speaker system. For most home listening situations, however, the figures in the table below will hold up pretty accurately.

## Power handling capability

With such a wide range of efficiencies available in current speaker products and with today's crop of power amplifiers delivering continuous power output from a few watts to hundreds of watts, I can sympathize with the speaker manufacturer who is trying to define the power handling ability of his products. If he rates power handling in terms of "continuous power" (often erroneously termed rms power), he is, in effect, penalizing his product since he is then specifying how much power the speaker can take when fed with a continuous sine-wave tone.

Obviously, no one listens to high-power sine-wave tones and a speaker subjected to this kind of signal for any length of time will "burn out" its voice coil with fewer watts applied than would be the case under musical programming conditions. Still, the "continuous power" concept is the most readily defined and the least arguable.

Some manufacturers use a "music power" maximum power rating, but this number is usually unrelated to the so-called "music power", dynamic power or IHF power rating used by amplifier manufacturers. The former takes into account the fact that *average* power under musical conditions will be some 10 to 15 dB lower than the peaks encountered during moments of musical crescendos, while the purely electronic "music power" term merely refers to an amplifier's ability to produce somewhat higher power output under musical input conditions than would be the case if a pure sine-wave tone were applied continuously.

Perhaps the only compromise possible would be for speaker system makers to suggest what power amplifier continuous power rating will safely operate with their product and at the same time caution the user that such safe operation is limited to *musical programming*. By so doing, he could avoid having to service products which were subjected to continuous-tone testing at this same high power level. In addition, to be perfectly safe, the manufacturer may want to specify a *time* and *continuous* power limit for his products. Thus, he might say that power capability is such that a 50-watt continuous power amplifier will safely drive his unit, but that continuous tone-testing at that power level should never exceed 10 minutes (or 2 minutes).

**TABLE I**
**RELATIONSHIP BETWEEN SPL AND DISTANCE FROM LOUDSPEAKER**

| SPL AT 1 WATT AMPLIFIER INPUT | DISTANCE IN METERS FROM SPEAKER | DISTANCE IN FEET FROM SPEAKER |
|---|---|---|
| 106.3 | 0.25 | 0.5 |
| 102.0 | 0.25 | |
| 100.4 | | 1.0 |
| 96.0 | 0.50 | |
| 90.6 | | 3.0 |
| 90.0 | 1.00 | |
| 88.2 | | 4.0 |
| 84.6 | | 6.0 |
| 84.0 | 2.00 | |
| 83.3 | | 7.0 |
| 80.2 | | 10.0 |
| 78.6 | | 12.0 |
| 78.0 | 4.00 | |
| 76.8 | | 15.0 |
| 75.1 | | 18.0 |
| 74.3 | 6.0 | |

NOTE: For each doubling of power input reference, add 3 dB to SPL Figures. (E.g., if you wish to know SPL for 2 watts input at 1 meter, add 3 dB to 90 dB figure, to obtain 93 dB.

To determine SPL at various distances when a different reference is quoted, add or subtract new SPL reference from value shown at desired distance. (E.g. if speaker produces, say 80 dB for 1 watt input at 1 meter, to determine SPL at 4 meters subtract 10 dB from 4-meter value of 78 dB to obtain 68 dB).

## Speaker specs that should be added

High-fidelity power amplifiers have very linear characteristics. Feed in 0.1 V of audio signal and you get, say 1 watt of audio power output. Feed in 1.0 V and you get 100 watts out (power out varies as the *square* of the voltage out). I have heard speakers which fail to *put-out* or really "open up" until they are driven to high power levels and this effect can only be described as nonlinearity. Think of it as a form of "dynamic expansion" if you will—and one which may actually be desirable, since it has the overall effect of increased dynamic range. Whatever your opinion about linearity, however, it should be specified in some meaningful way that is clear to the prospective purchaser. Perhaps a curve (Fig. 4) would provide this data.

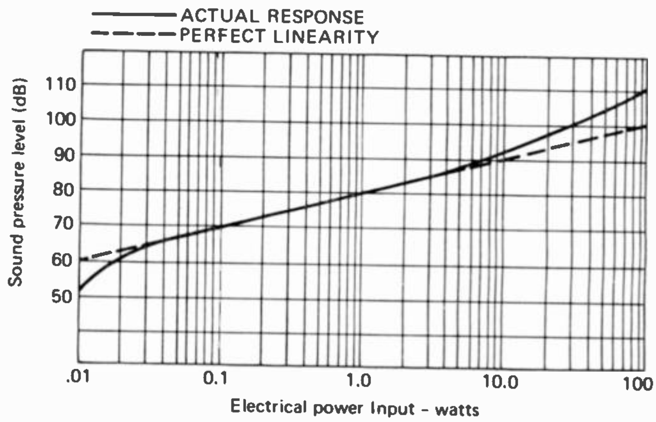



**FIG. 4—PROPOSED SPEAKER-SYSTEM CURVE that would show the relationship between signal input and sound output.**

I'd like to see a statement of *maximum* SPL attainable for a given speaker system, given in dB. Of course, such a specification would have to take into account distortion (harmonic and intermodulation) and also relate to the maximum "safe" operating level of the speaker system in

*(continued on page 92)*

# STATE-OF-SOLID-STATE

*The latest in the semiconductor crop is a group of IC's and SCR's. The surprise of the month is a monostable multivibrator for use in automobile tachometers and speedometers.*

**by LOU GARNER**
SEMICONDUCTOR EDITOR

SEMICONDUCTOR INDUSTRY EXECUTIVES are busily wooing the automotive industry with all the ardor of the male spider courting the female black widow. The union is obviously desirable, perhaps even a necessity, but it is almost certain that the larger female will gobble up the smaller male once the marriage is consummated.

Even today, the automotive market for semiconductor devices is substantial. Solid-state ignition systems are offered either as optional or standard equipment by most auto makers. All automotive entertainment equipment . . . radios and tape systems . . . use semiconductor circuitry. Solid-state diodes are used by the tens of millions in automotive alternators. There are semiconductor voltage regulators, cruise controls, and auto burglar alarms, while at least one manufacturer offers a computer-controlled fuel injection system. But these requirements, vast as they are, represent but a drop in the proverbial bucket compared to what the automotive industry could use if it really went "all out" for solid-state circuitry.

Electronic ignition and computerized fuel-control systems could become standard for all cars to reduce emission pollutants to the levels required by Federal regulations. Seat belt electronic interlocks, anti-skid systems, "drunk driver" controls and similar safety-oriented equipment could become mandatory. Digital semiconductor clocks, tachometers and speedometers could replace conventional mechanical and dial type instruments. LEDs might replace panel lamps, while special electronic sensors and control systems could be added to warn of impending parts failures or dangerous operating conditions.

All factors considered, a typical automobile or light truck could require as many as 200 semiconductor devices, according to some experts, about half of which would be IC's, half discrete devices, such as power transistors, LED's, SCR's, photosensors, and power diodes.

Multiply this figure by an estimated annual production of 12,000,000 vehicles and we discover that the automotive industry, alone, could require some *two billion, four hundred million* devices . . . every year! The replacement market, in itself, could require hundreds of millions of devices.

While the semiconductor industry undoubtedly could meet this challenge by expanding their facilities, it might be at the expense of the smaller user—that is, those firms requiring, say, from 5,000 to 25,000 devices annually. Custom hi fi, communications receiver, and test instrument manufacturers, for example, might well find themselves up the legendary creek without an outboard motor, oar, paddle, or even a pair of waterproof gloves. At the same time, the semiconductor industry, having wooed and won its mate, and basking in the warm glow of substantial and profitable orders, would be subject to the vagaries and uncertainties of the automotive industry. A strike in Detroit, typically, could cause tens of thousands of electronics production employees to be laid off in Texas, Arizona, New Jersey, Indiana and California.

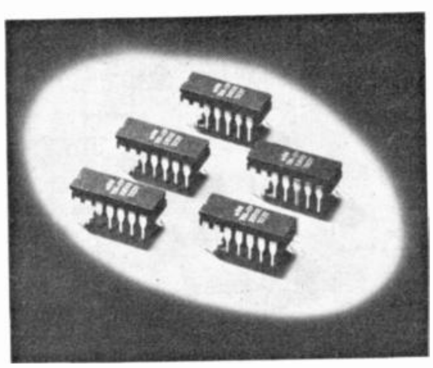


**FIG. 1—STEWART-WARNER SW781 IC is a special-purpose device developed for use as an electronic tachometer and speedometer.**

Despite the potential dangers, most semiconductor manufacturers feel that the prospective high profits are worth the risks. Motorola, for example, perhaps with an eye on the automotive market, recently has announced a new price schedule for its type MLED500 light emitting diode; this device can now be purchased for only *ten cents* each—in quantities of *one million*, up.

Another firm is a little more obvious in courting the automotive market . . . Stewart-Warner's Microcircuits Division (730 E. Evelyn Ave., Sunnyvale, Calif. 94086) has announced the development and production of a monolithic IC for use in automotive tachometers or speedometers.

Designated type SW781, the new device, Fig. 1, is a special-purpose monostable multivibrator with a high input threshold and extremely stable pulse output, thus permitting its use in the electrically noisy automotive environment while maintaining accuracy over wide temperature ranges and battery voltage variations. Housed in a 14-pin DIP, the SW781 comprises 11 npn transistors, 5 Zeners, 4 diodes, and 12 resistors, as shown in Fig. 2-a.

In a typical tachometer application, Fig. 2-b, trigger pulses are tapped off the distributor using two discrete resistors and a capacitor. The SW781 converts each input trigger to a pulse of closely controlled width and amplitude.

These output pulses are applied to a conventional dc meter movement through a discrete resistor. Under these conditions, the meter deflection is proportional to the dc component of the pulses received and, therefore, also proportional to the engine rpm. The constant of proportionality can be varied by varying the output pulse width, while the inertia and damping of the meter movement provides sufficient mechanical filtering, in most cases, to remove the ac component of the pulse train.

The device can be used in much the same fashion in a speedometer, except that a magnetic pick-up coupled to the wheels is used as a trigger source instead of the distributor.

If accepted and widely used, the SW781 probably will be only the first of a large family of IC's designed specifically for automotive applications.

## Reader's circuit

It's truly delightful to receive letters from my readers. Unfortunately, the task of keeping up to date on the solid-state field prevents my sending a

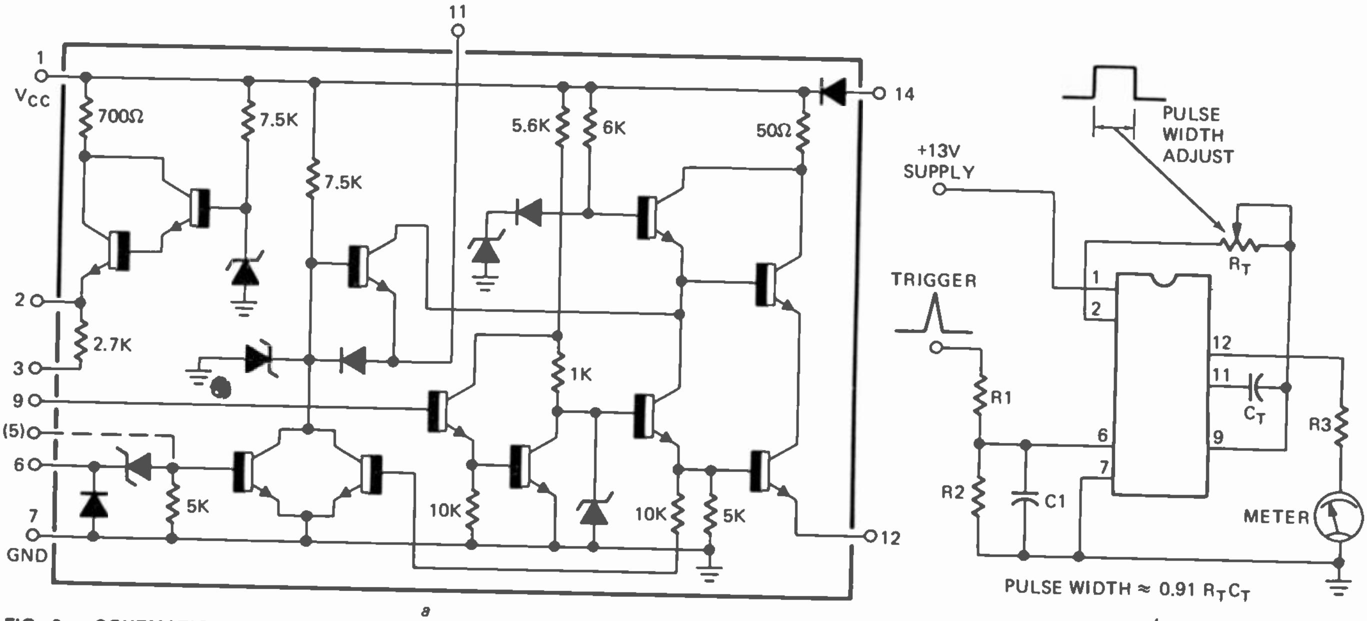



FIG. 2-a—SCHEMATIC OF THE SW781 IC—a precision monostable muntivibrator featuring high noise immunity. Fig. 2-b—BASIC TACHOMETER designed around the new IC.

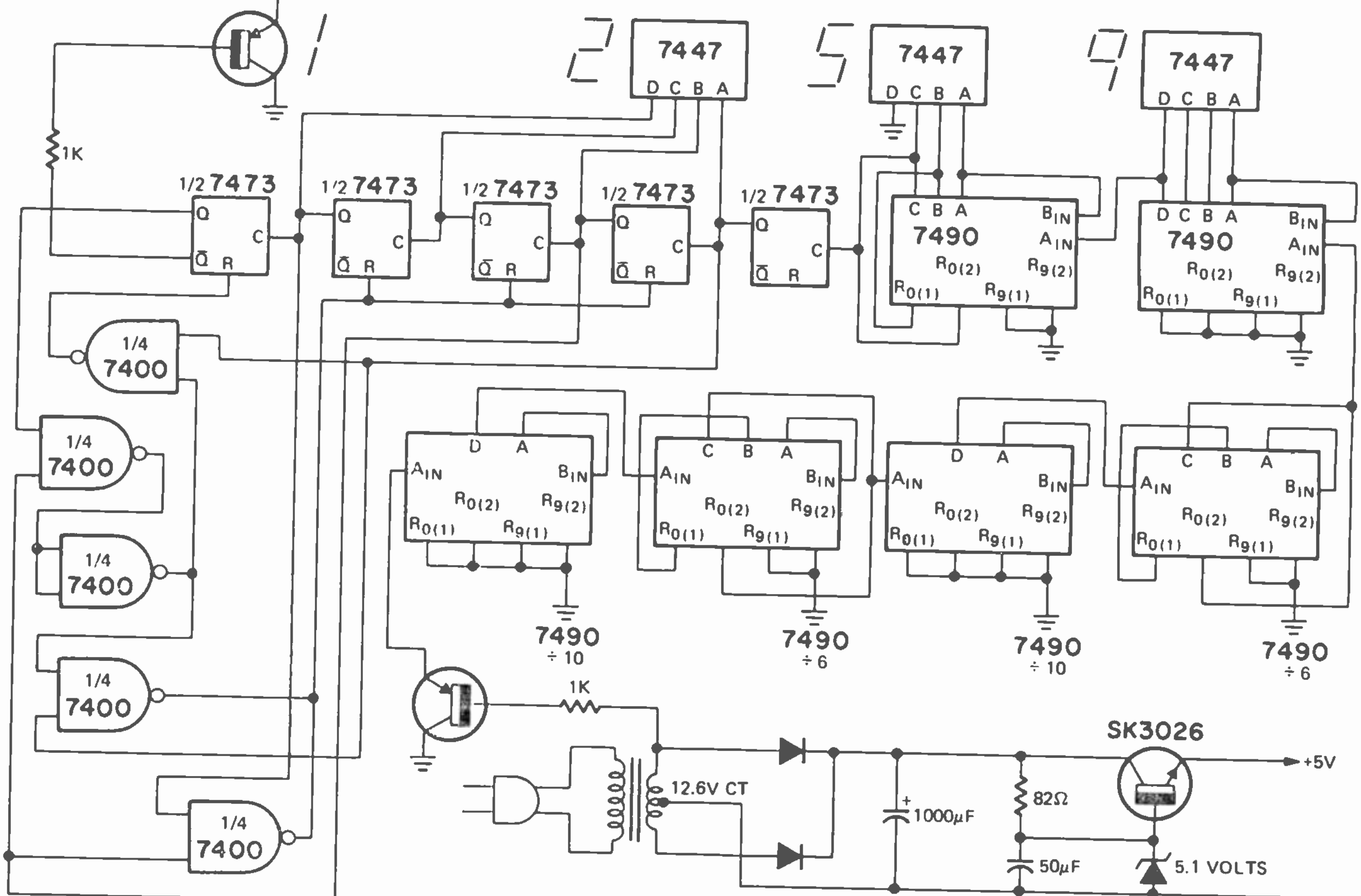



FIG. 3—A READER'S CIRCUIT OF A DIGITAL CLOCK. The circuit was designed for simplicity and low cost. You can select your favorite type of readout and adapt the circuit to fit.

personal reply to each and every letter, but *all* are read with care and your comments noted for future reference.

Where you've had complaints, I've tried to expand my coverage. Where you've had questions, I've tried to provide the answers in later columns. Often, a reader wishes to share one of his original circuits with his fellow readers. Where appropriate, then, and space permitting, I'll be pleased to present some of these circuits from time to time.

Reader J. P. Glover (23008 - 58 - West, Mount Lake Terrace, Wash. 98043) submitted the simple digital clock circuit illustrated in Fig. 3.

*Dear Lou:*

*I am enclosing a copy of a digital clock circuit I came up with. After looking at many schematics for clocks, I decided that they were too complicated or too fancy, so I came up with the simplest one I could. I used general-purpose transistors and low-cost IC's and readouts. The only* *thing not shown is the clock setting circuit, which was just a N.C. switch at X and 2 N.O. switches, one from 60 Hz and one from 1 Hz for fast and slow set. By using JK flip-flops it was easy to get hours to count 1-12 and back to 1—you will notice the first JK flip-flop has no connection on RESET, so when 13 (RESET) comes and the clock resets, Q stays high and the rest go low. Hope you enjoy my clock circuit.*

*Your devoted fan,*
*Joseph P Glover*

Thanks, Joe, it is indeed an interesting circuit, and I'm sure many of your fellow readers will enjoy experimenting with your design. Unfortunately, you didn't indicate which readouts you used with the 7447 BCD to 7 segment decoder/drivers, but these can be used, of course, with most standard 5-volt readouts. Keep up the good work and let me know if you develop other equally interesting circuits in the future.

## Product/device news

The hands at Texas Instruments' big spread (P.O. Box 5012, Dallas, Tex. 75222) have rounded up and put their TI brand on a whole corral full of new devices, including three high-power integrated transistor switches, a MOS/LSI digital storage buffer, four line drivers and receivers, two hex 32-bit MOS/LSI static shift registers, and 21 low-power Schottky TTL IC's.

Believed to be the first of their type, TI's new integrated power transistor switches are intended for high-power conversion applications which, formerly, required SCR's. They can be used in dc choppers for motor controls, in dc to ac inverters, and in ac to dc converters and power supplies. Designated types TIXH807, TIXH808, and TIXH809, each switch is housed in a conduction cooled aluminum case measuring 7 X 3.5 X 1.6 inches, as shown in Fig. 4. Typical turn-off time

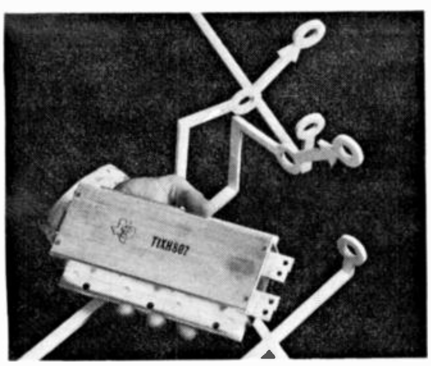


FIG. 4—HIGH-POWER INTEGRATED CIRCUIT SWITCHES, by TI, can replace SCR's.

is 0.5μsecs. Suitable turn-off time from dc to 10 kHz, the units can be driven by DTL or TTL IC's. The TIXH807 is rated at 150 A, 100 V; the TIXH808 at 200 A, 100 V; and the TIXH809 at 60 A, 400 V. In the works is a 100 A, 500 V unit.

Identified as the TMS4024, TI's new digital storage IC is a 9-bit wide and 64-bit deep first in/first out (FIFO) storage buffer intended for use as a link between two digital systems operating at different data rates.

Data is fed into the storage buffer at a certain rate and is made available upon demand at the output, with the input and output data rates completely independent. Capable of processing data at any desired rate from dc to one-half the continuous clock frequency, the unit has a guaranteed minimum data rate of 250 kHz. The TMS4024 is offered in either a 28-pin plastic or ceramic DIP.

Two dual-line drivers, types SN75121 and SN75123, and a pair of triple-line receivers, types SN75122 and SN75124, have been added to TI's line of computer system interface circuits. The SN75121 driver and SN75122 receiver are designed for coaxial cable, strip-line or twisted-pair transmission lines with impedances of 50 to 500 ohms, while the SN-75123 and SN75124 meet the requirements of the IBM System/360 input/output interface specification.

All are TTL compatible and designed for operation from a standard 5-V dc supply. The units are offered in both 16-pin plastic and ceramic DIP's.

TI's two new hex 32-bit MOS/LSI static shift registers, designated types TMS3122 and TMS3123, are intended for applications centered around the 96-column punch card, such as keypunch, key-to-type, and key-to-disc systems. A single device can be used to store a whole tier of a 96-column card. Both devices have a single low-capacitance clock which can be driven directly by TTL IC's. Other features include recirculate logic on the chip and direct TTL interface. Maximum speed is 2 MHz. The TMS3122 is offered in either a 16-pin plastic or ceramic DIP while the TMS3123 features an output gating control and is available in an 18-pin version of the same type packages.

Supplied in both plastic and ceramic DIP's, TI's new line of 21 low-power Schottky TTL IC's includes a comprehensive variety of quad, triple and dual gates, buffers, data selector/multiplexers, and counters. Two series are available, with those carrying a SN54LS prefix intended for critical military applications while those identified with a SN74LS prefix are less expensive units suitable for commercial and industrial designs.

Meanwhile, back at the ranch in Arizona, the men of "batwing-M" (Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, Ariz. 85036) are conducting their own round-up of choice devices on the hoof. Among the new units carrying the batwing-M brand are a family of *Thermowatt* plastic SCR's, two series of plastic sensitive gate Triacs, two new D/A converters, and a high-speed 64-bit MECL 10,000 series memory IC for buffer or cache memories.

Registered as types 2N6394 through 2N6399 and 2N6400 through 2N6405, Motorola's new plastic SCR's, Fig. 5, have peak reverse blocking voltages which range from 50 to 800 volts, depending on type. The forward

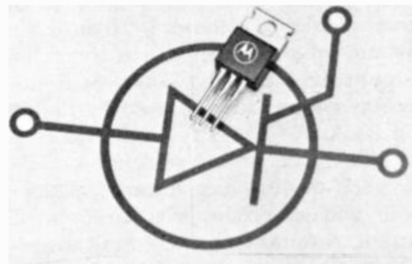


FIG. 5—MOTOROLA'S NEW PLASTIC SCR's feature $V_{ROM}$'s ranging from 50 to 800 volts with $I_{FM(surge)}$ ratings of 100 to 160 amps.

rms current for the 2N6394 series is 12 A and for the 2N6400 series, 16 A. Junction temperature limits are 125°C for both types. The peak forward surge current varies from 100 A for the 2N6394 series to 160 A for the 2N6400 series (1/2 cycle, sine wave, 60 Hz).

If you're using DIP IC's, you'll want to check into Vector's (Vector Electronic Co., Inc. 12460 Gladstone Ave., Sylmar, CA 91342) new line of low profile 14- and 16-pin dual-inline sockets. Illustrated in Fig. 6, the new

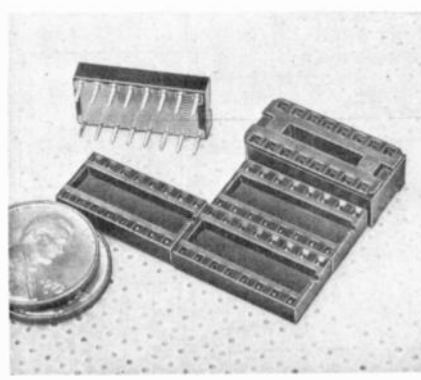


FIG. 6—NEW MOLDED SOCKETS for DIP devices are unusually shallow. They have tapered holes so the IC pins go in easily.

units feature a tapered entry way for easy automatic or manual insertion. Only 0.150 inch high, the sockets, types R714-2 and R716-2, reduce the height of installed dual in-line IC's and similarly housed devices by nearly 50 percent compared to conventional designs. **R-E**

# Step-By-Step TV Troubleshooter's Guide

THE MOST DIFFICULT PROBLEMS ARE NOT necessarily picked by this column deliberately, but I believe that if the tough ones are solved initially then lesser faults will soon show up. Therefore, at this point in the series, the big inductors in all television receivers—especially color—are to be dealt with in three phases: 1) those in hybrid or vacuum-tube receivers; 2) in transistor output solid-state sets; 3) and SCR deflection systems such as used by Philco and RCA.

All truths, we are told, are not always self-evident. For instance, a sawtooth voltage produces a parabola of current, a square-wave voltage induces a sawtooth of current, and a trapezoidal waveform is generated by a combination of sawtooth and rectangular pulses (Fig. 1); all to satisfy the needs of practical inductors having both resistance (sawtooth) and reactance (rectangular) that, together, form a trapezoid.

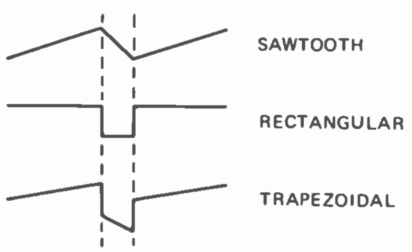



FIG. 1—TRAPEZOIDAL WAVE is a combination of sawtooth and rectangular pulses.

A few years ago, virtually all tube-type receivers drove their horizontal and vertical outputs with trapezoidal waveforms. Today, principally because of solid-state, sawtooth vertical and rectangular horizontal driving pulses are used. But the old trapezoid is still used—as you will shortly see—and its down (conduction) time still indicates retrace (at the horizontal output grid), and the rising portion is the forward-trace charge-time of the horizontal driver tube's waveshaping capacitors. When the grid of the output tube is cut off, magnetic flux change in the flyback produces both retrace and high-voltage pulse.

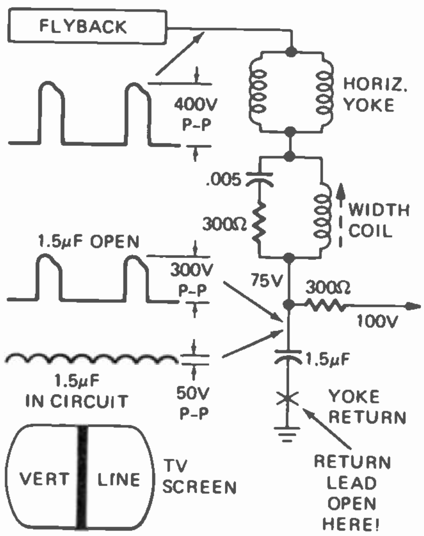



FIG. 2—OPEN YOKE was not the trouble in this circuit. See text for details.

We're also entering the era of high-voltage multipliers and tuned flyback transformers. Recalling that a 52.4-μs forward line scan amounted to a half-cycle resonance of about 20 kHz, and a 11.1-μs retrace at 90 kHz; today's flyback systems are mostly tuned to the 3rd and 5th harmonics for maximum efficiency—usually the 5th harmonic for solid-state. The harmonic frequency is determined by multiplying the *retrace fundamentals* of 45 kHz by 3 or 5 for a product of about 135 or 225 kHz, respectively. This can be measured on the time base of any accurately calibrated oscilloscope. In Y1W5 in Fig. 9, for example, 2 cycles/20 × $10^{-6}$ = 100 kHz.

## Inductive opens

In judging the origin of flyback and yoke circuit troubles, remember

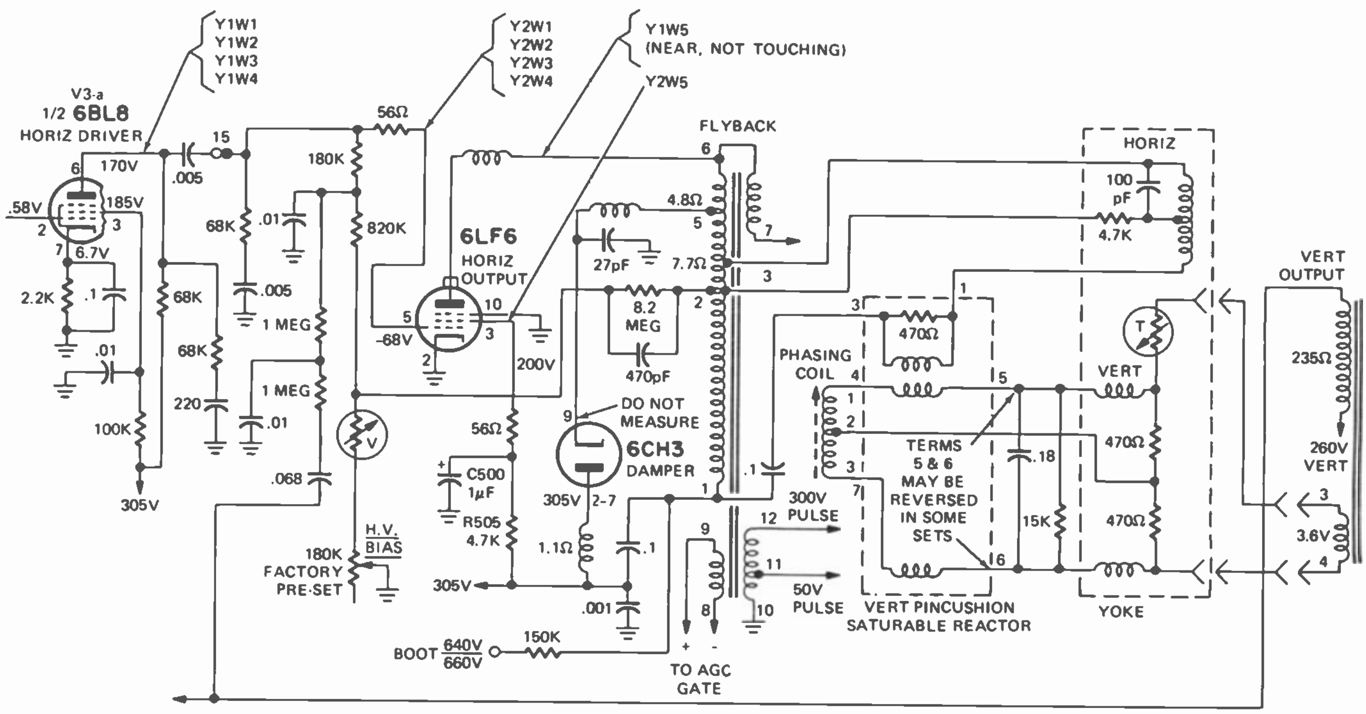



FIG. 3—HORIZONTAL DEFLECTION CIRCUIT of Motorola CATV5/6. Symptoms: no high voltage; horizontal output tube plate red.

*Horizontal and vertical deflection circuits are often problems. This month we will look at typical circuits used in today's vacuum tube and hybrid receivers*

**by STAN PRENTISS**

that adequate output voltage with little or no measurable sweep produces either a thin vertical line for horizontal problems, or a horizontal line for vertical faults. This is a very important part of the initial visual procedure because you're told immediately there is either a bad connection or something has opened. Or you may have only a blank raster or a trapezoidal vertical or horizontal display that indicates (especially if wax is dripping from the flyback or there is an arcing or frying sound about either the flyback or yoke) a probable short in either inductor, but virtually never in both.

Very recently there was the case of a Motorola CTV8 (solid-state) with a thin vertical line (Fig. 2) that had every appearance of an open deflection yoke. This receiver, of course, has plug-in boards but the field technician apparently either didn't have the magic mix or sufficient quantity. In any event, according to an oscilloscope, the flyback was putting out its good 400-volt p-p current-flux reversal pulse, and this could be measured continuously through the width coil with only about 100 volts drop. (Now some models of these receivers used to have a vertical centering circuit consisting of a pair of diodes, two resistors, and a couple of 150-$\mu$F filter capacitors to convert pulsing dc to steady-state dc.) A CTV8 set in good operating order showed a p-p waveform somewhat parabolically shaped of only 50 volts p-p at the 75-volt dc end of the width coil instead of 300 V p-p. Obviously, in the defective set, there was no filtering here. The 1.5-$\mu$F capacitor was found to have had its lower end raised above ground; actually cut with a pair of sidecutters. Therefore the width-yoke circuit had no ac ground. So with no yoke return to ground and incomplete filtering, the yoke could neither begin nor complete a sweep current, regardless of adequate drive. This 1.5-$\mu$F capacitor is also called an S-curve compensator since it slightly bends the yoke current extremes to compensate for an almost flat (instead of a curved) faceplate picture tube.

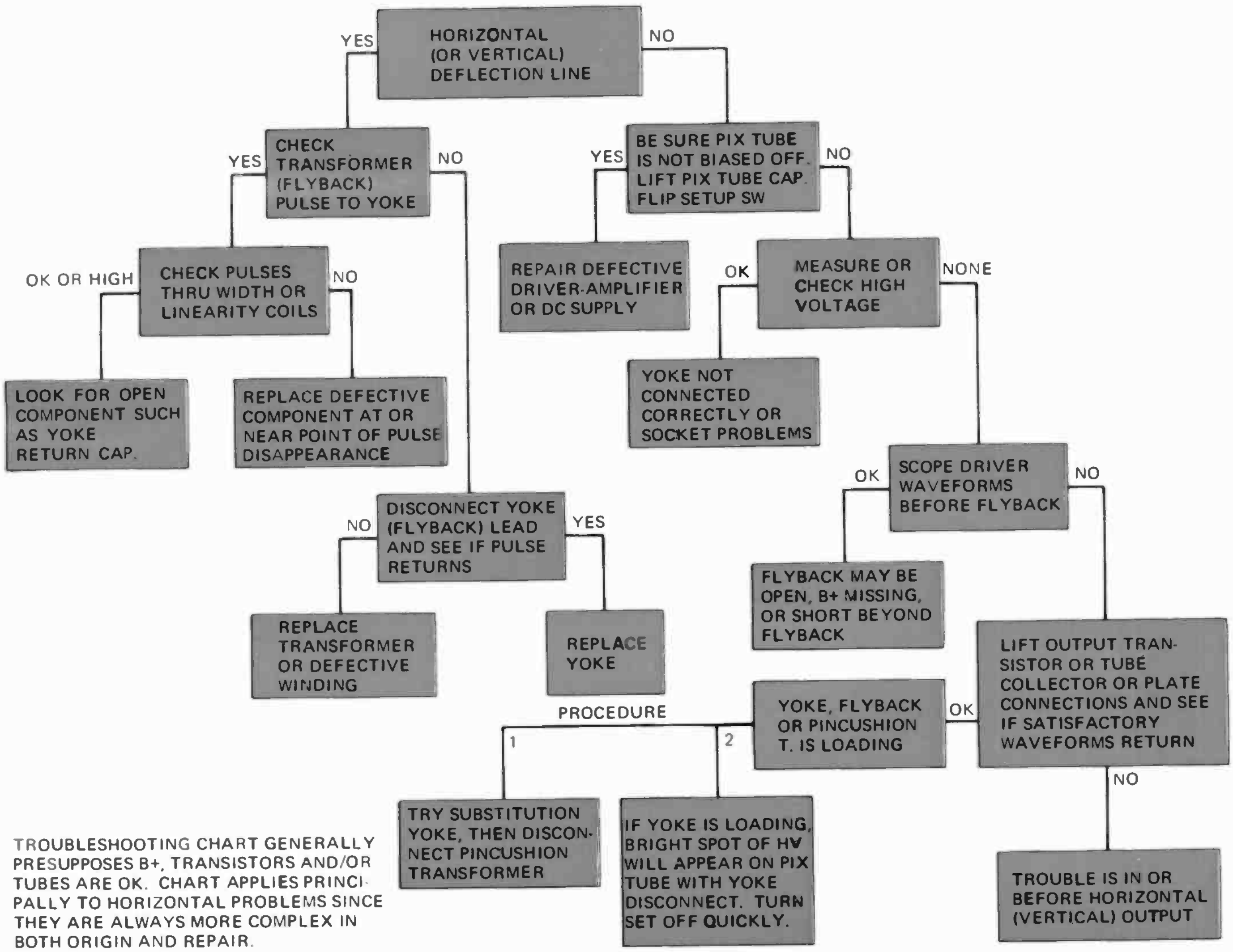



**FIG. 4—STEP-BY-STEP TROUBLESHOOTING CHART for both horizontal and vertical deflection circuits using vacuum tubes.**

## A very live short

The preceding is a very real (not induced) instance of an open that isn't a yoke, but just looks like one. A similar model symptom is often the cause for much yoke and flyback changing that is wholly unnecessary. A second Motorola (CATV5/6) has no visible high voltage, and the horizontal output tube (Fig. 3) plate glows red before a minute's operation. (Fig. 4 details the complete troubleshooting procedure.)

Experience tells you that an ancient Wintronix 820 analyzer or a very modern B & K 1077B television analyst can drive the flyback and deflection yokes of these newer tube (in this instance) receivers and put high voltage on the picture tube. and indeed they will *if* all components along the way are all right. Such was not the case here, however, and the short indicator on the test equipment glowed fiercely when the attempt was made. Now, ordinarily, you'd stop right there and begin making disconnections—but suppose you didn't have either of these testers and also must know whether the problem is in the grid or plate circuit of the horizontal output tube. The shop technician who'd been working on this receiver said the output tube grid measured a "solid -40 volts," and this was "fine with him." The schematic calls for -68 volts, however, and a self-biased grid-leak circuit with some *average* voltage of both ac and dc can very likely be somewhat variable. Grid voltage measured with a dc scope after repairs amounted to -60 volts—a 33% difference. How this is done is illustrated in the following waveforms.

In grid-drive problems, it's necessary to know both dc levels and peak-to-peak amplitude of the tube or transistor drivers and the output grid waveforms. The top wave form in Fig.

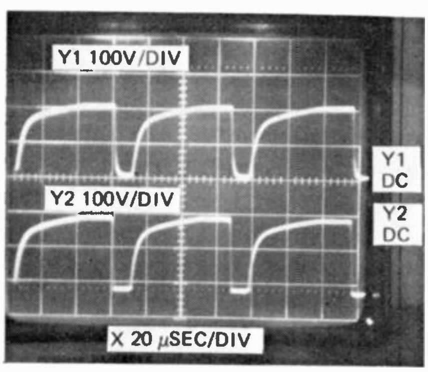



**FIG. 5—TYPICAL GRID-DRIVE WAVEFORMS. Are they good or bad?**

5 is the V3-a driver plate whose waveform swings from almost dc to 210 volts p-p. The Y2W1 grid drive is, of course, negatively biased voltage whose top tip hardly reaches dc. The question—is the grid waveform good or bad? At first glance you can see grid cutoff means about 12-μs (flyback time) and the risetime, while not a classic sawtooth, amounts to 200 volts p-p. And even though it doesn't look like the usual *uncalibrated* recurrent sweep trace, this trapezoidal waveform is probably pretty correct.

However, let's make another check. Removing the plate cap of the output tube, the Fig. 6 waveforms in-

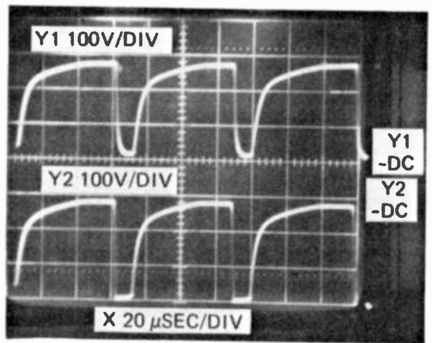



**FIG. 6—GRID-DRIVE WAVEFORMS increase in amplitude when plate cap is removed.**

crease in amplitude some 80 volts. Not an unusual situation, although the dc reference at the output grid shifts somewhat because of load lift. Now let's remove the output tube entirely and see what happens. The dc level and ac amplitude of the horizontal driver is hardly affected, but the output grid voltage immediately goes quite positive (by 220 volts) and increases in amplitude to a full 300 volts. (The difference between the positions of Y2 in Fig. 6 and Fig. 7 is a relative 220 volts. In the same way,

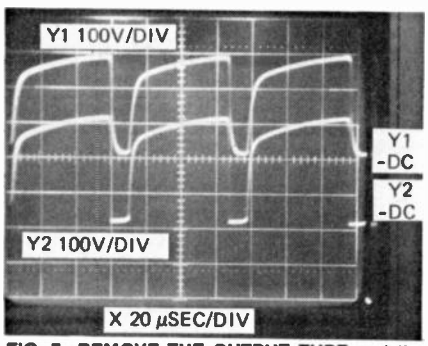



**FIG. 7—REMOVE THE OUTPUT TUBE and the waveforms change drastically.**

you can measure any dc level with an oscilloscope by switching from dc to ac amplifiers, add the dc blocking capacitor (ac), and simply count the number of major and minor divisions the trace rises or falls. Then multiply these by the vertical amplifier switch setting, taking into account the 10X LC probe you should always be using.

For instance, if the vertical attenuator is positioned at 10V/div and a 10X probe is connected, the graticule scale reading will be 10 X 10, or 100V/div as it is here. Now what has this signal analysis told you? Basically that there's really nothing wrong with the grid circuit of the horizontal output, and the drive circuits are excellent. The fault, evidently, must be in the flyback or beyond.

With deflection yokes in newer (and some older) receivers connected by mating plugs and jacks, just break the connection (you may need a B+ jumper for the horizontal output screen) and see if the output tube plate still runs red. If it doesn't, plug in another yoke, watch the output tube, and listen for the ssss-tttt of high voltage. Should the tube still glow ruby, unsolder a transformer lead to the pincushion transformer (if there is one) and look and listen again. If you still have problems—and there's no trouble with the high-voltage rectifier or damper—THEN suspect the flyback.

In the CTV5/6, the difficulty happened to be the pincushion reactor which, you will notice, is in series with one side of the horizontal yoke coil. A disconnect at terminal 6, of course, removed the short, and a new pincushion transformer restored the receiver to full operation (Y1, Fig. 8). In the

*(continued on page 103)*

# *R-E's substitution guide for replacement transistors*

## *PART VII*

**compiled by ROBERT & ELIZABETH SCOTT**

**R-E's Transistor Substitution Guide is a compilation of material abstracted from the substitution guides of eight leading semiconductor manufacturers and distributors. These are:**

**ARCH—Indicates the Archer brand of semiconductors sold only by Radio Shack and Allied Radio stores. Allied Radio Shack, 2725 W. 7th St., Ft. Worth, Texas 76107**

**G-E—General Electric Co., Tube Product Div., Owensboro, Ky. 42301**

**ICC—International Components, 10 Daniel Street, Farmingdale, N.Y. 11735**

**IR—International Rectifier, Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245**

**MAL—Mallory Distributor Products Co., 101 S. Parker, Indianapolis, Ind. 46201**

**MOT—Motorola Semiconductors, Box 2963, Phoenix, Ariz. 85036**

**RCA—RCA Electronic Components, Harrison, N.J. 07029**

**SPR—Sprague Products Co., 65 Marshall St., North Adams, Mass. 01247**

**SYL—Sylvania Electric Corp., 100 1st Ave., Waltham, Mass. 02154**

**Radio-Electronics has done its utmost to insure that the listings in this directory are as accurate and reliable as possible; however, no responsibility is assumed by Radio-Electronics for its use. We have used the latest manufacturers material available to us and have asked each manufacturer covered in the listing to check its accuracy. Where we have been supplied with corrections, we have updated the listing to include them. The first part of this Guide appeared in March 1973.**

| | ARCH | GE | ICC | IR | MAL | MOT | RCA | SPR | SYL |
|---|---|---|---|---|---|---|---|---|---|
| 2N1445 | NA | NA | NA | NA | PTC 144 | HEP-714 | NA | NA | NA |
| 2N1446 | RS276-2004 | GE-2 | ICC-253 | IRTR-85 | PTC 135 | HEP-253 | SK 3004 | RT-120 | ECG 102 |
| 2N1447 | RS276-2005 | GE-2 | ICC-254 | IRTR-85 | PTC 135 | HEP-254 | SK 3004 | RT-120 | ECG 102 |
| 2N1448 | RS276-2005 | GE-2 | ICC-254 | IRTR-85 | PTC 135 | HEP-254 | SK 3004 | RT-120 | ECG 102 |
| 2N1449 | RS276-2005 | GE-2 | ICC-254 | IRTR-85 | PTC 135 | HEP-254 | SK 3004 | RT-120 | ECG 102 |
| 2N1450 | RS276-2004 | GE-52 | ICC-253 | IRTR-85 | PTC 109 | HEP-253 | SK 3004 | RT-120 | ECG 102 |
| 2N1451 | RS276-2004 | GE-2 | ICC-253 | IRTR-85 | PTC 135 | HEP-253 | SK 3004 | RT-120 | ECG 102 |
| 2N1452 | RS276-2005 | GE-2 | ICC-254 | IRTR-85 | PTC 135 | HEP-254 | SK 3004 | RT-120 | ECG 102 |
| 2N1469 | RS276-2005 | GE-21 | ICC-254 | IRTR-85 | PTC 103 | HEP-254 | SK 3005 | RT-118 | ECG 100 |
| 2N1470 | NA | GE-66 | NA | IRTR-85 | PTC 118 | HEP-S5003 | SK 3005 | RT-118 | ECG 100 |
| 2N1471 | RS276-2005 | GE-1 | ICC-254 | IRTR-85 | PTC 102 | HEP-254 | SK 3005 | RT-118 | ECG 100 |
| 2N1472 | NA | GE-62 | NA | IRTR-87 | PTC 121 | HEP-50 | SK 3024 | RT-114 | ECG 128 |
| 2N1473 | RS276-2002 | GE-7 | ICC-641 | TR-08 | PTC 108 | HEP-641 | SK 3011 | RT-119 | ECG 101 |
| 2N1474 | RS276-2021 | GE-21 | ICC-51 | IRTR-52 | PTC 131 | HEP-51 | SK 3114 | RT-115 | ECG 159 |
| 2N1475 | RS276-2021 | GE-21 | ICC-51 | IRTR-52 | PTC 103 | HEP-51 | SK 3114 | RT-115 | ECG 159 |
| 2N1476 | NA | NA | NA | NA | PTC 127 | NA | NA | NA | NA |
| 2N1477 | NA | NA | NA | NA | PTC 127 | NA | NA | NA | NA |
| 2N1478 | RS276-2005 | GE-2 | ICC-254 | IRTR-85 | PTC 102 | HEP-254 | NA | RT-120 | ECG 102 |
| 2N1479 | RS276-2018 | GE-28 | ICC-243 | IRTR-76 | PTC 143 | HEP-243 | SK 3024 | RT-114 | ECG 128 |
| 2N1480 | RS276-2018 | GE-28 | ICC-243 | IRTR-76 | PTC 110 | HEP-243 | SK 3024 | RT-114 | ECG 128 |
| 2N1481 | RS276-2018 | GE-28 | ICC-243 | IRTR-76 | PTC 143 | HEP-243 | SK 3024 | RT-114 | ECG 128 |
| 2N1482 | RS276-2018 | NA | ICC-243 | IRTR-87 | PTC 110 | HEP-243 | SK 3024 | RT-114 | ECG 128 |
| 2N1483 | RS276-2018 | GE-66 | ICC-243 | IRTR-76 | PTC 144 | HEP-243 | SK 3024 | NA | NA |
| 2N1484 | NA | GE-66 | NA | IRTR-76 | NA | HEP-S5000 | NA | NA | NA |
| 2N1485 | RS276-2018 | GE-66 | ICC-243 | IRTR-76 | PTC 144 | HEP-243 | SK 3024 | NA | NA |
| 2N1486 | NA | GE-66 | NA | IRTR-76 | NA | HEP-S5000 | NA | NA | NA |
| 2N1487 | NA | NA | ICC-247 | IRTR-90 | PTC 118 | HEP-247 | NA | RT-131 | ECG 130 |
| 2N1488 | NA | GE-75 | ICC-247 | IRTR-90 | PTC 118 | HEP-247 | NA | RT-131 | ECG 130 |
| 2N1489 | NA | NA | ICC-247 | IRTR-90 | PTC 118 | HEP-247 | NA | RT-131 | ECG 130 |
| 2N1490 | NA | GE-75 | ICC-247 | IRTR-90 | PTC 118 | HEP-247 | NA | RT-131 | ECG 130 |
| 2N1491 | RS276-2009 | GE-17 | ICC-247 | TR-21 | PTC 121 | HEP-53 | SK 3048 | RT-102 | ECG 123A |
| 2N1492 | RS276-2009 | GE-17 | ICC-53 | IRTR-51 | PTC 121 | HEP-53 | SK 3048 | RT-102 | ECG 123A |
| 2N1493 | NA | NA | ICC-713 | IRTR-87 | PTC 144 | HEP-713 | NA | RT-110 | ECG 154 |
| 2N1494 | NA | GE 9 | NA | NA | NA | NA | NA | NA | NA |
| 2N1495 | NA | GE 9 | ICC-2 | IRTR-89 | PTC 107 | HEP-2 | NA | NA | ECG 160 |
| 2N1499 | RS276-2003 | GE-9 | ICC-635 | IRTR-89 | PTC 107 | HEP-635 | SK 3006 | NA | ECG 126 |
| 2N1500 | RS276-2003 | GE-9 | ICC-2 | IRTR-89 | PCT 107 | HEP-2 | SK 3006 | NA | ECG 126 |
| 2N1501 | NA | GE-4 | NA | TR-01 | PTC 106 | NA | SK 3012 | RT-124 | ECG 104 |
| 2N1502 | NA | GE-4 | NA | TR-01 | PTC 106 | NA | SK 3012 | RT-124 | ECG 104 |
| 2N1505 | NA | GE-18 | NA | IRTR-80 | PTC 144 | HEP-S3001 | SK 3039 | RT-113 | ECG 108 |
| 2N1506 | NA | GE-63 | NA | IRTR-80 | PTC 144 | HEP-S3001 | SK 3039 | RT-113 | ECG 108 |
| 2N1507 | NA | GE-18 | ICC-S3020 | IRTR-80 | PTC 125 | HEP-S3020 | SK 3039 | RT-113 | ECG 108 |
| 2N1508 | NA | NA | NA | NA | NA | HEP-714 | NA | NA | NA |
| 2N1509 | NA | NA | NA | NA | NA | HEP-S3020 | NA | NA | NA |
| 2N1510 | NA | GE-6 | NA | TR-08 | PTC 108 | NA | SK 3011 | RT-119 | ECG 101 |
| 2N1511 | NA | NA | NA | NA | NA | HEP-S5001 | NA | NA | NA |
| 2N1512 | NA | NA | NA | NA | NA | HEP-S5004 | NA | NA | NA |
| 2N1513 | NA | NA | NA | NA | NA | HEP-S5001 | NA | NA | NA |
| 2N1514 | NA | NA | NA | NA | NA | HEP-S5004 | NA | NA | NA |
| 2N1515 | RS276-2003 | GE-1 | ICC-3 | IRTR-89 | PTC 109 | HEP-3 | SK 3006 | NA | ECG 160 |
| 2N1516 | RS276-2003 | GE-2 | ICC-3 | IRTR-89 | PTC 102 | HEP-3 | SK 3006 | NA | ECG 160 |
| 2N1517 | RS276-2003 | GE-1 | ICC-3 | IRTR-89 | PTC 109 | HEP-3 | SK 3006 | NA | ECG 160 |
| 2N1518 | NA | GE-4 | ICC-231/233 | TR-03 | PTC 106 | HEP-231/233 | SK 3012 | NA | ECG 105 |
| 2N1519 | NA | GE-4 | ICC-233 | TR-03 | PTC 106 | HEP-233 | SK 3012 | NA | ECG 105 |
| 2N1520 | NA | GE-4 | ICC-231/233 | TR-03 | PTC 106 | HEP-231/233 | SK 3012 | NA | ECG 105 |

| | ARCH | GE | ICC | IR | MAL | MOT | RCA | SPR | SYL |
|---|---|---|---|---|---|---|---|---|---|
| 2N1521 | NA | GE-4 | ICC-233 | TR-03 | PTC 106 | HEP-233 | SK 3012 | NA | ECG 105 |
| 2N1522 | NA | GE-4 | ICC-231/233 | TR-03 | PTC 106 | HEP-231/233 | SK 3012 | NA | ECG 105 |
| 2N1523 | NA | GE-4 | ICC-233 | TR-03 | PTC 106 | HEP-233 | SK 3012 | NA | ECG 105 |
| 2N1524 | RS276-2003 | GE-50 | ICC-3 | IRTR-89 | PTC 107 | HEP-3 | SK 3008 | NA | ECG 160 |
| 2N1525 | RS276-2003 | GE-50 | ICC-3 | IRTR-89 | PTC 107 | HEP-3 | SK 3008 | NA | ECG 160 |
| 2N1526 | RS276-2005 | GE-50 | ICC-638 | IRTR-89 | PTC 107 | HEP-638 | SK 3008 | NA | ECG 126 |
| 2N1527 | RS276-2003 | GE-50 | ICC-3 | IRTR-89 | PTC 107 | HEP-3 | SK 3008 | NA | ECG 160 |
| 2N1528 | RS276-2009 | GE-50 | ICC-53 | TR-21 | PTC 144 | HEP-53 | SK 3124 | RT-102 | ECG 123A |
| 2N1529 | RS276-2006 | NA | ICC-230 | TR-01 | PTC 105 | HEP-230 | SK 3009 | RT-127 | ECG 121 |
| 2N1530 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1531 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1532 | RS276-2006 | GE-3 | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1533 | NA | GE-3 | ICC-625 | TR-01 | PTC 105 | HEP-625 | SK 3009 | RT-127 | ECG 121 |
| 2N1534 | RS276-2006 | NA | ICC-230 | TR-01 | PTC 105 | HEP-230 | SK 3009 | RT-127 | ECG 121 |
| 2N1535 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1538 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1537 | RS276-2006 | GE-3 | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1538 | NA | GE-3 | ICC-625 | TR-01 | PTC 105 | HEP-625 | SK 3009 | RT-127 | ECG 121 |
| 2N1539 | RS276-2006 | NA | ICC-230 | TR-01 | PTC 105 | HEP-230 | SK 3009 | RT-127 | ECG 121 |
| 2N1540 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1541 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1542 | RS276-2006 | GE-3 | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1543 | NA | GE-3 | NA | TR-01 | PTC 105 | HEP-625 | SK 3009 | RT-127 | ECG 121 |
| 2N1544 | RS276-2006 | NA | ICC-230/232 | TR-01B | PTC 105 | HEP-230/232 | SK 3009 | RT-127 | ECG 121 |
| 2N1545 | RS276-2006 | NA | ICC-624 | TR-01 | PTC 105 | HEP-624 | SK 3009 | RT-127 | ECG 121 |
| 2N1546 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1547 | RS276-2006 | GE-3 | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1548 | NA | GE-3 | ICC-625 | TR-01 | PTC 105 | HEP-625 | SK 3009 | RT-127 | ECG 121 |
| 2N1549 | RS276-2006 | NA | ICC-230/232 | TR-01 | PTC 105 | HEP-230/232 | SK 3009 | RT-127 | ECG 121 |
| 2N1550 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1551 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1552 | RS276-2006 | GE-3 | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1553 | RS276-2006 | NA | ICC-230/232 | TR-01 | PTC 105 | HEP-230/232 | SK 3009 | RT-127 | ECG 121 |
| 2N1554 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1555 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1556 | RS276-2006 | GE-3 | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1557 | RS276-2006 | NA | ICC-230/232 | TR-01 | PTC 105 | HEP-230/232 | SK 3009 | RT-127 | ECG 121 |
| 2N1558 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1559 | RS276-2006 | NA | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | EOG 121 |
| 2N1560 | RS276-2006 | GE-3 | ICC-232 | TR-01 | PTC 105 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1561 | RS276-2003 | GE-9 | ICC-3 | TR-17 | PTC 107 | HEP-3 | NA | NA | ECG 160 |
| 2N1562 | RS276-2003 | GE-9 | ICC-3 | TR-17 | PTC 107 | HEP-3 | NA | NA | ECG 160 |
| 2N1563 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2N1564 | NA | GE-18 | NA | TR-87 | PTC 125 | HEP-713 | NA | NA | NA |
| 2N1565 | NA | GE-18 | NA | TR-87 | PTC 125 | HEP-713 | NA | NA | NA |
| 2N1566 | NA | GE-18 | NA | TR-84 | PTC 144 | HEP-713 | NA | NA | NA |
| 2N1567 | NA | GE-4 | NA | NA | NA | NA | NA | NA | NA |
| 2N1568 | NA | GE-4 | NA | NA | NA | NA | NA | NA | NA |
| 2N1569 | NA | GE-4 | NA | NA | NA | NA | NA | NA | NA |
| 2N1570 | RS276-2004 | GE-2 | ICC-253 | TR-05 | PTC 102 | HEP-253 | SK 3005 | RT-118 | ECG 100 |
| 2N1572 | NA | GE-18 | NA | TR-78 | PTC 125 | HEP-712 | SK 3045 | RT-110 | ECG 154 |
| 2N1573 | NA | GE-18 | NA | TR-78 | PTC 144 | HEP-712 | SK 3045 | RT-110 | ECG 154 |
| 2N1574 | NA | GE-18 | NA | TR-78 | NA | HEP-712 | SK 3045 | RT-110 | ECG 154 |
| 2N1581 | RS276-2004 | GE-2 | ICC-253 | TR-05 | PTC 102 | HEP-253 | SK 3005 | RT-118 | ECG 100 |
| 2N1583 | RS276-2004 | GE-2 | ICC-253 | TR-05 | PTC 102 | HEP-253 | SK 3005 | RT-118 | ECG 100 |

NA = NOT AVAILABLE

| | ARCH | GE | ICC | IR | MAL | MOT | RCA | SPR | SYL |
|---|---|---|---|---|---|---|---|---|---|
| 2N1584 | RS276-2004 | GE-2 | ICC-253 | TR-05 | PTC 102 | HEP-253 | SK 3005 | RT-118 | ECG 100 |
| 2N1585 | RS276-2002 | GE-7 | ICC-641 | TR-08 | PTC 108 | HEP-641 | SK 3011 | RT-119 | ECG 101 |
| 2N1586 | RS276-2009 | GE-11 | ICC-53 | TR-70 | PTC 132 | HEP-53 | SK 3124 | RT-108 | ECG 107 |
| 2N1587 | RS276-2009 | GE-11 | ICC-53 | TR-70 | PTC 132 | HEP-53 | SK 3124 | RT-108 | ECG 107 |
| 2N1588 | NA | GE-61 | NA | TR-21 | PTC 132 | HEP-S0007 | SK 3122 | RT-102 | ECG 123A |
| 2N1589 | RS276-2009 | GE-11 | ICC-53 | TR-70 | PTC 132 | HEP-53 | SK 3124 | RT-108 | ECG 107 |
| 2N1590 | RS276-2009 | GE-11 | ICC-53 | TR-70 | PTC 132 | HEP-53 | SK 3124 | RT-108 | ECG 107 |
| 2N1591 | RS276-2009 | GE-61 | ICC-53 | TR-21 | PTC 132 | HEP-53 | SK 3020 | RT-102 | ECG 123A |
| 2N1592 | RS276-2009 | GE-11 | ICC-53 | TR-95 | PTC 139 | HEP-53 | SK 3124 | RT-108 | ECG 107 |
| 2N1593 | RS276-2009 | GE-11 | ICC-53 | TR-95 | PTC 139 | HEP-53 | SK 3124 | RT-108 | ECG 107 |
| 2N1594 | RS276-2009 | GE-61 | ICC-53 | TR-21 | PTC 133 | HEP-53 | SK 3124 | RT-102 | ECG 123A |
| 2N1595 | NA | GEMR-5 | NA | NA | NA | HEP-R1101 | NA | NA | NA |
| 2N1596 | NA | GEMR-5 | NA | NA | NA | HEP-R1102 | NA | NA | NA |
| 2N1597 | NA | GEMR-5 | NA | NA | NA | HEP-R1103 | NA | NA | NA |
| 2N1600 | NA | NA | ICC-302 | SCR-04 | NA | HEP-R1241 | NA | NA | ECG 122 |
| 2N1601 | NA | NA | ICC-302 | SCR-04 | NA | HEP-R1243 | NA | NA | ECG 122 |
| 2N1602 | NA | NA | ICC-302 | SCR-04 | NA | HEP-R1243 | NA | NA | ECG 122 |
| 2N1603 | NA | NA | NA | IR-1603 | NA | HEP-R1244 | NA | NA | NA |
| 2N1604 | NA | NA | NA | IR-1604 | NA | HEP-R1245 | NA | NA | NA |
| 2N1605 | RS276-2001 | GE-8 | ICC-641 | TR-08 | PTC 108 | HEP-641 | SK 3011 | RT-119 | ECG 101 |
| 2N1606 | RS276-2021 | NA | ICC-51 | NA | PTC 127 | HEP-51 | SK 3114 | RT-115 | ECG 159 |
| 2N1607 | RS276-2021 | NA | ICC-51 | NA | PTC 127 | HEP-51 | SK 3114 | RT-115 | ECG 159 |
| 2N1608 | RS276-2021 | NA | ICC-51 | NA | PTC 127 | HEP-51 | SK 3114 | RT-115 | ECG 159 |
| 2N1609 | NA | GE-16 | NA | NA | PTC 105 | NA | NA | NA | NA |
| 2N1610 | NA | GE-16 | NA | NA | PTC 105 | NA | NA | NA | NA |
| 2N1611 | NA | GE-03 | NA | NA | NA | NA | NA | NA | NA |
| 2N1612 | NA | GE-03 | NA | NA | NA | NA | NA | NA | NA |
| 2N1613 | NA | GE-18 | ICC-714 | TR-87 | PTC 144 | HEP-714 | SK 3024 | NA | NA |
| 2N1614 | RS276-2004 | GE-2 | ICC-253 | TR-84 | NA | HEP-253 | NA | NA | ECG 158 |
| 2N1615 | NA | NA | NA | NA | PTC 125 | HEP-713 | NA | NA | NA |
| 2N1616 | NA | NA | NA | NA | NA | HEP-S5001 | NA | NA | NA |
| 2N1617 | NA | NA | NA | NA | NA | HEP-S5004 | NA | NA | NA |
| 2N1618 | NA | NA | NA | NA | NA | HEP-S5004 | NA | NA | NA |
| 2N1620 | NA | NA | NA | NA | NA | HEP-S5004 | NA | NA | NA |
| 2N1622 | RS276-2002 | GE-54 | ICC-641 | TR-08 | PTC 108 | HEP-641 | SK 3011 | RT-119 | ECG 101 |
| 2N1623 | RS276-2021 | GE-21 | ICC-51 | RTR-88 | PTC 131 | HEP-51 | SK 3114 | RT-115 | ECG 129 |
| 2N1624 | RS276-2001 | GE-6 | ICC-641 | TR-08 | PTC 108 | HEP-641 | SK 3011 | RT-119 | ECG 101 |
| 2N1625 | NA | GE-50 | NA | TR-17 | PTC 107 | NA | NA | NA | NA |
| 2N1631 | RS276-2003 | GE-9 | ICC-635 | TR-05 | PTC 107 | HEP-635 | SK 3008 | NA | ECG 126 |
| 2N1632 | RS276-2003 | GE-9 | ICC-635 | TR-85 | PTC 107 | HEP-635 | SK 3008 | NA | ECG 126 |
| 2N1633 | NA | GE-9 | ICC-2 | TR-17 | PTC 107 | HEP-2 | SK 3008 | NA | ECG 160 |
| 2N1634 | NA | GE-9 | ICC-2 | TR-17 | PTC 107 | HEP-2 | SK 3008 | NA | ECG 160 |
| 2N1635 | RS276-2003 | GE-9 | ICC-635 | TR-12 | PTC 107 | HEP-635 | SK 3008 | NA | ECG 126 |
| 2N1636 | RS276-2003 | GE-9 | ICC-635 | TR-12 | PTC 107 | HEP-635 | SK 3008 | NA | ECG 126 |
| 2N1637 | RS276-2003 | GE-9 | ICC-635 | IRTR-85 | PTC 107 | HEP-635 | SK 3008 | NA | ECG 126 |
| 2N1638 | RS276-2005 | GE-9 | ICC-636 | TR-05 | PTC 107 | HEP-636 | SK 3008 | NA | ECG 160 |
| 2N1639 | RS276-2005 | GE-9 | ICC-636 | TR-17 | PTC 107 | HEP-636 | SK 3008 | NA | ECG 160 |
| 2N1640 | NA | GE-21 | NA | TR-19 | PTC 131 | NA | SK 3118 | RT-126 | ECG 106 |
| 2N1641 | NA | GE-21 | NA | TR-19 | PTC 131 | NA | SK 3118 | RT-126 | ECG 106 |
| 2N1642 | NA | GE-21 | NA | TR-19 | PTC 131 | NA | SK 3118 | RT-126 | ECG 106 |
| 2N1643 | RS276-2021 | GE-21 | ICC-51 | TR-21 | PTC 153 | HEP-51 | SK 3114 | RT-115 | ECG 159 |
| 2N1644 | RS276-2009 | GE-27 | ICC-53 | TR-21 | PTC 144 | HEP-53 | SK 3122 | RT-102 | ECG 123A |
| 2N1646 | RS276-2003 | GE-51 | ICC-3 | TR-17 | PTC 107 | HEP-3 | NA | NA | ECG 160 |
| 2N1647 | NA | NA | NA | NA | NA | HEP-S5000 | NA | NA | NA |
| 2N1649 | NA | NA | NA | NA | NA | HEP-S5000 | NA | NA | NA |
| 2N1651 | RS276-2006 | NA | ICC-232 | NA | NA | HEP-232 | SK 3014 | RT-147 | ECG 179 |
| 2N1652 | RS276-2006 | GE-3 | ICC-232 | NA | PTC 138 | HEP-232 | SK 3014 | RT-127 | ECG 121 |
| 2N1653 | NA | GE-3 | NA | NA | PTC 138 | HEP-236 | SK 3009 | RT-127 | ECG 121 |
| 2N1654 | NA | GE-18 | NA | NA | PTC 125 | NA | NA | NA | NA |
| 2N1655 | NA | GE-27 | NA | NA | PTC 125 | NA | NA | NA | NA |
| 2N1656 | NA | GE-27 | NA | NA | PTC 125 | NA | NA | NA | NA |
| 2N1657 | NA | NA | NA | NA | NA | HEP-245 | NA | NA | NA |
| 2N1663 | RS276-2009 | GE-20 | ICC-50 | IRTR-51 | PTC 136 | HEP-50 | SK 3122 | RT-102 | ECG 123A |
| 2N1664 | NA | GE-2 | NA | TR-05 | PTC 102 | HEP-630 | SK 3005 | RT-118 | ECG 100 |
| 2N1665 | NA | GE-1 | ICC-2 | TR-17 | PTC 109 | HEP-2 | NA | NA | ECG 160 |
| 2N1666 | RS276-2006 | GE-3 | ICC-232 | TR-01 | PTC 138 | HEP-232 | SK 3009 | RT-127 | ECG 121 |
| 2N1667 | RS276-2006 | GE-16 | ICC-230 | TR-01 | PTC 105 | HEP-230 | SK 3009 | RT-127 | ECG 121 |
| 2N1668 | RS276-2006 | GE-3 | ICC-230 | TR-01 | PTC 105 | HEP-230 | SK 3009 | RT-124 | ECG 104 |
| 2N1669 | RS276-2006 | GE-3 | ICC-230 | TR-01 | PTC 105 | HEP-230 | SK 3009 | RT-124 | ECG 104 |
| 2N1670 | NA | GE-1 | ICC-2 | NA | PTC 107 | HEP-2 | SK 3005 | NA | ECG 160 |
| 2N1671 | NA | NA | NA | NA | NA | HEP-310 | NA | NA | NA |
| 2N1672 | RS276-2002 | GE-6 | ICC-641 | NA | PTC 108 | HEP-641 | NA | RT-122 | ECG 103A |
| 2N1673 | RS276-2005 | GE-1 | ICC-254 | IRTR-85 | PTC 107 | HEP-254 | SK 3005 | RT-121 | ECG 102A |
| 2N1674 | RS276-2009 | GE-61 | ICC-53 | TR-21 | PTC 133 | HEP-53 | SK 3122 | RT-102 | ECG 123A |
| 2N1676 | RS276-2021 | GE-22 | ICC-51 | TR-73 | PTC 103 | HEP-51 | SK 3114 | RT-115 | ECG 159 |
| 2N1677 | RS276-2021 | GE-22 | ICC-51 | TR-73 | PTC 103 | HEP-51 | SK 3118 | RT-115 | ECG 159 |
| 2N1678 | NA | GE-51 | ICC-2 | NA | PTC 107 | HEP-2 | SK 3008 | NA | ECG 160 |
| 2N1681 | RS276-2005 | GE-1 | ICC-254 | IRTR-85 | PTC 102 | HEP-254 | NA | RT-121 | ECG 102A |
| 2N1682 | RS276-2009 | GE-17 | ICC-53 | TR-86 | PTC 121 | HEP-53 | SK 3124 | RT-100 | ECG 123 |
| 2N1683 | RS276-2005 | GE-1 | ICC-254 | TR-05 | PTC 102 | HEP-254 | SK 3005 | RT-118 | ECG 100 |
| 2N1684 | RS276-2004 | GE-1 | ICC-253 | TR-05 | PTC 109 | HEP-253 | SK 3005 | RT-118 | ECG 100 |
| 2N1685 | RS276-2001 | GE-6 | ICC-641 | TR-08 | PTC 108 | HEP-641 | SK 3011 | RT-119 | ECG 101 |
| 2N1690 | NA | NA | NA | NA | NA | HEP-S3020 | NA | NA | NA |
| 2N1691 | NA | 32 | NA | NA | NA | HEP-714 | NA | NA | NA |
| 2N1694 | RS276-2001 | GE-5 | ICC-641 | TR-08 | PTC 108 | HEP-641 | SK 3011 | RT-119 | ECG 101 |
| 2N1699 | NA | GE-9 | NA | TR-12 | PTC 107 | NA | NA | NA | ECG 126 |
| 2N1700 | RS276-2018 | GE-28 | ICC-243 | IRTR-76 | PTC 144 | HEP-243 | NA | RT-114 | ECG 128 |
| 2N1701 | NA | GE-66 | NA | NA | NA | HEP-243 | NA | NA | NA |
| 2N1702 | NA | NA | ICC-247 | NA | PTC 140 | HEP-247 | NA | RT-131 | ECG 130 |
| 2N1703 | NA | GE-19 | NA | NA | NA | HEP-S5001 | NA | RT-131 | ECG 130 |
| 2N1704 | RS276-2009 | GE-18 | ICC-53 | IRTR-51 | PTC 121 | HEP-53 | SK 3122 | RT-102 | ECG 123A |
| 2N1705 | RS276-2005 | GE-2 | ICC-254 | TR-85 | PTC 102 | HEP-254 | SK 3004 | RT-120 | ECG 102 |
| 2N1706 | RS276-2005 | GE-2 | ICC-254 | TR-85 | PTC 102 | HEP-254 | SK 3004 | RT-120 | ECG 102 |
| 2N1707 | RS276-2005 | GE-2 | ICC-254 | TR-85 | PTC 102 | HEP-254 | SK 3004 | RT-120 | ECG 102 |
| 2N1708 | RS276-2009 | GE-20 | ICC-50 | TR-21 | PTC 136 | HEP-50 | SK 3122 | RT-102 | ECG 123A |
| 2N1709 | NA | GE-66 | NA | NA | NA | HEP-S3010 | NA | NA | NA |
| 2N1710 | NA | GE-28 | NA | TR-55 | PTC 110 | HEP-S3010 | NA | NA | NA |
| 2N1711 | RS276-2009 | GE-18 | ICC-736 | NA | PTC 123 | HEP-736 | SK 3024 | NA | NA |
| 2N1713 | NA | NA | NA | NA | NA | HEP-638 | NA | NA | NA |
| 2N1714 | NA | GE-63 | NA | NA | PTC 144 | HEP-S3020 | NA | NA | NA |
| 2N1715 | NA | NA | NA | NA | PTC 144 | HEP-714 | NA | NA | NA |
| 2N1716 | NA | GE-63 | NA | NA | PTC 144 | HEP-S3020 | NA | NA | NA |
| 2N1717 | NA | NA | NA | NA | PTC 144 | HEP-714 | NA | NA | NA |
| 2N1718 | NA | GE-66 | NA | NA | NA | HEP-S3020 | NA | NA | NA |
| 2N1719 | NA | NA | NA | NA | NA | HEP-714 | NA | NA | NA |
| 2N1720 | NA | GE-66 | NA | NA | NA | HEP-S2020 | NA | NA | NA |
| 2N1721 | NA | NA | NA | NA | NA | HEP-714 | NA | NA | NA |
| 2N1726 | NA | GE-9 | ICC-2 | NA | PTC 107 | HEP-2 | SK 3006 | NA | ECG 160 |
| 2N1727 | NA | GE-9 | ICC-2 | NA | PTC 107 | HEP-2 | SK 3006 | NA | ECG 160 |
| 2N1728 | NA | GE-9 | ICC-2 | NA | PTC 107 | HEP-2 | SK 3006 | NA | ECG 160 |

NA = NOT AVAILABLE

*(continued, next month)*

# R-E's Service Clinic

## Hardware Noise—A type of TVI

*How to identify and localize it.*

JACK DARR
SERVICE EDITOR

OUTSIDE OF CERTAIN COMMERCIALS, one of the things that annoys TV viewers the most is interference or noise in the picture. It comes in all shapes and sizes; from older cars, home electrical appliances, and so on. Anything in the house can be tracked down, and identified, by simply turning it on and off. Filtering can then be used to clear it up. Some interference can come from outside sources, though. We used to call this "hash", but now I supose we should say noise pollution. Either one is correct.

An irate reader wrote me "I've got so much interference on my TV set that I don't like to watch it. There are two wide bands of dots and streaks that roll slowly up the picture. They interfere with the sound, and even make the picture roll at times. Looks like ignition noise, but I don't think it is. What can I do about it?"

Complain loudly to the power company. I've seen this a great many times. The polite name for it is hardware noise. It's caused by old or defective equipment on the ac lines feeding your house. You'll notice that the interference shows two bands of dots, meaning that it has a characteristic 120-Hz frequency. Without going into too much detail, it's due to a *corona* discharge. Not on your home's service wiring, which is 230 volts maximum in most places, but on the feeders or tertiary lines which supply the pole step-down transformers. These lines run around 7,600 volts, etc.

Several things can cause it, including defective or cracked insulators, but probably the most frequent offender is the terminals on the transformers themselves. If these are old, or not correctly designed, the corona discharge takes place *inside* the transformer, above the oil, from the shank of the bolt to the metal case. I have seen some "horrible examples" of these after they'd been replaced, and the shank of the terminal bolt is actually pitted and eaten away by the corona! There are newer types, designed to prevent this; they have plastic insulation, etc. on the shank of the bolt. Your power company, especially the REA, has a training film on this, which shows all of the effects and how to cure them.

The reason for the 120-Hz effect is simple. The corona discharge takes place twice during each cycle of the voltage; once on the positive peak and again on the negative peak. Each peak generates the corona discharge, which in turn generates a burst of high-amplitude rf "signals", which cover all frequencies. We're going to do something with this effect in a moment.

The first step should be to file a complaint, in writing, with your local power company. Tell them you have hardware noise, and they'll know what you're talking about. Most companies have noise locating equipment, and it shouldn't take them long to find the offending unit.

If you want to try finding it yourself, there are a couple of ways. Drive around the area with a radio equipped car, or even a portable radio. Set the dial off-station, somewhere near 800 kHz. For some reason, this noise peaks at that frequency. When you find a place where the noise is very loud, turn the dial of the set back and forth. It will usually be of such a high amplitude that you won't be able to use "loudness" alone to pin it down.

When you get closer to the source, the noise will start to spread; it will cover more and more of the dial. For example, if you get noise from 600 to 900 kHz, you're getting closer, but you're not there yet. Keep on looking and tuning, and when you find a place where you can get nothing but noise from one end of the dial to the other, you're getting warm—really warm.

Find the nearest pole. If it has a transformer on it, so much the better. Listen to the noise, and hit the pole a sound whack with a heavy hammer. If

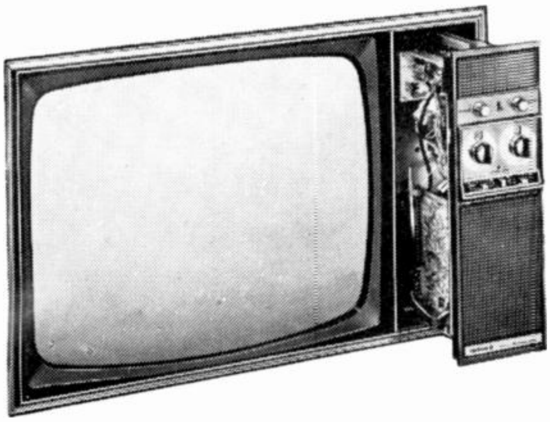
*(continued on page 78)*

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

# Let ICS mail you a FREE demonstration lesson without obligation... to prove that you can learn TV Servicing at home.

Credit towards a Certified Electronic Technician (C.E.T.) rating will be granted by the National Electronics Association to ICS students upon completion of the ICS Career Program in TV Service/Repair.



## Practice on a new 25″ MOTOROLA QUASAR II® chassis.

TV Servicing is a satisfying career . . . and the pay is great. Qualified men are needed now to maintain the 93 million sets in U.S. homes. And prospects for the future are even brighter.

Now . . . here's an opportunity for you to prove to yourself that *you* can learn TV Servicing . . . at home, in your spare time. ICS, the world's most experienced home-study school, will send you a *FREE* Demonstration Lesson (complete with sample questions) if you will merely fill out the coupon below and mail it to us.

In addition to your free demonstration lesson, we'll send you . . . also FREE . . . a brochure that describes the 25″ (diagonally measured screen) MOTOROLA QUASAR II® Color TV chassis that we include in our TV Service Training Program.

This chassis with automatic fine tuning control is ideal for training purposes because it combines solid state devices with vacuum tubes to give you both kinds of practical experience. All parts carry Motorola's two year replacement guarantee!

The QUASAR II chassis comes to you in three basic sub-assemblies . . . NOT AS A KIT . . . because we want you to learn how to *repair* TV sets, not build them.

Our free literature also describes the fully assembled test equipment you receive such as the Deluxe 5″ Solid State Oscilloscope, the tools and the learn-by-doing kits, all of the finest quality.

And we're going to tell you about eight other career opportunities in Electronics and the ICS Career Programs that can help prepare you for them.

All you've got to do is mail the attached postpaid card or coupon—today!

**ICS**

**International Correspondence Schools**
Since 1890
**School of Electronics**
**Scranton, Pa. 18515**

Approved for Veterans' Training. Eligible Institution under the Guaranteed Student Loan Program. Accredited Member National Home Study Council. Canadian residents use coupon address for service from ICS Canadian, Ltd. In Hawaii: 931 University Ave., Honolulu, Hawaii 96814

**ICS School of Electronics**
**International Correspondence Schools**
**Scranton, Pa. 18515**

YES, I want you to mail to me without obligation, the FREE DEMONSTRATION LESSON and complete literature on the career program checked below. (Please check one.)

- ☐ **Color TV Servicing & Repair**
- ☐ **Computer Maintenance**
- ☐ **CATV/MATV Technician**
- ☐ **Telephony**
- ☐ **Electrician**
- ☐ **FCC Licensing**
- ☐ **Communications/ Broadcasting**
- ☐ **Hi-Fi Sound Systems**
- ☐ **Industrial Electronics**

AA639U

Name____________________ Age________

Address____________________________

City______________________________

State____________________ Zip________

*Circle 16 on reader service card*

**SERVICE CLINIC**
*(continued from page 73)*

this changes the noise, there you are.

Second method. If you have a highly directional TV antenna with a rotator, turn it all the way around, and watch the screen. Find the direction where the noise is most intense. Make a line along this bearing, on a city map. Now locate a friend with an antenna of the same type. Take a bearing on the noise with his antenna. Draw this on the map. At the point where the lines cross, there's the noise. If you can get a third bearing, preferably at a point distant from the first two, you can pin it down even more closely. We used this method on a very bad case, some time ago, and pinned it down to a very bad insulator, on a pole almost two miles away. Some nut had shot the insulator with a high-powered rifle!

Due to the fact that power lines make excellent "long-wire antennas", you may run into some ambiguity in your bearings. In fact, it's more likely that you'll see a triangle instead of a single point where they cross. At any rate, you're in the ball-park.

Go to the general area where the noise is originating and then switch to the car radio or portable. Use the frequency-spread of the noise as the indicator and follow the power line until you find the pole where the noise covers the whole dial. There you are. Look for a little metal tab or label on the pole. This will give you the number, and you can report it to the power company. **R-E**

# reader questions

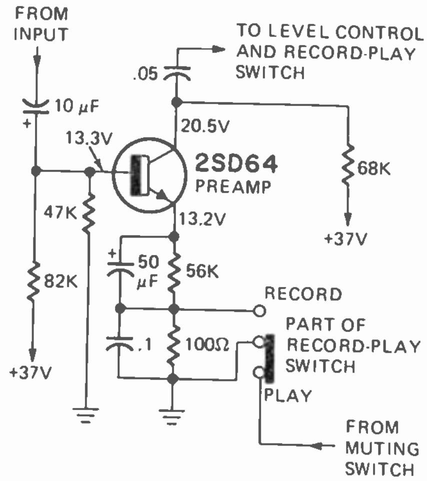
### SUDDEN LOSS OF CONVERGENCE

*Here's one for you. In a Sylvania D-15, I had a sudden loss of convergence. I couldn't get the center vertical line, red and green, to converge at all. The trouble turned out to be a shorted electrolytic capacitor, C-800, 6.8 μF located on the convergence board. This might apply to other chasses, too.—Harold Jones, Harold's TV, 810 College, Bowling Green, Ky.*

Thank you very much, Harold. Filed and noted for future reference.

### NO SOUND

*I can't get anything through the amplifier of this Sony TC-102 hybrid tape recorder. The dc voltages on the 6AU6 second af amplifier are about +60 volts, plate and screen, but I read +8 volts on all three elements of the preamp transistor. That doesn't sound right.—H.C., Monroe, La.*




It certainly doesn't. From a reading like this, you have one or two possible things; the transistor is shorted to all three elements, or there is a resistor open in the supply! Take the transistor out and check it. If it shows a normal "diode-effect" reading out of circuit, then turn the power on, and check the voltages on the transistor connections on the board.

From these readings, I'd suspect something like an open collector load resistor, R9, 68,000 ohms. If this was
*(continued on page 80)*

# JERROLD HAS TAKEN THE MYSTERY OUT OF MASTER ANTENNA TV.


Now, you don't have to worry about decibels or any other theory. Just pick out one of the Universal Systems shown in the Jerrold Instant MATV Guide, install it and you have an excellent system.

If you can deliver good TV signals to one set from one antenna, you can easily install any system in this guide.

Complete with actual Layouts, Bills of Materials and Installation Tips.

Send for your Jerrold INSTANT MATV Guide today.

**IT'S FREE!**

**JERROLD ELECTRONICS CORPORATION**
P.O. BOX 350, 200 WITMER ROAD, HORSHAM, PA. 19044

JERROLD'S SILVER ANNIVERSARY 25 1948-1973

JERROLD
a GENERAL INSTRUMENT company

*Circle 18 on reader service card*

READER QUESTIONS

(continued from page 78)

good, and the transistor shorted, you'd be reading much higher voltages.

### VERTICAL SYMPTOMS, HORIZONTAL TROUBLE

*The raster of this RCA CTC-55 slowly shrank, and just as it was almost gone, the circuit-breaker tripped. It does this after about 10 minutes of operation. I found nothing bad in the vertical output stage; in fact, if I feed a 30-V ac signal to the output grid, while the raster's shrinking, I can get a full raster again. Only thing I can see is a gradual drop in the boost, while it shrinks. This is weird.—A.J., Minneapolis, Minn.*

Right! Your vertical stage is OK. The raster-shrink is due to the drop in *boost;* this feeds the input-half plate, through the vertical size control. So you have a vertical symptom and a horizontal cause.

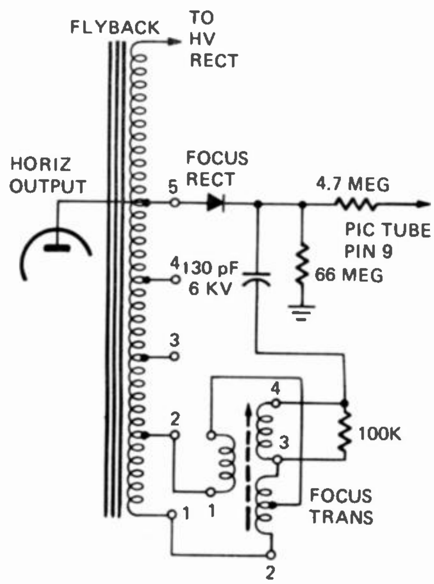
Find out why your boost is dropping. In quite a few of these chasses, this has been due to grid emission in the 31LZ6 horizontal output tube. It upsets the bias and makes the cathode current rise; this trips the breaker.

### FOCUS PROBLEM

*After I replaced the picture tube on this Catalina 122-770B, it worked fine. I was converging it, and all of a sudden I lost focus. Smoke started coming out of the high-voltage cage. The flyback was pretty warm. I tried new tubes; same thing. 6JE6 cathode current went off-scale on 250 mA range.*

*Nothing helped; horizontal efficiency coil, focus adjustment, had no effect. The raster is full, but badly smeared; no focus at all. Do you think the flyback has gone?—A.S., Chicago, Ill.*

Not *yet,* if you still have a full raster. Don't leave it on too long, or it probably will be. This sounds very much as if your focus transformer is shorted. As you can see from the diagram. It is shunted right across terminals 1 and 2 on the flyback.




To check, just disconnect the focus transformer from the flyback and try again. If your 6JE6 current goes back to normal, and the flyback stays fairly cool, this is it. You'll probably see much better focus, if the transformer was shorted; this is only a *control* on the focus voltage. Incidentally, you won't find this model listed in Sams, but the diagram of an AMC CER-75A (828-1) matches it.

### COLOR SYNC LOST

*This Motorola TS-918 had a bad arc-over from the ultor connection to the shield; burned up the insulating cap. After I got this fixed, I found there was very little color sync, and the color looked very odd. Should I realign the color stages?—R.G., Provo, Utah*

No. The chances are that this is component damage, due to the high transients generated by the arcing. I have seen similar things happen.

In this model, check the color sync and gate stage, the 6BL8. It is quite possible that the 4700-ohm glass-film resistor has been damaged. If so,

# SOUTHWEST TECHNICAL PRODUCTS CORPORATION

219 W. RHAPSODY

SAN ANTONIO, TEXAS 78216

PHONE: 512 DI 4-3140

September, 1973

Dear Radio-Electronics Readers,

I understand from my mail, phone calls and other feedback that there are still some of you out there who cannot believe our kits are any good due to the reasonable prices that we charge. It sort of makes me wonder at times if we wouldn't automatically increase our business 50% if we just doubled our prices so that they would compare with other kits that are available. At least we wouldn't have this credibility problem with our potential customers. No, don't worry, it's not about to happen, but for those doubters let me once more try to explain the deal.

This is strictly a direct mail business, for the first thing. We don't sell through dealers, and don't have any expensive, fancy company owned outlets. This type operation makes it impossible for us to demonstrate our equipment for you, but it also saves you the 30 to 40% markup that the dealer would normally get on the equipment. We are gambling that there are enough people who know a superior circuit when they see one and a good deal when one is offered them, to keep us clear of the bankruptcy courts. We are not trying to cut any corners on quality, in fact our parts are probably better than the great majority of those you see in electronic equipment. Our circuit boards are all G-10 fibreglass and all resistors are highly stable film types. How many other kit companies do you know who can honestly make a similar statement? So next time you are tempted to try a kit from the "other" kit company, but cannot believe the price, just add 1/3 to the price in our catalog. See, now don't you feel better thinking about our "Tiger .01" amplifier, for example, as a $99.50 kit rather than a $75.00 kit.

One thing more should be mentioned. We design our kits for people who have experience with electronics. We don't waste time and money writing "hand holding" or "overkill" instructions. We expect you to have a multimeter of some kind at the very minimum and to know how to use it. We expect you to know how to read a schematic and how to solder. In other words we expect you to be seriously involved in electronics and not just be looking for a nice hobby to pass the time. I don't consider having built 537 Heath, or EICO kits as qualifying anyone in the field of electronics anymore than I would consider having done 537 number paintings qualifying you as an artist. Please, if you are like the approximately one guy a month who returns a transformer because he tested the winding with his multimeter Ohms scale and found that it did not check out with the impedence we called for; save us both problems, and get the built-up version. Not that I have anything against beginners, or students. I am happy for them to build our kits as long as they understand the situation and are adult enough to accept the possible consequences with a minimum amount of sniveling. We have a repair department just in case you get in over your head, but service work is limited to repairs. We won't build ¾ of the kit for you.

I would like to send you a free copy of our new 30 page catalog if you are interested in our kits. Just circle our number on the "Bingo" card in the back of the magazine, or mail us a card.

Sincerely,

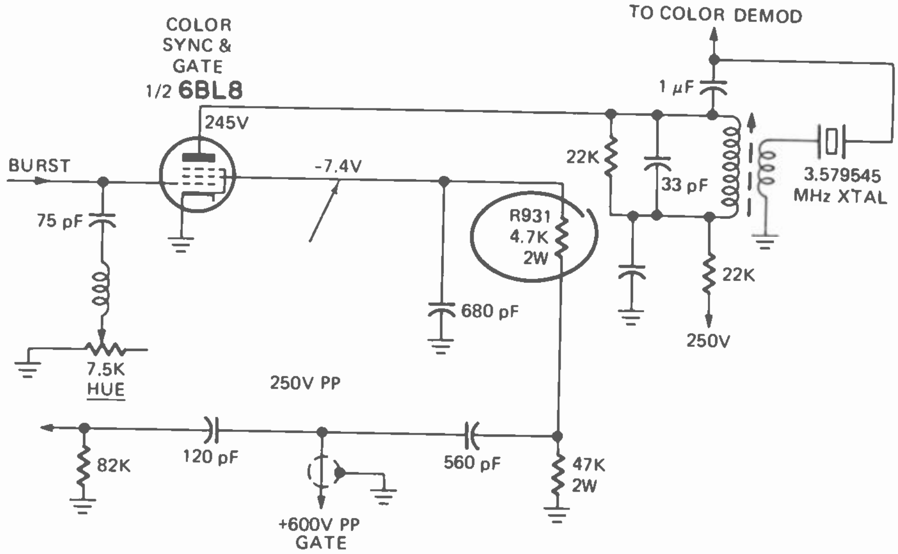
Dan

Daniel Meyer

SOUTHWEST TECHNICAL PRODUCTS CORPORATION
219 W. RHAPSODY DEPT. RE-L
SAN ANTONIO, TEXAS 78216

*Circle 20 on reader service card*

**READER QUESTIONS** *(continued from page 80)*



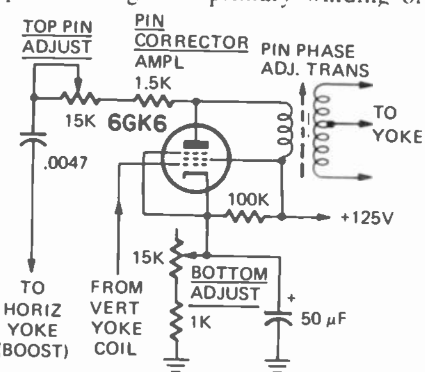

you'll have no gating pulse on the 3.58-MHz signal to the crystal and no color sync at all. This is R931.

### BURNT "PLATE LOAD"

*The plate resistor of the pincushion-corrector tube of this Setchell-Carlson U802 burns up; so does the 15,000-ohm pot that feeds this resistor. I changed the 6GK6 pincushion-corrector tube, but that didn't help. The raster goes out of focus and pulls in.—J.A., Rome, Ga.*



May I make a small correction? The 15,000-ohm pot and 1500-ohm resistor *do not* feed dc to the pin-corrector tube. The dc plate voltage is supplied through the primary winding of

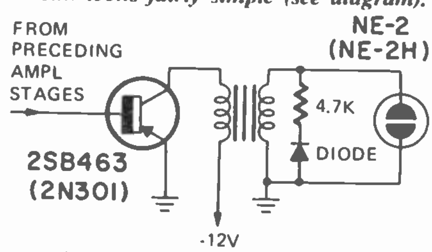



the pin-phase *transformer*, to the right of the tube in the diagram. If you'll notice, the dc path to the resistors is *blocked* by the .0047-μF capacitor. Nothing but pulses *should* come through here.

I believe that I'd suspect that .0047-μF capacitor of being shorted.

### INDICATOR LAMP FAILURE

*The neon lamp indicator in an Allied Knight KG-711 depth finder kept burning out. The original is a type NE-2. They last only a few hours. The output transistor, a 2SB463, went out on me, and I replaced it with a 2N301. The circuit looks fairly simple (see diagram).*



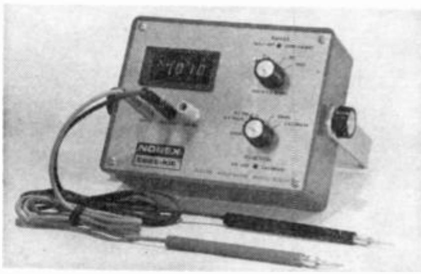

*I finally got mad and replaced the NE-2's with NE-2H's.—K.W., Sheboygan, Wis.*

Right. I'll take both fixes. **R-E**

# new products

*More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.*

**DIGITAL MULTIMETER KIT,** *model 8700K* is a general-purpose instrument for the hobbyist, technician or engineer. 3½ digit readout; 0.5% accuracy; all




solid-state construction. Unit measures ac volts, dc volts and ohms in four ranges for each type of measurement.—**Nobex Electronics Division, Griffith Plastics Corp.,** P.O. Box 4365, Burlingame, Calif. 94010.

*Circle 31 on reader service card*

**AUTOMATIC ANTENNA ROTATOR,** *Selecta-Channel 10W 606.* Decorator styled control cabinet houses a moving direction indicator light synchronized with antenna movement and shows antenna position. Weatherproof drive unit has heavy-duty precision worm-gear drive to


provide a strong turning force and lock antenna in position—preventing any chance of windmilling.

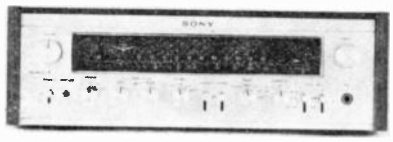
Quick connect pressure terminals speed installation and reduce chance of short circuits. Quiet operation. Comes with premounted hardware and takes four-wire rotator cables.—**RCA Parts and Accessories,** P.O. Box 100, Deptford, N.J. 08096.

*Circle 32 on reader service card*

**STEREO RECEIVER,** *model STR-7055* delivers 35 watts per channel continuous power output at all frequencies from 20 Hz to 20,000 Hz driving an 8-ohm load. Amplifier sections use differential amplifier input circuits and balanced negative and positive supplies. Resulting direct-coupled output circuit has wide-band response, minimal phase shift and a high damping factor (50 at 8-ohms). Harmonic and IM distortion is less than 0.2% at rated output.

FM tuner has new junction FET's in mixer and rf stages to provide 2.0 μV IHF sensitivity. Solid-state filters and an IC limiter produce 70 dB IHF selectivity and a capture ratio of 1 dB.

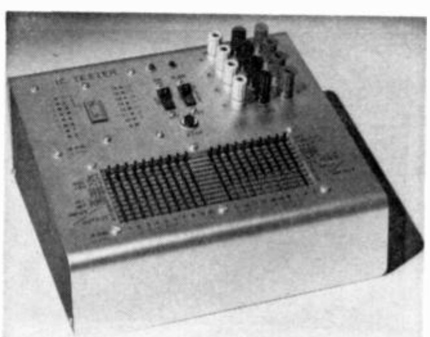
AM section has triple-tuned solid-



state filters and a new IC with agc to maintain high sensitivity, minimum distortion and optimum signal-to-noise ratios.—**Sony Corporation of America,** 47-47 Van Dam St., Long Island City, N. Y. 11101

*Circle 33 on reader service card*

**IC TESTER,** *ICT-1800* is used to breadboard IC's while developing circuits. Features include internal 2-speed clock, twelve binding posts that allow

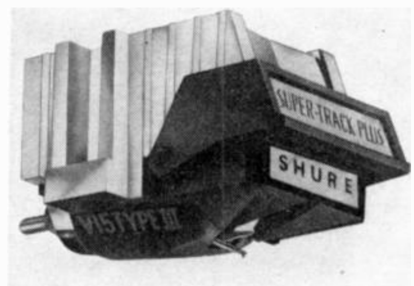



connections with external equipment such as a scope, oscillator or additional power source and 18 LED indicators which show the status of the IC under test.

Front-mounted push-button switch allows the user to advance counters, dividers and shift registers one step at a time. 10 by 20 matrix switch is used to program the functions and logic levels for the IC under test. Matrix programmer allows the patch-in of any internal or external function to any pin or combination of pins on the IC.—**Micro Instrumentation & Telemetry Systems, Inc.,** 2016 San Mateo N.E., Albuquerque, N.M. 87110.

*Circle 34 on reader service card*

**STEREO CARTRIDGE,** *V-15 Type III* has a laminated magnetic core structure and stylus assembly that results in a 25% reduction in effective stylus mass. This model has high trackability at low track-

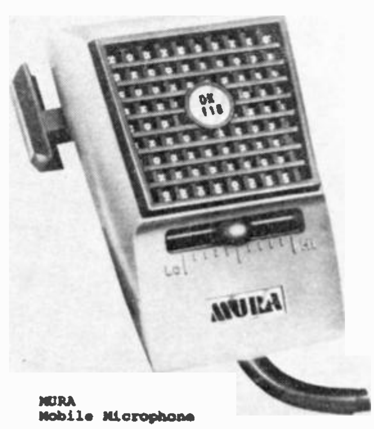



ing force (¾ to 1¼ grams), virtually flat frequency response with no noticeable emphasis or de-emphasis at any frequency and an extended dynamic range at no loss in output level. Frequency response (using optimum load) is 10 to 25,000 Hz.

Type III should be used only in arms which are designed for low tracking forces and have low friction at all bearing surfaces. Has biradial elliptical diamond stylus; also available with spherical diamond stylus and biradial elliptical stylus with tracking force range of 1½ to 3 grams (for mono 78 rpm records). 6 grams; $72.50.—**Shure Brothers Inc.,** 222 Hartrey Avenue, Evanston, Ill. 60204.

*Circle 86 on reader service card*

**MOBILE MICROPHONE,** *model DX-116A,* for use in boats, cars, trucks or at base stations. Transistor compression ampli-




MURA
Mobile Microphone

fier assures full, clear modulation and has a gain of 0-12 dB (adjustable).

Incorporates FET integrated circuits for speech clipping and compression. Frequency response is 300 to 5000 Hz; sensitivity is -42 dB and impedance is 600 ohms. Controls include volume and push-to-talk button. Wired for relay and electronic switching, comes with 5 foot coiled cord. $23.95.—**Mura Corp.,** 50 South Service Road, Jericho, N.Y. 11753.

*Circle 36 on reader service card*

**TWO-WAY RADIO,** *Messenger 210T* is an AM land mobile radio. Tone-Alert selective signaling keeps the radio silent until one of your own units calls. Then the called radio emits an audible tone and a red call indicator lights. Call in-

dicator remains on until operator returns the call.

System operator receives a license for operation on his own, reasonably private, channel. Five watts output. Operates from any 12-V dc negative ground system; accessories permit use in other dc or in 120-V ac systems.—**E. F. Johnson Company,** 299 Tenth Avenue S.W., Waseca, Minn. 56093.

*Circle 37 on reader service card*

**MINI-SCOPE,** *B & K 1403* has a bandwidth of dc to 2.0 MHz and has direct-deflection terminals for viewing waveforms to 150 MHz. Vertical sensitivity is 20 mV/cm or better. Maximum input is 600 V, peak-to-peak; input impedance is

1 megohm shunted by 30 pF. Continuously variable gain control range is greater than 22 dB. There are four time-base ranges from 10 Hz to 100 kHz, continuously variable between ranges.

Solid-state; has dc amplifiers on both horizontal and vertical axes. Power requirements are 117/234 Vac, 50 to 60 Hz; has 3-wire grounded line cord. Wide-angle crt reduces case depth. 5¼" x 7⅜" x 11¼"; 8.5 lbs.; $179.95.—**Dyna-scan Corp.,** 1801 West Belle Plaine Avenue, Chicago, Ill. 60613.

*Circle 38 on reader service card*

**AC MILLIVOLT METER,** *LMV-89* checks audio-signal quality of 4-channel and 2-channel (stereo) circuitry. Range is from 100 μV to 300 V in 12 steps and full-scale accuracy is ±3%. Decibel scale

readings are at 0 dB = 0.775 V and 1 V each over the entire range.

Single, easy-to-read meter face and two independent scales with separate pointers. Each channel has individual switches and amplifier systems to assure operation without crosstalk. Both channels operate separately or in common at channel 2. Scale calibration is based on effective value of a sine wave output. Dual power supply; 8" x 6" x 10"; 8 lbs.; $229.95.—**Leader Instruments Corp.,** 37-27 27th Street, Long Island City, N.Y. 11101.

*Circle 39 on reader service card*

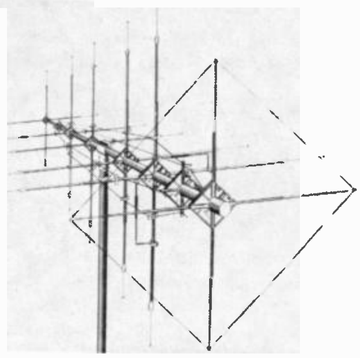
**CB BASE ANTENNA,** *Moonraker 6* is a 6-element dual-polarity beam that combines five sets of crossed dipole-type



*Circle 23 on reader service card*

elements plus a quad-type reflector for rejection and gain. Tunable gamma matching on both vertical and horizontal elements, gets low SWR and provides lightning protection.

With antenna's dual polarity, it can follow or avoid skip signals bounced off



the ionosphere. When the skip changes, polarity can be changed to eliminate the unwanted interference. 31½-foot boom; 17 dB gain over isotropic, 44 dB rejection, 24 dB side rejection and 1.2:1 SWR.—**Avanti Research & Development**, 33 West Fullerton Avenue, Addison, Ill. 60101.

*Circle 40 on reader service card*

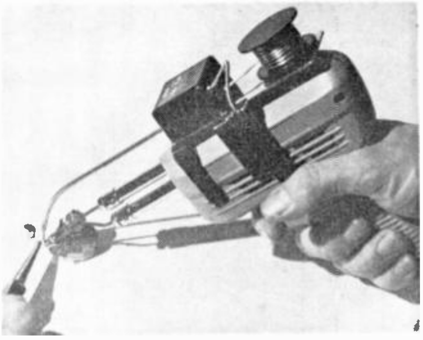
**FM WIRELESS MICROPHONE,** *WM-10* transmits voice and music through any FM radio or tuner. Has electret microphone. Maximum microphone-to-radio transmitting distance of 100 feet—depen-

dent upon receiver sensitivity and the nature of obstructions between receiver and microphone. Standard 9-volt battery is required power source.

Antenna is a short insulated wire that hangs from behind the unit. A lavalier accessory is included. Frequency range is 88 MHz to 108 MHz with drift-free stability. Tuning wand is provided to tune or change the microphone's transmitting frequency. 2½ oz.; $29.95.—**EV Game Inc.**, 186 Buffalo Avenue, Freeport, N.Y. 11520.

*Circle 41 on reader service card*

**SOLDER FEEDER,** *Free-Hand* clamps on top of most soldering guns and feeds standard flux-core solder through the adjustable tube at a rate controlled by the thumb-actuated lever. Device frees one hand for small parts handling and allows pliers to be used while its precision tube offers pinpoint accuracy as well as an adjustable feed point. Trigger can be positioned on either side of gun for right

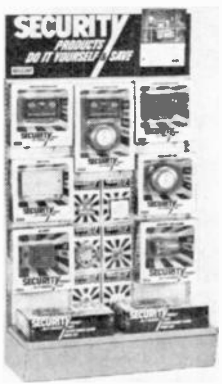


or left-hand use.

Features heavy-duty construction plus light weight with durable nylon and precision-made steel parts used in all internal construction. Can be used as a stand for the gun when not in use. 5 oz. includes solder; $8.95.—**Schurman Products,** P.O. Box 13, Weymouth, Mass. 02188.

*Circle 42 on reader service card*

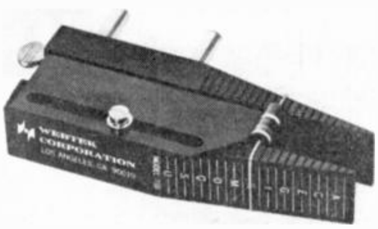
**SECURITY PRODUCTS** include smoke/fire alarms, car alarms, closed-circuit alarms, personal alarms and ultrasonic alarms. In addition, there are ac-




cessories that allow users to personalize their own security systems. Each bright yellow and black box includes complete installation instructions.—**Mallory Distributor Products Company,** 101 South Parker, Indianapolis, Ind. 46206.

*Circle 43 on reader service card*

**LEAD BENDING BLOCK,** *model 710* prepares axial-leaded components for mounting on printed circuit boards or chassis. Right-angle or spring-loaded lead bends for resistors, capacitors, in-




ductors, are made for accurate alignment to mounting holes or terminals. Gives neat, rounded bends within .100" of the component body on centers up to 3". Case lengths are accommodated to 1¾". Adjustable gauge plate can be preset. $14.95.—**Webtek Corp.,** 4326 West Pico Blvd., Los Angeles, Calif. 90019. **R-E**

*Circle 44 on reader service card*

# new lit

*All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free. Use the Reader Service Card inside the back cover.*

**ELECTRONIC COMPONENTS.** 8-page booklet presents perforated breadboards and terminals, breadboarding accessories, power transistor mounting kits with sockets or hardware, power transistor mounting kits diode mounting clips and battery holders & accessories.—**Keystone Electronics Corp.,** 49 Bleecker Street, New York, N.Y. 10012.

*Circle 45 on reader service card*

**INSTANT MATV** is an 18-page catalog that contains VHF/FM system and all-channel (VHF, FM, UHF) system for: home or small motel; apartment house; motel, school or garden apartment; apartment house or hotel. Also contains instructions on connecting TV sets to tape-offs, installation tips and instant MATV products. **$1.00** at your distributor.—**Jerrold Electronics Corp.,** 200 Witmer Road, Horsham, Pa. 19044.

*Circle 46 on reader service card*

**CREATIVE KITS** *brochure* includes (pictures, prices and specifications) tachometer kit, crystal radio kit, Morse code kit, transmitter kit, table radio kit, one-tube radio kit, strobe lite kit, audio color organ kit, and burglar alarm kit.—**Graymark Enterprises Inc.,** Suite 700-26, Benjamin Fox Pavilion, Jenkintown, Pa. 19046.

*Circle 47 on reader service card*

**WIRE-WRAPPING CATALOG** includes charts of bits and sleeves, sections on terminal spacing, tool specifications, various illustrations along with part numbers, descriptions and prices of every tool.—**O.K. Machine & Tool Corp.,** 3455 Conner Street, Bronx, N.Y. 10475.

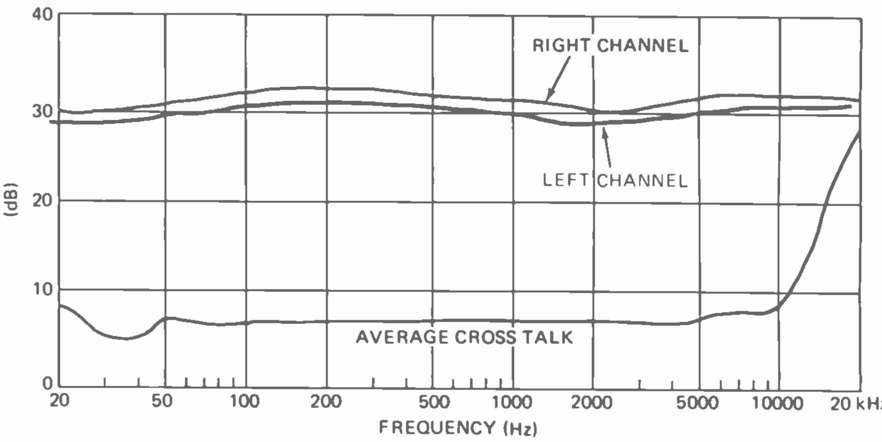
*Circle 48 on reader service card*

*Write direct to the manufacturers for information on items listed below:*

**MATV PRODUCTS CATALOG,** *No. 109* contains 36 pages of illustrations, descriptions and specifications for over 250 products such as Ultra-Plex strip amplifiers, power panels, splitters, drop taps, line amplifiers and tilt compensators. Covered are commercial systems equipment for MATV, CCTV, ITV, ETC, CATV, NATV and sub-channel.—**Winegard Company,** 3000 Kirkwood Street, Burlington, Iowa 52601.

**TEST EQUIPMENT** 24-page catalog features field-effect multimeters, sweep-circuit analyzer, field strength meter, tube testers, picture-tube testers, transistor tester, universal power supply, oscilloscopes, color generators, sweep & marker generators, RC substitution units, time savers and AM-FM stereo analyzer. Complete specifications and photo of each model. Lists factory service centers.—**Sencore,** 3200 Sencore Drive, Sioux Falls, S.D. 57107. **R-E**

**EQUIPMENT REPORT** *(continued from page 30)*



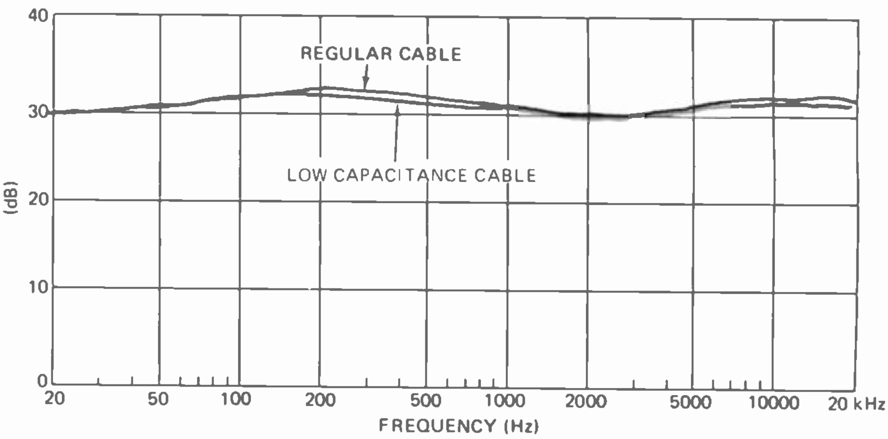




**FIG. 1—(top) INCLUDING THE TOLERANCE limits of the frequency response test record and the recorder the worst-case frequency response variation of the Shure V15 Type III phono pickup was 1.5 dB, while the output level matching between the left and right channels was within 1 dB. Note the broad, notably smooth cross-talk to 10 kHz at the test record's inherent cross-talk limit of 25 dB, and this was with the recorder pen at high speed, rather than damped as is usual for cross-talk measurements. Also note the smooth reduction in separation from 10 kHz to 20 kHz. No peaks or resonances to produce noise bursts in the opposite channel. (The reduced high-frequency separation is typical of all pickups we've seen.)**

**FIG. 2—(above) EXCEPT FOR LESS THAN 1-DB difference at 20 kHz the frequency response from the Shure V15 type III is the same for both standard and low-capacitance connecting cables, a decided advantage if the same turntable and tone arm combination is to be used for both stereo (matrix 4-channel) and discrete (CD-4) 4-channel records. Standard cable capacitance measures between 170 pF and 200 pF for a 5-foot cable, or 34 to 40 pF per foot. Low-capacitance cables can run as low as 12 pF per foot.**

nated the peak is greater; if the peak is reduced the dip is greater. Normally, pickups are designed so the overall response stays within ±2 dB or ±3 dB limits in production models, which meets the performance requirements of high fidelity. But any variation in frequency response is reflected as coloration in the reproduced sound. If there is little dip and a relatively large peak the sound might be described as *bright*, or *brilliant* (slightly accented midband and highs). If the peak is reduced by providing a broad midband dip the sound might be described as *mellow*.

In the Shure V15 Type III pickup the normal resonance has been moved above 20 kHz—above the limits of hearing—so that within the audible frequency range the pickup's output is "flat". According to Shure the V15 Type III *production* (not laboratory) models are within 2 dB in frequency response and channel output matching from 30 to almost 10 kHz with a worse-case match of about 3 dB at the extreme ends of the spectrum.

As shown in Fig. 1, the worst-case response variation from both channels 20 to 20 kHz was 1.5 dB, with an output level variation between channels no greater than 1 dB. In actual fact this performance level is within the tolerance limits of the test record and the graphic recorder, meaning, in plain terms, that the Shure V15 Type III's performance is even better. (Frequency response test records are notorious for considerable variations in response between individual records.)

Note in particular the averaged midband cross-talk (separation) of 25 dB, actually the limit of the test record. Since the record itself has a built-in 25 dB limiting factor what is important is the overall smoothness of the cross-talk curve from 20 to 10 kHz. Also note that as the separation decreases between 10 and 20 kHz (typical) there are no peaks or resonances in the curve, which would appear as noise bursts.

Of somewhat greater interest are the frequency-response variations between low and normal capacitance cables between the pickup and amplifier, an important consideration if you plan to use the same turntable and arm for both stereo and discrete (CD-4) record reproduction. While Shure specifies the typical total capacitance value of 400 to 500 pF (through the phono input), reducing the capacitance to 50% (200 pF) by using low-capacitance cables (for CD-4 pickups) produces an almost insignificant variation in frequency response, actually less than a dB at 20 kHz. (see Fig. 2).

The Shure Type III pickup is available with biradial (elliptical) or spherical styli for stereo and matrix 4-channel use, or with a biradial stylus for monaural 78's. Because of the high compliance inherent in the pickup, and because it requires minimal applied friction force from the tone arm for optimum tracking, the Shure V15 Type III is suggested for use only in tone arms of the highest quality, and the tone arms provided on the better quality "automatic" and manual turntables can be considered suitable. R-E

# appliance clinic

## BEGINNERS ONLY

by JACK DARR
SERVICE EDITOR

THIS ONE IS STRICTLY FOR BEGINNERS only—the novices and the young men who are just getting interested, in this bewildering profession of ours. So all you Double-E's and CET's go read something more difficult while I jump on the kids about some elementary but essential safety precautions about electricity.

The idea behind this is pretty simple. We want these people to *live* to become qualified technicians. If they don't observe these rules, or worse still, if they don't know about them, some of them won't make it.

Electricity is a very useful thing, but it can be lethal. (That means that this stuff can kill you, Clyde.) The standard ac line coming into your home has two wires. There is 120 volts ac between the two. Of these two, one is always tied to a good earth ground, and the other one is "hot." The significant fact about this is that the hot side is *hot to everything that is grounded.*

*What's ground? The earth itself; all water piping; all metal heating ducts; a bare cement floor. If you're standing on a cement floor in a pair of leather soled shoes, you could safely touch one side* of the ac line. That is, IF you touch the grounded side. However, all you can see is two wires. How do you know which one is the hot one? The answer is you don't. Not until you make tests to find out which side is which.

For safety's sake, always wear shoes with insulating soles; rubber, plastic, etc. Leather soles, I repeat are

(turn page)

**APPLIANCE CLINIC**
*(continued from page 89)*

not insulators. If your soles are of the "spongy" type, and you've been walking in water, watch it. They can soak up enough water to become good conductors. You can be even safer if you stand on a dry rubber mat, or dry duck-boards.

There are other safety rules; the most important one probably is "Never work on anything hot:" translation, always be sure that the thing has been disconnected from the ac outlet. Pull the line plug and form a habit of putting it on the bench where you can see it. If there's more than one thing on the bench with a line cord, be sure you can see the *right* plug.

There are several ways of testing to find the hot side of the line or to make sure that there is no power on the unit. One of the handiest of these is the little neon-lamp voltage tester sold in hardware and electrical supply stores. They have a tiny neon bulb in a plastic case, with two flexible test leads having metal tips. To find out if an outlet is hot, or if there is voltage across certain points, just touch one test-lead to each point. If there's voltage there, the neon lamp will glow.

Another handy tester, similar to this, is one of the oldest testers used. It's called a test-lamp, for obvious reasons. It's nothing but a weatherproof lamp socket with flexible leads. Strip the insulation off the leads for about ¼ inch and tack the strands of wire together with solder. Then screw a small lamp into the socket and you've got a handy voltage-tester. Touch the leads to any two points in a circuit. If there's line voltage there, the lamp will light. You can make it more useful by extending the wires to about 24 inches and using standard test prods on the ends.

You can make it safer and handier, by attaching small alligator clips to the ends of the leads. Use the type with a rubber insulator over the jaws. You can turn the power off, and clip the leads to the points you want to test. Then, take your hands out, turn the power on and see if the lamp lights. This is handy for tests such as heating elements. Clip the test lamp across the ends of the element, and turn the switch on. If the lamp lights, this means that power is getting to the element.

The main idea behind all of this is to make *sure* that you avoid making *any body contact* with points which could be hot. You can never know that a given point isn't hot until you make some kind of test that will give you a definite answer. *Don't guess and don't take chances.* If you're wrong, you might not get another. It takes only 11-mA through the heart to cause fibrillation. This is on the arm-to-arm path, where the current passes through the chest.

So keep your cotton-pickin' fingers out of dangerous places, until you have made sure that it's safe. **R-E**



# quiz answers
(quiz on page 95)

1. npn
2. minus
3. common emitter
4. same as input
5. germanium
6. both answers correct
7. zero
8. increase

If you got all eight correct label yourself a solid-state expert. If you got six or seven correct, some study is required. If you got five or less right, we suggest you review your semiconductor basics. You've missed a few important points along the way.

If you enjoyed this quiz please let us know so we can include others in the months to come. Do you like electronic crossword puzzles? Can you suggest a puzzle or two of your own?

# next month

OCTOBER 1973

## SPECIAL ISSUE—4-CHANNEL STEREO

- **4-Channel Equipment Roundup**
  Herb Friedman presents an up-to-the-minute survey of all the 4-channel equipment currently available. If you're thinking of buying some four-channel gear, you'll want to read this story first.

- **4-Channel FM Broadcasting**
  R-E's Contributing High-Fidelity Editor, Len Feldman explains the many different broadcast systems that have been proposed to the FCC. He shows how they work and how they differ.

- **4-Channel Record Review**
  R-E's editorial staff has reviewed a mass of 4-channel matrix recordings. These reviews rate the 4-channel effect of the records. Might give you a clue as to what to use as a demonstration disc.

- **Setting Up For 4-Channel Discrete Records**
  We had one of our authors set up a discrete (CD-4) system. His report tells how it's done and what results to expect.

**PLUS:**
**IC's For FM**
**State-Of-Solid-State**
**Step-By-Step Troubleshooting Charts**
**Add Voice Actuation To The Phone Sentry**
**R-E's Transistor Replacement Guide**
**Jack Darr's Service Clinic**
**October issue on sale September 18**

**SPEAKER SPECS**

*(continued from page 64)*

terms of its ability to withstand the power input required to produce that maximum stated SPL.

Speaking of distortion, very few manufacturers do. I think it is no longer a secret among speaker purchasers that total harmonic distortion and intermodulation distortion figures for speaker systems are not going to be preceded by

**TECHNICAL SPECIFICATIONS: THE "SOUNDER" MODEL A SPEAKER SYSTEM**

**Frequency Response:*** Uniform within ±3 dB from 35 to 18,000 Hz, based upon ⅓ octave averaging, measured under free-field conditions, at 1 meter from speaker surface, on axis.

**Dispersion:*** 120 degrees, at 5 kHz; 95 degrees at 10 kHz; 70 degrees at 18 kHz.

**Efficiency:** 85 dB SPL for 1 watt electrical input, at 1 kHz, measured at 1 meter from speaker system, on-axis.

**Power Handling Capacity:** May be used with amplifiers having up to 75 watt/channel continuous power rating for all musical programming. May be safely fed with 25 watts of continuous-tone at any frequency from 35 Hz to 10 kHz for an indefinite time period.

May be subjected to intermittent continuous power tests of up to 50 watts for periods not exceeding 5 minutes.

**Maximum SPL:** 104 dB at 1 meter at less than 3% THD & IM from 100 Hz to 5 kHz.

**Impedance:*** Nominally 8-ohms, varies from 12 ohms (at 50 Hz) to a low of 5.3 ohms at 300 Hz.

**Harmonic Distortion:** Less than 3% at any frequency at SPL up to 95 dB. Less than 2% at any frequency at SPL up to 90 dB. 5% at 50 Hz for SPL of 100 dB.

**Linearity:** Within 3 dB from 0.5 watts electrical input to 50 watts electrical input.

**Total Number of Transducers:** 5 (1 woofer, 2 mid-range units, 2 tweeters)

**Operating Principle:** Bass-reflex ported enclosure

**Dimensions:** 34" x 18" x 15" deep.

**Preferred Mounting:** Vertical orientation. (In horizontal mode, lateral dispersion will be reduced to 80 degrees at 5 kHz, 60 degrees at 10 kHz and 40 degrees at 18 kHz.)

**Preferred position:** On floor (shelf mounting will result in additional 3 dB of attenuation at 50 Hz.)

**Weight:** 35 lbs.

**Finish:** Walnut

**Price:** $125.00

**Suitable curves may be substituted for these specifications*

decimal points and zeros so commonly associated with preamplifier, amplifier and even tuner products, so why keep them a secret. A system that can produce, say 100 dB SPL at any audible frequency from 40 Hz to 16,000 Hz with less than 2% THD or IM will still be judged by specification sheet readers to be better than one which does the same thing at less than 4% THD or IM and the buying public is, I think, intelligent enough to compare speaker specs with speaker specs and not with amplifier specs.

To sum it all up, Shown above is my attempt to write a more meaningful "Spec Sheet" for a loudspeaker system. The actual numbers are fictitious and do not apply to any particular system. The table is presented, rather, as a format for future "specmanship" when it comes to loudspeaker system performance and measurement. **R-E**

# The World's Largest Consumer Electronics Catalog

• Stereo Hi-Fi • Citizens Band • Ham Gear • Tape Recorders • Test Equipment • TV and Radio • Phonographs, Accessories • Intercoms and PA • Closed Circuit TV • Tubes and Parts • Cameras • Auto Accessories • Musical Instruments • Tools • Books • And Much More!

***More Items—More Values—Than Ever Before!***

# FREE


1974
LAFAYETTE
CATALOG
740

*Serving The Public Since 1921*

**468 Pages**

## SHOP THE WORLD'S MOST COMPLETE HI-FI and ELECTRONICS CENTER

PLACE
STAMP
HERE

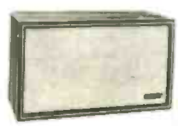
LAFAYETTE RADIO ELECTRONICS
P.O. BOX 10
SYOSSET, L.I., N.Y. 11791

***Exclusively Yours at Lafayette***

The Latest In 4-Channel Stereo Hi-Fi Components

RK-48A Compatible 2 and 4-Channel Cartridge Tape Deck

LR-4000 AM/FM 4-Channel Stereo Receiver



Criterion™ Speaker Systems

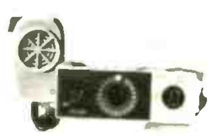
PLACE
STAMP
HERE

LAFAYETTE RADIO ELECTRONICS
P.O. BOX 10
SYOSSET, L.I., N.Y. 11791

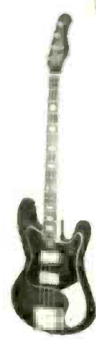
***Satisfaction Guaranteed or Money Refunded***

Citizens Band 2-Way Radios

Dyna-Com Walkie-Talkies



Micro 23 2-Way CB Radio



Ham Gear, Tools & Parts

Musical Instruments and Accessories

PLACE
STAMP
HERE

LAFAYETTE RADIO ELECTRONICS
P.O. BOX 10
SYOSSET, L.I., N.Y. 11791

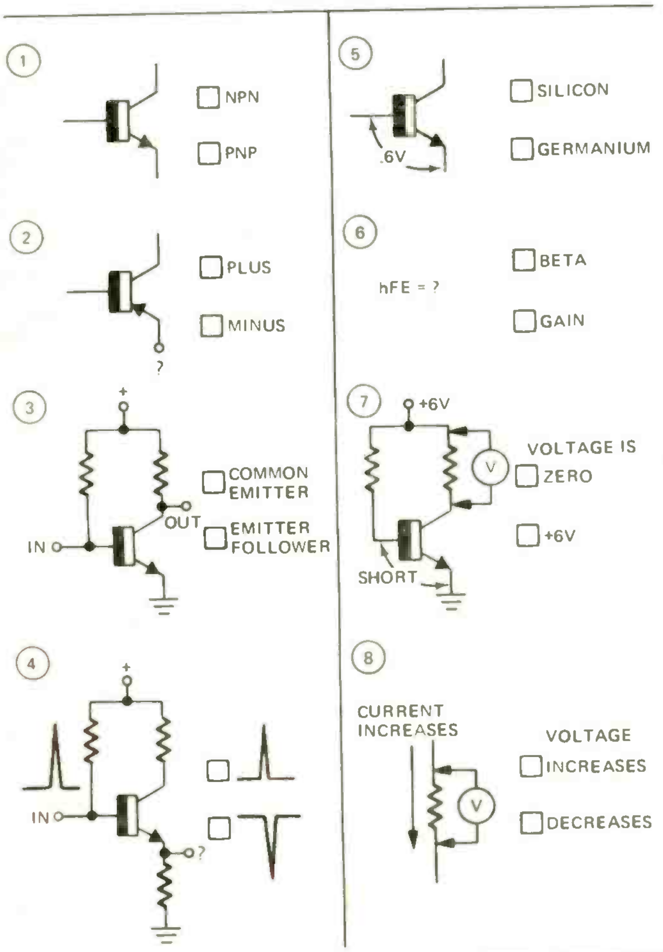
Do A Friend A Favor . . . Send us his name and address and we will send him his own personal copy of the FREE 1974 LAFAYETTE Catalog 740.

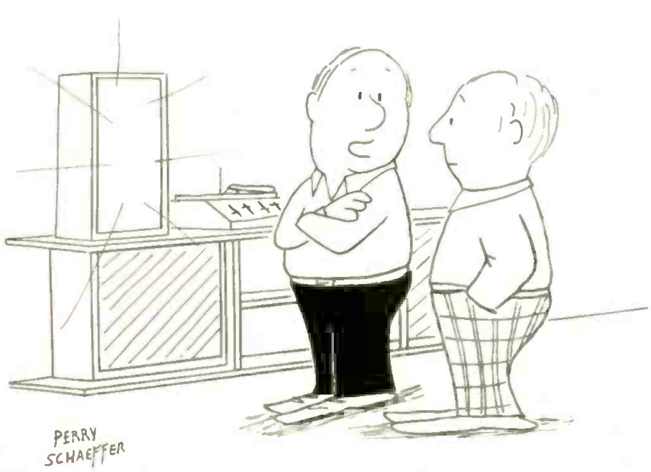
# solid-state quiz

by JUD WILLIAMS

Here's a little quiz, courtesy of Jud Williams, manufacturer of the Jud Williams Model A Curve Tracer. Jud has given this quiz at several technician conferences and from the results, we can only deduce that the quiz is tougher than it looks. Why not try your hand. Answers are on page 90.

QUICK TEST



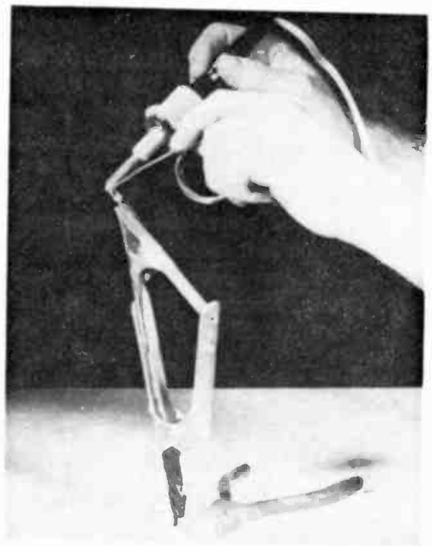




"Of course my audio color organ produces only black and white colors—I'm color blind."

# try this

### SOLDERING VISE AND HEATSINK

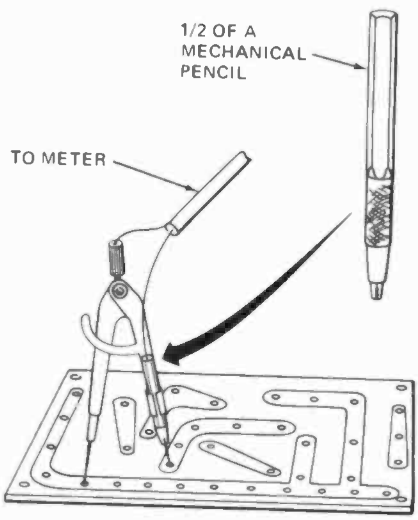
By doubling up on regular spring clamps their usefulness can be extended. One such use is shown. One handle



of the smaller clamp is slipped under the spring of the larger to clamp it securely.—*R. G. Cooper*

### ONE-HAND TEST PROBES

Here is how you can modify your test prods so you can handle them with one hand—particularly useful when testing small PC boards. The tool is made from an inexpensive pencil compass with the pencil replaced by half




of a mechanical pencil or ball-point pen with a metal cartridge. A needle is forced into the tip of the pencil or pen. The test lead is thin coax cable with its core soldered to the pencil tip (the *positive* prod) and the shield (the *negative* lead) is soldered to the body of the compass at the top. Connectors on the other end of the cable match your meter.—*Peter Legon*

R-E

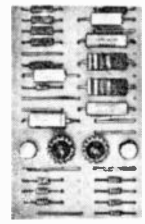
# SUPER SPECIALS

**FREE $1 BUY WITH EVERY 10 YOU ORDER** Only applies to "$1" Buys **FREE GIFT WITH EVERY ORDER**

**CANADIANS: Ordering is easy — we do the paperwork — try a small order**

## SHANNON MYLAR RECORDING TAPE

| | | | |
|---|---|---|---|
| 2½" — 225' | $ .17 | 7" — 2400' | $1.79 |
| 3" — 225' | .19 | 7" — 3600' | 2.95 |
| 3" — 300' | .27 | CASSETTE C-60 | .59 |
| 3¼" — 600' | .58 | CASSETTE C-90 | 1.00 |
| 5" — 600' | .62 | CASSETTE C-120 (TDK) | 1.97 |
| 5" — 900' | .80 | 2½" TAPE REEL | .05 |
| 5" — 1200' | .97 | 3" TAPE REEL | .06 |
| 5" — 1800' | 1.49 | 3¼" TAPE REEL | .07 |
| 7" — 1200' | .77 | 5" TAPE REEL | .14 |
| 7" — 1800' | 1.12 | 7" TAPE REEL | .15 |



## IBM COMPUTOR SECTIONS

8 assorted Units we sell for $1 are loaded with over 150 valuable parts.

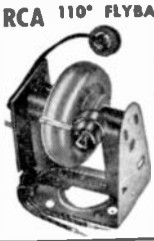
Incl. — Transistors, Condensers, Resistors, Heat Sinks, Diodes, Etc.

8 for $1
100 for $10

## WESTINGHOUSE ALL TRANSISTOR HOME/OFFICE MESSAGE CENTER

Leaves messages for other for replay . . . Built in speaker/microphone for talk-into convenience . . . Records up to 3 minutes of messages . . . Illuminated signal shows when a message is waiting. Control adjusts playback volume without affecting recording volume . . . Capstan Drive; BRAND NEW SOLD AS IS $7.95

## RCA 110° FLYBACK TRANSFORMER



We scooped the Market. Latest type — standard for all 110° TV's

RCA's design of large Coil produces 18KV — assuring adequate width. Incl Schematic Diagram application for any TV

List price $13.90

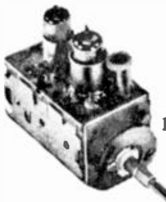
Your price .. $3

10% off in lots of 3

- ☐ 110° TV DEFLECTION YOKE for all types TV's incl schematic — $3.95
- ☐ "COMBINATION SPECIAL" RCA 110° FLYBACK plus 110° DEFLECTION YOKE — $5.95
- ☐ 90° FLYBACK TRANSFORMER for all type TV's incl schematic — $2.95
- ☐ 90° TV DEFLECTION YOKE for all type TV's incl schematic — $2.95
- ☐ 70° FLYBACK TRANSFORMER for all type TV's incl schematic — $2
- ☐ 70° TV DEFLECTION YOKE for all type TV's incl schematic — $2
- ☐ SHARP 110° FLYBACK & YOKE COMBINATION #8FT-592 Good for most portable TV — $5.00
- ☐ 90° COLOR YOKE For all Rectangular 19 to 25" Color CRT's — $10.95

## SARKES TARZIAN TUNER

41mc



Latest Compact Model good for all 41 mc TV's.

BRAND NEW—

Best TUNER "SARKES TARZIAN" ever made—last word for stability, definition & smoothness of operation. An opportunity—to improve and bring your TV Receiver up-to-date. $7.95

COMPLETE with Tubes

- ☐ ALL NEW TV TUNER *Standard* makes—less tubes — $1
- ☐ WESTINGHOUSE FM TUNER (12DT8 Tube) — $1.95
- ☐ WESTINGHOUSE FM TUNER #476-V-015D01 . . . Transistor — $3.99
- ☐ WELLS GARDNER TV TUNER 25A1288 (6LJ8 – 6 HA tubes) — $7.95
- ☐ UHF TUNER—TRANSISTOR TYPE Used in all TV sets — $3.95
- ☐ STANDARD TUNER—TRANSISTOR (GUIDED GRID) 4 Channel closed circuit — $1
- ☐ PHILCO TV TUNERS Model–76-13983-3 (5GJ7–3HQ6) — $4.95
- ☐ MAGNAVOX TV TUNER 340137-3 (6CG8–6GK5 tubes) — $7.95
- ☐ GE—STANDARD COIL TV TUNER Model EU-S6XI (6HQ5–6GJ7) Model-ET 86X304–(6LJ8–6HA5) — $7.95
- ☐ TV TUNERS VHF/UHF all new standard makes, including Tubes — $7.95
- ☐ 70° COLOR TUBE BRIGHTNER — $3.95
- ☐ 90° COLOR TUBE BRIGHTNER — $4.95
- ☐ CO-AX CABLE RG59U grey or black 250'–$9 100'–$3.69 50'– — $2
- ☐ 4 – TV ALIGNMENT TOOLS most useful assortment #1 — $1
- ☐ 4 – TV ALIGNMENT TOOLS For Color TV #2 — $1.49
- ☐ 6 – TV COLOR ALIGNMENT TOOLS Most popular type — $2.79
- ☐ COLOR POWER TRANSFORMER – Good for most sets 26R150 List Price–$36.75 — $6.95

---

- ☐ 2 COLOR-TV CRT SOCKETS Wired leads, for all color TV's — $1
- ☐ 3 – RCA 110° CRT SOCKETS Wired leads, for all TV'S — $1
- ☐ COLOR CONVERGENCE ASSEMBLY Universal type–good for most sets — $2.49
- ☐ COLOR-TV RECTIFIER – Used in most color sets–6500 kv 3 for — $1.95
- ☐ 20 – ASSORTED TV COILS I F., VIDEO, sound, ratio, etc. — $1
- ☐ 50 – ASSORTED PEAKING COILS All popular sizes — $1
- ☐ TV TWIN LEAD-IN 300 ohm 500' – $7 100'– $1.50 50' — $1
- ☐ 2 – COLORBURST QUARTZ-CRYSTAL For Most Color TV sets 3579.545 KC — $1.89
- ☐ UNIVERSAL TV ANTENNA Back of set mounting . . . 5 section rods — $1.98
- ☐ 5 ASSTD. GLOBAR VARISISTOR Popular replacements for most COLOR TV — $1

## KNOB SPECIAL

- ☐ 100 – ASSORTED RADIO KNOBS All standard types $20 value — $1
- ☐ 50 – TV KNOBS – POPULAR TYPES Mostly Selector & Fine Tuning — $1
- ☐ 25 – VERTICAL LINEARITY KNOBS Long shank . . . Front mount . . . miniature assortment — $1
- ☐ 20 – VERTICAL LINEARITY KNOBS . . . Side mount . . . Standard sizes — $1
- ☐ 25—KNURLED RADIO KNOBS Hard to get . . . Best selection — $1
- ☐ 40 —DELUXE RADIO KNOBS Choice assortment . . . Popular types — $1

ANY 6 KITS FOR $5

- ☐ TRANSISTOR RADIO *asst type* good, bad, broken, as-is, potluck — $1.50
- ☐ TAPE RECORDER—assorted types good, bad, broken, as-is, potluck — $4
- ☐ 300 – ASST. ½ W RESISTORS Top Brand, Short Leads, Excellent Selection — $1
- ☐ 100 – ASST ¼ WATT RESISTORS stand, choice ohmages, some in 5% — $1
- ☐ 100—ASST ½ WATT RESISTORS stand, choice ohmages, some in 5% — $1
- ☐ 70 – ASST 1 WATT RESISTORS stand, choice ohmages, some in 5% — $1
- ☐ 35 – ASST 2 WATT RESISTORS stand, choice ohmages, some in 5% — $1
- ☐ 50 – PRECISION RESISTORS asst. list-price $50 less 98% — $1
- ☐ 20 – ASSORTED WIREWOUND RESISTORS, 5, 10, 20 watt — $1
- ☐ 10—ASSORTED SLIDE SWITCHES SPST, SPDT, DPDT, etc. — $1
- ☐ 300 – ASSORTED HEX NUTS 2/56, 4/40, 5/40, 6/32, 8/32 — $1
- ☐ 250 – ASST. SOLDERING LUGS best types and sizes — $1
- ☐ 250 – ASST. WOOD SCREWS finest popular selection — $1
- ☐ 250 – ASST. SELF TAPPING SCREWS #6, #8, etc. — $1
- ☐ 150 – ASST. 6/32 SCREWS and 150 6/32 HEX NUTS — $1
- ☐ 150 – ASST. 8/32 SCREWS and 150– 8/32 HEX NUTS — $1
- ☐ 150 – ASST. 2/56 SCREWS and 150– 2/56 HEX NUTS — $1
- ☐ 150 – ASST. 4/40 SCREWS and 150– 4/40 HEX NUTS — $1
- ☐ 150 – ASST. 5/40 SCREWS and 150– 5/40 HEX NUTS — $1
- ☐ 500 – ASSORTED RIVETS most useful selected sizes — $1
- ☐ 300 ASSORTED WASHERS most useful selected sizes — $1
- ☐ 100 – ASST. RUBBER BUMPERS for cabinet bottoms – other uses — $1
- ☐ 100—ASSORTED RUBBER GROMMETS best sizes — $1
- ☐ 10—ASSORTED DIODE CRYSTALS 1N34, 1N48, 1N60, 1N64, etc. — $1
- ☐ 6 – TOP BRAND SILICON RECTIFIERS 1 amp. 1000 PIV — $1
- ☐ 5 – PNP TRANSISTOR general purpose, TO-5 case — $1
- ☐ 5 – NPN TRANSISTORS general purpose, TO-5 case — $1
- ☐ 50 – ASSORTED TRANSISTORS big factory scoop–sold as-is — $1
- ☐ ALL AMERICAN TUBE KIT (12AVG-12BE6-12BA6-35W4-50C5) — $2.99

---

## TEST EQUIPMENT SPECIAL DISCOUNT PRICES

B&K EICO Leader SENCORE

- ☐ 12" UNIVERSAL SPEAKER Top Quality . . . Large Magnet — $4.89
- ☐ 10" PHILCO SPEAKER Top Quality . . . Large Magnet — $2.99
- ☐ 8" UNIVERSAL SPEAKER – Large Magnet–Special Buy — $2.99
- ☐ 5" UNIVERSAL TWEETER 1 Oz. Magnet — $1.29
- ☐ UNIVERSAL 4" PM SPEAKER Top Quality — $1
- ☐ 2½" x 4" SPEAKER Special Buy 10 For $5– — 69¢ Ea.
- ☐ 4" X 6" "QUAM" 16 OHM SPEAKER Large magnet . . . Special BUY (10 for $15.00) — $1.79
- ☐ 1 – 5" SPEAKER with output transformer — $1.39
- ☐ 6" PHILIPS "INVERTED CONE" SPEAKER Top quality . . . Thinline — $2.29
- ☐ 1—6" x 9" HEAVY DUTY 10 OZ. SPEAKER Ceramic Type . . . 8 Ohm — $3.95
- ☐ UTAH 8" – HEAVY DUTY 10 OZ. SPEAKER Ceramic Type – 8 Ohm — $3.95
- ☐ ENCLOSURE WITH 6" SPEAKER Excellent value, regularly $14.95 — $5.95
- ☐ 6" UNIVERSAL SPEAKER Top quality Special buy Ea. — $1.29
- ☐ RCA COLOR FLYBACK Part #113382–(Stancor # HO-601C) — $12.95
- ☐ STEREO CAR SPEAKER SET Deluxe Service Mount — $6.50
- ☐ RCA 2 SPEAKER AM FM CHASSIS Deluxe front panel, good for wall mount — $20.00
- ☐ 20 – DIPPED MYLAR CAPACITORS .01–600V — $1
- ☐ 20 – DIPPED MYLAR CAPACITORS 033–600V — $1
- ☐ 20 – DIPPED MYLAR CAPACITORS .0033–1000 V — $1
- ☐ 20 DIPPED MYLAR CAPACITORS .047–400 V — $1
- ☐ 15 – MOLDED TUBULAR CAPACITORS .068–400 V — $1
- ☐ 20 – DIPPED MYLER CONDENSERS .0039–400 V — $1
- ☐ 10 – SPRAGUE "ORANGE DROP" CAPACITORS .0056–2000 Volt — $1
- ☐ 3—ELECTROLYTIC CONDENSERS 100 mfd.–100 V, 50 mfd–75 V — $1
- ☐ 2—ELECTROLYTIC CONDENSERS C.D 500 mfd–200 volts — $1
- ☐ 2—ELECTROLYTIC CONDENSERS UNECAP . . . 2000/1000 Mfd . . . 30 Volt — $1
- ☐ 2—SPRAGUE ELEC. CONDENSERS 80/30/4 - Mfd. - 475 V — $1
- ☐ 1 – ELECTROLYTIC CONDENSERS 200 mfd - 200V — $1
- ☐ 2 – ELECTROLYTIC CONDENSERS 1500 mfd – 35V — $1
- ☐ 6 – MINIATURE ELECTROLYTIC CAPACITORS 5MFD–150 V — $1
- ☐ 12—MINIATURE ELECTROLYTIC CONDENSERS For Transistor & miniature work — $1
- ☐ 2 – ELECTROLYTIC CONDENSERS 200/30/4 mfd – 350V — $1
- ☐ 4—ELECTROLYTIC CONDENSERS 75/30mfd–150v — $1
- ☐ 4—50' HANKS HOOK-UP WIRE assorted colors — $1
- ☐ 100'—SPOOL SPEAKER WIRE 2 cond, mini zip, clear, 101 uses — $1.50
- ☐ 10 – ASST. RADIO & TV TUBES Every Tube a good number — $1
- ☐ 5 – AUDIO OUTPUT TRANSFORM Sub-min for Trans Radios — $1
- ☐ 5 – I.F. COIL TRANSFORMERS 456-kc for Transistor Radios — $1
- ☐ 10 – SETS PHONO PLUGS & PIN JACKS RCA type — $1
- ☐ 8—PRINTED CIRCUIT IF TRANSFORMERS 4-Lug, 456 KC — $1
- ☐ STEREO TONE ARMS Most popular type – turn over cartridge — $2

---

## MARKET SCOOP COLUMN

### KLEPS "CLEVER" TEST PRODS

"Third-hand" test prods, reach into out of way places - Insulated - cannot slip - accommodates bare wire or banana plug—no soldering.

- ☐ PRUF 10 - VERSATILE TEST PROBE — .79
- ☐ KLEPS 10 - BOATHOOK CLAMP - 4¾" long — $1.19
- ☐ KLEPS 20 - BOATHOOK CLAMP - 7" long — $1.39
- ☐ KLEPS 30 - FLEXIBLE-FORKED TONGUE 6" long — $1.47
- ☐ KLEPS 40 - FLEXIBLE-PC BOARD TERMINALS 6¼" long — $2.39
- ☐ KLEPS 1-ECONOMY KLEPS-FOR LIGHT WORK — .99

- ☐ ASTATIC PICKUP MODEL 700-39T Contains 89T ceramic cartridge LIST PRICE $17.00 — $2.95
- ☐ CLARICON AM FM TUNER Solid state, walnut cabinet — $59.95
- ☐ WEN SOLDER GUNS Model 225K ........ $8.50 Model 288 ........ $7.50 Model 250 ........ $9.95 Model 100K ........ $5.95
- ☐ 8 ELEMENT COLOR OUTDOOR ANTENNA Big shot Jr. List $11.95 — $5.95
- ☐ ARISTO WIRELESS INTERCOM Walnut Cabinet, with buzzer call, AC operation — $22.50
- ☐ MERCURY TUBE TESTER MODEL 990 Compact, latest model — $39.95
- ☐ MIDLAND STEREO AMPLIFIER Model 26-002, 12 Watt, solid state — $36.50
- ☐ MIDLAND STEREO AMPLIFIER Model 26-003, 25 Watt, Solid State — $55.00
- ☐ RONETTE STEREO CARTRIDGE latest dual sapphire flipover type — $2
- ☐ STEREO HEADPHONES Hi-Fi Quality . . . Complete with Stereo plug — $5.95
- ☐ 8-TRACK TAPE PLAYBACK DECK Compact design fits anywhere — $27.50
- ☐ SIMPSON 2½" ROUND PANEL METERS Model 125 (0-100 DC Milliammeters — $3.95
- ☐ TUBE AND CONTINUITY CHECKER 4¾" X 3¾" – Tests fuses, lamps etc. — $2.49
- ☐ SONOTONE CARTRIDGE NC 3T-S — $5
- ☐ 32' – TEST PROD WIRE DELUXE QUALITY, red & black — $1
- ☐ SOLID STATE UHF CONVERTOR Channels 14-83, easy to install — $17.95
- ☐ VARCO STEREO CARTRIDGE-CN-62 With mounting bracket, flipover needle. — $2.95
- ☐ MONO-TONE ARM Turn Over Cartridge — $1.29
- ☐ 100' – FINEST NYLON DIAL CORD best size, .028 gauge — $1
- ☐ 5 – 9 VOLT MOTORS Excellent for hobbyist — $1
- ☐ 200' – #24 SOLID PUSH BACK WIRE Yellow or Black excellent buy — $1
- ☐ 1 – 20 FT. COILED GUITAR CABLE With plugs — $2.95
- ☐ 1—CASSETTE TYPE DYNAMIC MICROPHONE with universal plugs–200 Ohms. — $2.49
- ☐ 3 – ELECTROLYTIC CONDENSERS 20/20 Mfd. – 450 Volt — $1.00
- ☐ MATCHED PAIRS TRANSISTORS NPN & PNP (2N4252-2N2904) (2N2222-2N2907) Each set — $1
- ☐ 10 – STANDARD TRANSISTORS NPN & PNP 2N404, 2N414, etc. — $1
- ☐ 15 – MINIATURE 456KC IF TRANSFORMERS PC ½" X ½"–good value — $1
- ☐ BURGLAR DOOR ALARM WITH CHAIN sets off loud alarm . . . easy to install — $3.49
- ☐ PANISONIC TRANSISTOR 2SB473 (Eqv. HEP 642) — $1
- ☐ 2 – RCA SK3009 POWER TRANSISTOR Eqv.Hep-230, Syl.- ECG121,- GE-25 — $1.69
- ☐ RCA TRANSISTOR SK-3018 5 for — $1
- ☐ 5" X 7" SPEAKER 20 Ohm impedence — $1
- ☐ 3½" ROUND SPEAKER Special buy — 59¢
- ☐ ROCKER TOGGLE SWITCH DPDT . . . Latest type 4 for — $1
- ☐ 50—CERAMIC TUB TYPE—(GIMMICKS) Low capacity range — $1

Minimum Order $3.00.

**IMMEDIATE DELIVERY** . . . Scientific light packing for safe delivery at minimum cost.

**HANDY WAY TO ORDER** . . . Send check or money order, add extra for shipping. Lists of new offers will be returned in your order.

Please specify refund on shipping overpayment desired: ☐ CHECK ☐ POSTAGE STAMPS ☐ MERCHANDISE (our choice) with advantage to customer

**BROOKS RADIO & TV CORP., 487 Columbus Ave., New York, N. Y. 10024** 212-874 5600 TELEPHONE

*Circle 69 on reader service card*

# experiments with WWVB

*Concluding details on receiving methods and syncing Superclock and WWVB*

**by DON LANCASTER**

TECHNIQUE No. 4—*Add a "Flywheel."* This is a sledge hammer trick and adds all sorts of parts and complexity, but it really works well and doesn't cost too much. Essentially, we build a phase-lock loop on the output whose frequency is 1 hertz and whose loop bandwidth is half a minute and is critically damped. The output of the flywheel now drives the decoder.

We can go to a 4-Hz VCO and a divide-by-four to get the one second output frequency, and gain a bunch in the "1"-"0" identification process. To do this, we decode the first three of the four states. The circuit is shown in Fig. 9.

The first state does the gated phase detection and lasts for a quarter-second time interval between 0.875 seconds on the previous second to 0.125 seconds on the next second. Normally, a sudden drop will occur precisely at 1 second. An early-late error can then be fed to the integrator which averages out a series of early-late commands to get an average error signal which the loop continuously drives to zero.

We then use a second "noise gate" to look for a low state between 0.625 and 0.875 seconds and a final noise gate to look for a low state between 0.375 and 0.625 seconds. The first noise gate tells us if a pulse is present, while the second noise gate tells us if a "0" is *not* present. Together, we get the detected "1"s and "0"s.

Once we have a reliable signal, we have to decode it and send it to the clock. First, we have to detect 1's, 0's, and pulses. We get these ready to go from the flywheel, or we can add the 1-0 sync detectors shown in Fig. 10 instead. The "1"s and "0"s are marched through the shift register. The sync or detected P pulses detects the double pulse occurring at the beginning of each minute and sets up a two-stage shift register consisting of the third and fourth D-flops in the string. The third register goes high on second No. 2 and drops on second No. 10, with an update for the minutes and seconds being derived on the falling edge. The fourth register goes high on second No. 10 and drops on second No. 20, providing the hours update. The update process will be within a fraction of a second of true WWVB time. For more precision, the input signal can be delayed slightly more and eleven seconds can be parallel loaded into the seconds counters at the precise update time. Fig. 11 is the required interface for use between the circuit in Fig. 9 and 10 and Superclock.

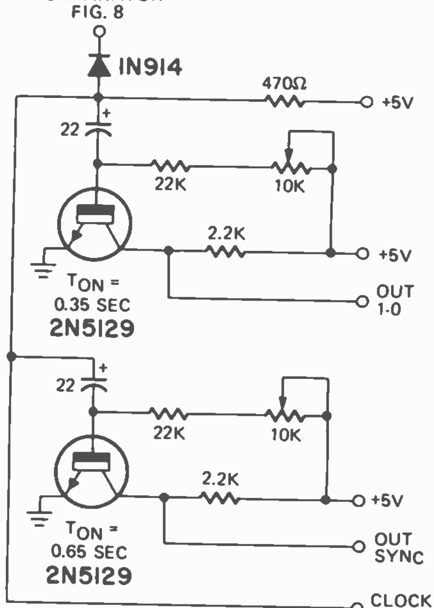



**FIG. 10—SYNC DETECTOR extracts the 1's and 0's from the WWVB incoming signal.**

## Local conditions

A final note on using the receivers. Some local interference can really wipe the receiver out, so be careful where you put it and how you use it. For instance, if you are within 8 feet of a television set, the horizontal oscillator can cause problems. So

*(continued on page 101)*

# books

*TRANSISTOR SPECIFICATIONS MANUAL, Fifth Edition, by Howard W. Sams Engineering Staff. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 160 pp. $4.50.*

Since the first transistors were made available, the total number of types has increased tremendously. Many of these types are no longer sold, many were produced without registered type numbers and others by manufacturers no longer producing transistors. This manual contains three principal sections designed to provide a maximum of information about the transistor—a specification section, a lead identification section and an outline section. The specification section is composed of the electrical data that will be required for most applications. These are voltage, power, current and temperature limits that should not be exceeded as well as polarity, leakage and gain parameters that determine how the transistor will function in the circuit. The lead and terminal identification sections supplies the physical arrangement of the leads and identifies each as to whether it is collector, emitter or base. The outline section contains drawings of the physical shape and includes all pertinent physical dimensions. A valuable guide for anyone who may require a precise replacement transistor.

*MARINE ELECTRONICS HANDBOOK by Leo G. Sands. Tab Books, Monterey & Pinola Sts., Blue Ridge Summit, Pa. 192 pp. Hardcover, $7.95, Softcover, $4.95.*

Written for both the marine radio technician and the radio user, this handbook covers high-band FM, single sideband and low-band AM marine radio telephones and includes information about antennas, power sources, sound systems and intercoms, radio direction finders and ship-to-ship pagers. In addition, the handbook summarizes the latest FCC rules and includes comments and interpretations and suggested operating practices.

*AUTOMOBILE ELECTRONICS SERVICING GUIDE by Joseph J. Carr. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 128 pp. $4.95.*

Here is all the knowledge an individual needs to be proficient in automotive electronic servicing. For the purposes of this text, automotive electronics means AM car radios, FM car radios and audio tape players. Starting with a basic review of superhet theory, the reader is taken step-by-step through circuit stages and sections of common automobile electronics gear. In addition to chapters on specific equipment, there is information on noise suppression, reception problems and bench test equipment.

*UNDERSTANDING RADIO ELECTRONICS, Fourth Edition, by Milton Kaufman, Herbert Welch, Herbert Watson and George Eby. McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, N.Y. 10020. 709 pp. $10.95.*

Complete coverage of the communication electronics field is provided in this extensively revised edition that has been updated to include solid-state concepts. Presenting the basic electrical and electronic principles through the instruction of radio electronics, the text is designed for self-study and is specifically written for high school or college students with little or no previous training in electricity or electronics. There is a self-test at the end of each chapter to help the reader review important material and increase comprehension.

*HI-FI STEREO HANDBOOK by William F. Boyce. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 400 pp. $5.95.*

Since the first edition of this book in 1956, constant change and improvement in sound communications, storage and reproduction techniques and the development of low-cost, high-quality stereo compacts have made hi-fi stereo an economic reality for everyone. True fidelity, as you learn in the first chapter of this book, is only occasionally achieved, but modern recording techniques provide maximum control of source, location, vocal, instrumental and other elements arranged with emphasis, presence, balance and three-dimensional effect to create a final mix that can be dramatically superior to live programs. This book was prepared as a reference and guide for persons interested in high-quality sound reproduction. In addition to supplying information to help and plan in selecting and installing systems, it also describes the various system components plus what they do and how they operate. R-E

**4-CHANNEL UPDATE**

Next month Radio-Electronics takes an in-depth look at the latest developments in 4-channel sound. We'll examine equipment, techniques and records. Reserve your copy now.

# circuits

## KNOW YOUR FREQUENCY

Nowadays a 100-kHz crystal calibrator is almost a necessity. Many short-wave receivers are equipped with one, or have provision for adding it. A 25-kHz generator can be even more helpful. Since it puts out signals at 25-kHz intervals, it can do anything the 100-kc calibrator can, and a lot more. Fig. 1 shows the circuit of a 100-kHz oscillator followed by a 4:1 frequency divider.

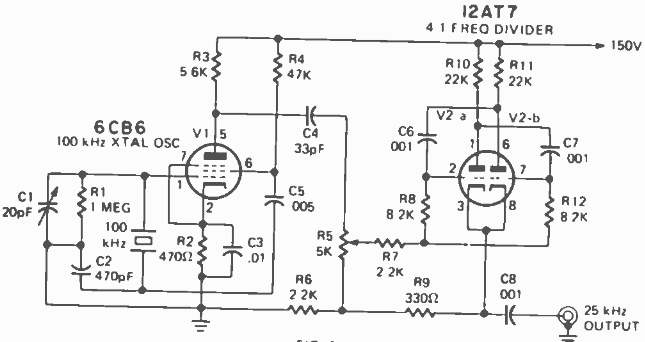
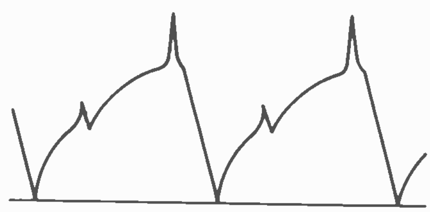



FIG 1

After construction, it should be calibrated against WWV just like a 100-kHz calibrator. This is done with C1. Then R5 should be set so V2 divides the frequency by 4. This may be done by listening on a nearby broadcast receiver. You should hear the generator signals at 800, 825, 850, 875, 900 kHz, for example. Or you may adjust R5 while observing the output waveform on an oscilloscope. Fig. 2 shows the typical wave seen. V2-a and V2-b conduct alternately, so there are four output pulses for each cycle.



OUTPUT WAVEFORM OF 4:1 DIVIDER
FIG. 2

The divider signals may be heard on a short-wave receiver up to at least 30 MHz. Assuming that the 100-kc oscillator has been precisely calibrated against WWV, you can determine very accurately frequencies like 14.025 MHz.

As one unusual application of this generator, you can check and adjust Citizens-Band transmitter frequencies (CB channels are on 26.965, 26.975, 26.985 MHz). Note that each frequency ends with the digit "5", so it cannot be a harmonic of 100 kHz. Certain channels, however, end with "25" or "75", so will be a harmonic of 25 kHz.

A CB transmitter may not stray more than .005% from the channel center frequency, so an error of 1,300 hertz is tolerated. If your standard generator may have 300 hertz error (see above), then the beat between your standard and the CB transmitter should not exceed 1 KHz to assure on-channel operation.

Beat signals may be measured by comparing with a calibrated audio oscillator or by feeding into a direct-reading frequency meter.—*Issac Queen* R-E can SCR light dimmers, power tool controls, and worst of all, psychedelic lighting controls. In most locations you can work inside the building or in an attic crawl space, but get away from and above any and all metal. Some rotation of the antenna might eliminate directional interference. Be sure to try several locations if you seem to have local interference or reception problems. **R-E**

**PC BOARDS AND MORE SUPERCLOCK INFORMATION**

Replicas of the PC boards for the Preamp (Fig. 4) and the Flywheel (Fig. 9) are available free from

SOUTHWEST TECHNICAL PRODUCTS
219 WEST RHAPSODY
SAN ANTONIO, TEXAS 78216

Complete Superclock Kits, PC boards, Time Zone chips and Time Zone conversion kits also remain available.

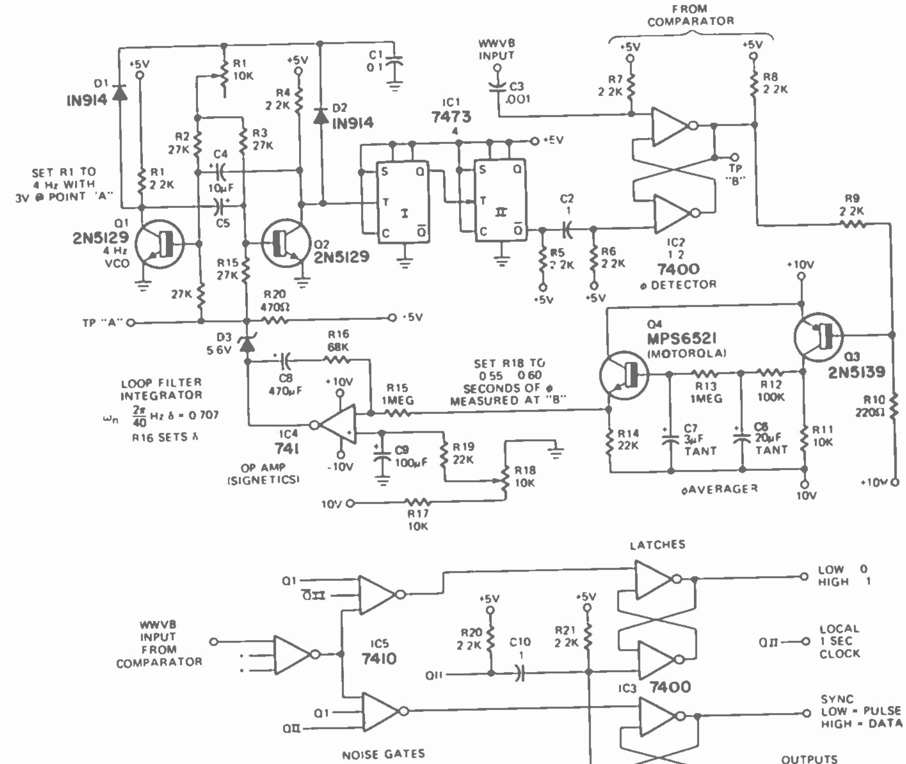



**FIG. 9—OPTIONAL PHASE LOCK "FLYWHEEL" output loop to minimize noise errors. The "Q" inputs to the 7410 sections are from IC1.**

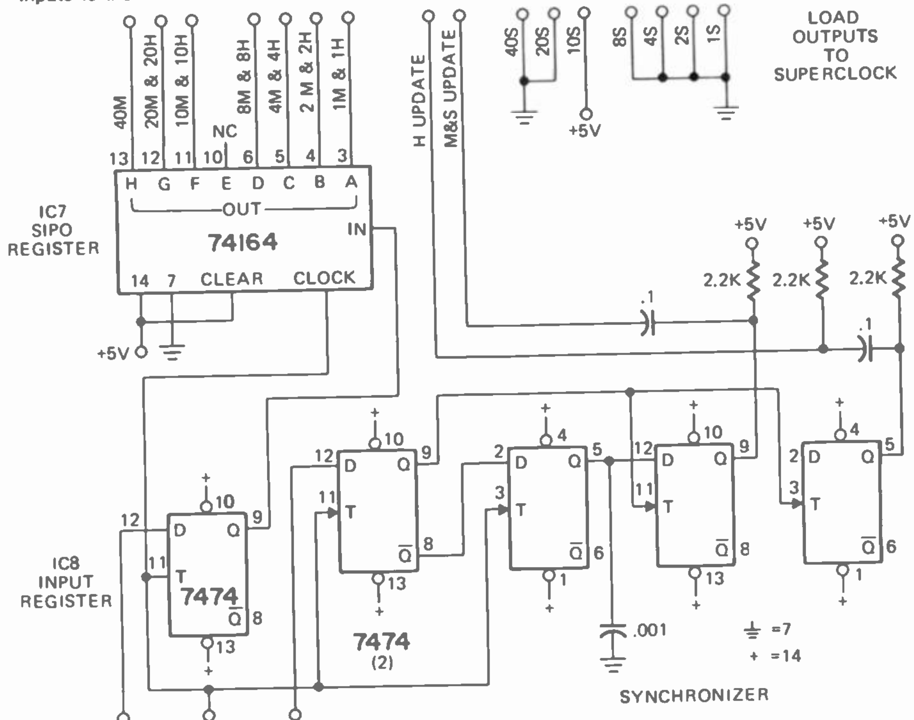



**FIG. 11—DECODER works with the flywheel in Fig. 9 or detector in Fig. 10. It interfaces to Superclock.**

**SYNTHESIZER MODULES**
*(continued from page 55)*

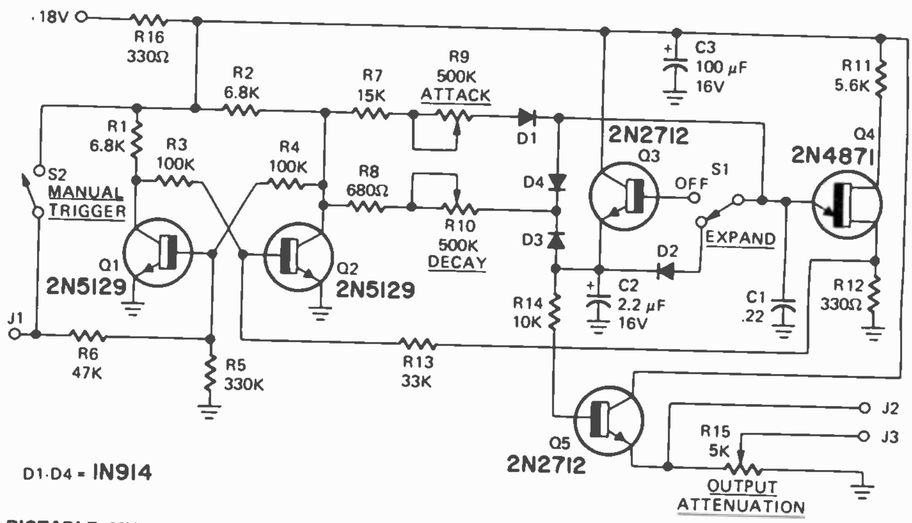
charges through DECAY control R10 and diode D4.

The EXPAND switch is included to provide for the wide range of attack times that are useful in electronic music production. In the off position of this switch, capacitor C2 is charged by the current supplied by emitter follower Q3 and this voltage is in turn isolated by emitter follower Q5 and appears at J2 and J3 as the control voltage output. C2 discharges through D3 and the now grounded collector of Q2 during the decay portion of the output.

When longer attack times are required, switching S1 to the EXPAND position causes C1 and C2 to be paralleled thereby expanding the attack time by a factor of approximately 20. Decay times are not affected by this switch.

If a voltage step rather than a pulse is used to trigger the circuit the bistable is unable to reset until the input voltage is removed so the output voltage remains high until the triggering step is removed.

This module may be tested with a vom by reading the voltage between the output jacks and ground. The MANUAL trigger pushbutton can be used to trigger the generator for test purposes. With the expand switch on and both attack and decay controls rotated fully clockwise the output should take about 1 second to climb to 5V and another second to fall back to zero. As the attack and decay times are shortened the vom will be unable to follow them but an oscilloscope should show an attack time variable from 2 ms to 40 ms with the EXPAND off and 30 ms to 1 second with it on. Decay times should be variable from 5 ms to 1 second and there should be no interaction between the controls. When the MANUAL button is pressed and held the output voltage should rise to 5 volts and hold as long as the button is held down. **R-E**




**BISTABLE MULTIVIBRATOR, Q1-Q2, is the heart of this function or envelope generator. Fixed and variable outputs are at J2 and J3, respectively.**

*All resistors ½W 10% unless noted*

R1, R2—6,800 ohms
R3, R4—100,000 ohms
R5—330,000 ohms
R6—47,000 ohms
R7—15,000 ohms
R8—680 ohms
R11—5,600 ohms
R12, R16—330 ohms
R13—33,000 ohms
R14—10,000 ohms
R9, R10—500,000 ohms, linear taper potentiometer
R15—5,000 ohms, linear taper potentiometer
C1—.22-µF Mylar
C2—2.2-µF 10V electrolytic
C3—100-µF 16V electrolytic
D1-D4—1N914
Q1, Q2—2N5129
Q3, Q5—2N2712
Q4—2N4871

**The following kits containing all parts required for duplicating the modules as shown are available from PAIA Electronics, Inc., P.O. Box 14359, Okla. City, Okla. 73114**

**Voltage Controlled Amplifier No. 2720-1 $12.95 postpaid**

**VCF (low pass) No. 2720-3L $9.95 postpaid**

**VCF (band pass) No. 2720-3B $11.95 postpaid**

**Envelope Generator No. 2720-4 $19.95 postpaid**

**Control Osc./Noise No. 2720-5 $19.95 postpaid**

**Complete Synthesizer with one each of the described modules 2720-1 through 2720-7. No. 2720 $139.00 plus postage for 18 lbs. and insurance.**

**Circuit boards are available separately at a cost of $2.50 for single unit boards and $3.50 for double unit boards postpaid.**

**Oklahoma residents please add 3% sales tax.**

## More to come

One more module will be described next month. It is a special control oscillator used to produce such unusual effects as tremolo (a slow cyclic variation in the amplitude of a signal) and vibrato (cyclic variation in the frequency of a signal). A white-noise source is included as an integral part of this special control oscillator. White noise is indispensable for creating the sounds of wind, surf, snare drums, cymbals, and various assorted sounds of explosions.

**STEP-BY-STEP**
*(continued from page 70)*

final Y1 waveform (Fig. 9), an LC probe (at 100V/div) is placed *near* the flyback transformer just to show the high voltage is operating. This is only a quick check method without actual voltage measurement, and is not quantitative in any sense, but it can save you much blind man's buff. Y2 in Fig. 9 is nothing more than the horizontal output screen voltage of this receiver showing that at 50V/div it is indeed resting at 200 volts.

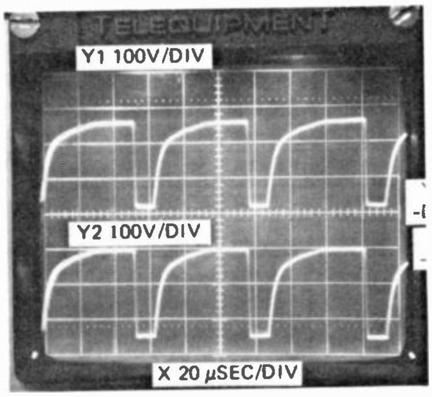



**FIG. 8—NORMAL WAVEFORMS. Replacement pincushion transformer restored operation.**

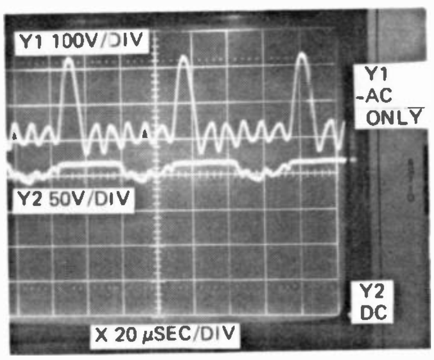



**FIG. 9—PROBE HELD NEAR FLYBACK to check for HV produces this trace.**

If 1-μF C500 was open here, you'd have another 200-volt p-p waveform superimposed where the small ripple now exists. If C500 was quite leaky or shorted, R505 would either be severely singed or burned open and there would be no high voltage because the screen grid would be close to zero.

In any "no high voltage" situation, don't forget that too much or too little beam current in the picture tube can produce a blank screen. So don't neglect the luminance and pix tube cathode driver amplifiers and, by all means, at least quick check or actually measure the high voltage. With many sets, you may also flip your setup switch or remove the cap from the pix tube to see if high voltage is simply loaded down or actually doesn't exist. **R-E**

# market center

## WANTED

**QUICK** cash . . . for electronic equipment components, unused tubes. Send list now! **BARRY,** 512 Broadway, NY 10012, 212 WAlker 5-7000

## ELECTRONICS ENGINEERING & INSTRUCTION

+ − × ÷ **CALCULATOR owners: Compute Square Roots, trigonometric functions, logarithms,** exponentials, and more! Quickly, accurately, easily! Manual $2.00. Send today—Unconditional money-back guarantee. **MALLMANN OPTICS AND ELECTRONICS,** Dept.-1B, 836 South 113, West Allis, Wisconsin 53214

**EVALUATE complex functions** on any four function arithmetic calculator. Details 25¢ (refundable) **ADTECH** POB 1068 Englewood CO 80110

**SHORTCUTS** To Success! Highly Effective, Profitable Short Courses. (75 Choices). Study At Home. Diploma Awarded. Our 27th Year. Free Literature. **CIEE-E,** Box 10634, Jackson, MS 39209

**LOGIC newsletter,** design and construction, sample copy $1.00, **LOGIC NEWSLETTER,** Box 252, Waldwick, N.J. 07463



**HAM radio is fun, learn code with code oscillator and book $9.95 HUGE ELECTRONICS CO. Box 48261 Dorsville Ga. 30340**

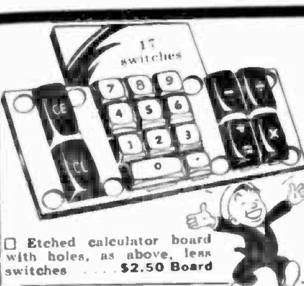
**TV TUNER** repairs-Complete course details, 12 repair tricks. Many plans. Two lessons, all for $1. Refundable. **FRANK BOCEK,** Box 3236 (Enterprise), Redding, Calif. 96001

## BUSINESS OPPORTUNITIES

**START** small, highly profitable electronic production in your basement. Investment, knowledge unnecessary. Postcard brings facts. **BARTA-REI,** Box 248, Walnut Creek, Calif. 34597

## FOR SALE

**B & K, SENCORE TEST EQUIPMENT, DISCOUNT PRICES. FREE CATALOG AND PRICE SHEET. FORDHAM RADIO, 558 MORRIS AVENUE, BRONX, N.Y. 10451**




# Calculator Keyboard Sale – $12.50

3 for $30

Properly etched, drilled, "MULTIPLEXED," with proper diodes. Ready to go! Used with our own CAL TECH's 5001 chip advertised at $12.95 or equal to Cal Tech or Mostek chip. Keyboard uses the new manufactured by OAK, printed-circuit low-profile FEATHER TOUCH switches. 0-to-9 in white with black letters. Decimal white with black dot. CE, CL and the 4 function switches are in blue with white characters. Designed by top maker. Size: 6½ x 4½ x ½". All etched connections link to take a 12-pin edge connector.

☐ Etched calculator board with holes, as above, less switches .... $2.50 Board

## OAK FEATHER-TOUCH CALCULATOR KEYBOARD SWITCHES

- For RTTY
- Printed Circuits
- For Unique Panel Switches

Mfd. by OAK (Ham's note, RTTY, too) data systems, same as used in Keyboard Calculator. SPST, Normally Open, 24V 1 amp contacts. Characters and letters easily changed. ⅜" high. Printed circuit.

| No. | Sale | | |
|---|---|---|---|
| ☐ 0* | $.69 | ☐ 8* | .49 |
| ☐ 1* | .49 | ☐ 9* | .49 |
| ☐ 2* | .49 | ☐ CE† | .69 |
| ☐ 3* | .49 | ☐ CL† | .69 |
| ☐ 4* | .49 | ☐ –† | .69 |
| ☐ 5* | .49 | ☐ + =† | .69 |
| ☐ 6* | .49 | ☐ ÷† | .69 |
| ☐ 7* | .49 | ☐ X† | .69 |
| | | ☐ •* | .49 |

*White top, black numbers. †Blue top, white characters.

☐ Kit of 17 above switches for keyboard $9.

## POLY PAKS STOCKS "C-MOS" IC CIRCUITS

| Type | Sale |
|---|---|
| ☐ 74C00 | $.95 |
| ☐ 74C02 | .95 |
| ☐ 74C04 | 1.15 |
| ☐ 74C10 | .95 |
| ☐ 74C73 | 1.79 |
| ☐ 74C74 | 1.59 |
| ☐ 74C76 | 1.79 |
| ☐ 74C157 | 2.50 |
| ☐ 74C160 | 3.50 |
| ☐ 74C161 | 3.50 |
| ☐ 74C162 | 3.50 |
| ☐ 74C163 | 3.50 |

## POLY PAK'S NEW "AUDIO AMP ALLEY"

Buy Any 3 — Take 10%

| Watts | Mfr. | Type | Case | Heat Sink | Sale |
|---|---|---|---|---|---|
| ☐ 1W | Westinghou | WC334 | TO5 | No | $1.49 |
| ☐ 2W | National | LM380 | DIP | No | $1.95 |
| ☐ 3.5W | G.E. | PA263 | DIP | Yes | $2.95 |
| ☐ 4W | Texas | SN76024 | DIP | Yes | $3.95 |
| ☐ 5W | SGS | TBA800 | DIP | Yes | $4.50 |
| ☐ 4W | Motorola | MEP9000* | DIP | Yes | $2.95 |
| ☐ Dual 1W | Sprague | 2277 | DIP | Yes | $2.95 |
| ☐ — | Fairchild† Dual Stereo Preamp | 739 | DIP | No | $1.95 |

*With built-in preamp. All 9-24V, to 8-16 ohms load

## Potter & Brumfield KAP RELAYS

Your choice 3 for $7.50 **$2.98**

☐ 115 VAC 3PDT .... $2.98
☐ 12 VDC 3PDT .... 2.98

Excellent for "HAM" use as antenna switching, latching, transmit, receive, etc., and 100's of commercial or industrial uses. Includes plastic dust-cover with diagram and hookup info, 11-pin plug-in base. Contacts movable gold flashed silver, stationary overlay, with silver cadmium oxide movables. All contacts 10 amp 3PDT. Coil data, 115VAC 2250 ohms, 17.5 ma, 12 VDC 21 ma, 168 ohms. Size: 2⅛" x 1 5/16". Wt. 4 ozs. Center pin missing. Comar Mfg. type equal too.

## STUD 'TRIACS'

| PRV | 15 amp | 25 amp |
|---|---|---|
| 50 | ☐ $.65 | ☐ $.85 |
| 100 | ☐ .85 | ☐ 1.05 |
| 200 | ☐ 1.25 | ☐ 1.45 |
| 300 | ☐ 1.45 | ☐ 1.65 |
| 400 | ☐ 1.65 | ☐ 1.95 |
| 500 | ☐ 2.55 | ☐ 2.25 |
| 600 | — | ☐ 2.65 |

# AM-FM-Stereo-Mux
## SOUND CONTROL CENTER

ALL 3 PIECES Only ☐ **29.95** HYBRID


FEATURES

- AM, FM, FM-Multiplex stereo phono inputs!
- Separate Tuner! Amplifier! and Multiplex!
- FM Tuner has automatic frequency control
- Hybrid tube, transistor printed circuitry!
- Separate volume and power control!
- Separate bass and treble controls!
- Remote speaker controls!
- Connects easily to record changer!
- Mike, tape, phono inputs!
- Push-pull power output solid state!

Shpg. wt. for 3-pc. Sound Control Center — 10 lbs.

This is a Poly Pak exclusive. Bought for the economy-minded hi-files. This unique audio system was designed for $300 consoles. 15 watts of stereo music power. 3 separate units, each unit professionally designed by U.S.A. engineers. AM-FM tuner, Multiplex, push-pull TO-66 power transistors mounted on chassis. Outputs connect to any good speaker system. Voice coils of 8 to 16 ohms. Unique switch on panel connects external stereo speakers to other parts of rooms, home or office. Concentric volume controls for perfect stereo balance. Has built-in preamplifier, built-in AM antenna. 13"x6"x 8".

TUNER — 13" x 6" x 8"

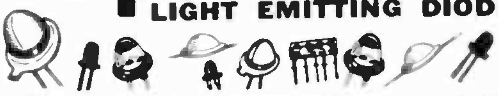
Tuner uses 17C9 for FM r-f amplifier and converter, 12BA6 for 1st FM i-f amp and AM i-f amp, 12BA6 for 2nd FM i-f amp and AM detector, 12BE6 AM converter, 12AX7 multiple preamp. Separate speaker arrangements for hi-fi and TV. Built-in AFC. Comes complete with 8-pg. 8½"x11" factory booklet, chock-full of diagrams, printed circuit layouts of all parts, etc. All parts are easily identified. Power consumption 115 VAC 60 cy. Complete with all interconnecting cables. Wide frequency response. Includes printed front panel template. WHERE CAN YOU GET SO MUCH AM! FM! STEREO! FOR SO LITTLE MONEY?

MULTIPLEX — 4" x 6" x 3"

Multiplex uses 12AT7 amp-doubler, 12AX7 38 kc output amp, with availability of "STEREO STATION INDICATING" lamp.

POWER AMPLIFIER CHASSIS — 12" x 6" x 2". All solid state devices, using a pair of driver transistors to push-pull TO-66 "Sound Control Center" power.

# Opto Electronics Sale
## LIGHT EMITTING DIODE GaAs INDICATORS



| | |
|---|---|
| ☐ 2-MV1*, Amber, visible jumbo epoxy lens upright | $1.00 |
| ☐ 1-MV2*, TO-18, Dome, green, visible | 1.19 |
| ☐ 3-MV3*, visible, "coax pin pak", red, mini dome lens | 1.00 |
| ☐ 1-MV4*, stud, high power, red, 2-watts | 3.95 |
| ☐ 1-MV4H*, stud, high power, hi-dome, red, 2-watts | 3.95 |
| ☐ 3-MV10B, visible, red, clear, dome lens, TO-18 | 1.00 |
| ☐ 3-MV10C visible, red, diffused, dome lens, TO-18 | 1.00 |
| ☐ 3-MV50*, axial leads micro-mini dome, clear, red | 1.00 |
| ☐ 3-MV5012*, visible, red, small dome lens | 1.00 |
| ☐ 2-MV5022*, jumbo red dome, TO-18, visible | 1.00 |
| ☐ 2-MV5020*, jumbo clear dome, TO-18, visible, red | 1.00 |
| ☐ 1-MV5040*, 4-LED red array, with 5-lead pak | 1.49 |
| ☐ 3-MV5054*, visible, red, jumbo dome lens, upright | 1.00 |
| ☐ 2-MV5080*, TO-18, micro-mini, clear dome, red | 1.00 |
| ☐ 4-MV5082, visible, red, clear flat lens, TO-18 | 1.00 |
| ☐ 1-MV5222*, jumbo dome, green, panel snap-in | 1.98 |
| ☐ 1-MV5322*, jumbo dome, GaAsp, panel snap-in Yellow | 1.98 |
| ☐ 1-MV9000*, cartridge panel lamp, sealed, red, clear lens | 1.49 |
| ☐ 2-MT-2*, Photo Transistor, light sensor, TO-18 | 1.00 |
| ☐ 1-ME-1*, infra-red, parabolic lens, pin type | 1.19 |
| ☐ 2-ME-4*, infra-red, "invisible", TO-18, diff. dome | 1.19 |
| ☐ 2-ME60*, infra-red, "invisible", axial, micro-mini | 1.00 |

## OPTO-COUPLERS *Monsanto Equivalent

| | |
|---|---|
| ☐ MCA2-30* 1500V Photo Darlington Relay | $1.00 |
| ☐ MCD1* 4000V Isolation Photo Transistor | 4.95 |
| ☐ MCD2* 1500V Isolation Photo Diode | 1.00 |
| ☐ MCT1* 4000V Isolation Photo Transistor | 4.95 |
| ☐ MCT2* 1500V Isolation Photo Transistor | 1.00 |
| ☐ MCT2-D* 1500V Isolation Twin Photo Transistor | 1.98 |
| ☐ MCT5-10* 10,000V Isolation Photo Transistor | 4.95 |
| ☐ MCT5-25* 25,000V Isolation Photo Transistor | 5.95 |

## 1¢ SALE SCHOTTKY TTL IC

| | REG. | 1¢ MORE |
|---|---|---|
| ☐ SN74S00 | $0.98 | 2 for .99 |
| ☐ SN74S01 | .98 | 2 for .99 |
| ☐ SN74S02 | .98 | 2 for .99 |
| ☐ SN74S03 | .98 | 2 for .99 |
| ☐ SN74S04 | .98 | 2 for .99 |
| ☐ SN74S05 | .98 | 2 for .99 |
| ☐ SN74S08 | .98 | 2 for .99 |
| ☐ SN74S09 | .98 | 2 for .99 |
| ☐ SN74S10 | .98 | 2 for .99 |
| ☐ SN74S11 | .98 | 2 for .99 |
| ☐ SN74S15 | .98 | 2 for .99 |
| ☐ SN74S20 | .98 | 2 for .99 |
| ☐ SN74S22 | .98 | 2 for .99 |
| ☐ SN74S40 | .98 | 2 for .99 |
| ☐ SN74S50 | .98 | 2 for .99 |
| ☐ SN74S51 | .98 | 2 for .99 |
| ☐ SN74S60 | .98 | 2 for .99 |
| ☐ SN74S64 | .98 | 2 for .99 |
| ☐ SN74S73 | 1.98 | 2 for 1.99 |
| ☐ SN74S74 | 1.98 | 2 for 1.99 |
| ☐ SN74S78 | 1.98 | 2 for 1.99 |
| ☐ SN74S82 | 1.98 | 2 for 1.99 |
| ☐ SN74S106 | 1.98 | 2 for 1.99 |
| ☐ SN74S107 | 1.98 | 2 for 1.99 |
| ☐ SN74S108 | 1.98 | 2 for 1.99 |
| ☐ SN74S112 | 1.98 | 2 for 1.99 |
| ☐ SN74S113 | 1.98 | 2 for 1.99 |
| ☐ SN74S114 | 1.98 | 2 for 1.99 |
| ☐ SN74S139 | 1.98 | 2 for 1.99 |
| ☐ SN74S140 | 1.98 | 2 for 1.99 |
| ☐ SN74S151 | 2.50 | 2 for 2.51 |
| ☐ SN74S153 | 3.98 | 2 for 3.99 |
| ☐ SN74S157 | 3.50 | 2 for 3.51 |
| ☐ SN74S158 | 3.00 | 2 for 3.01 |
| ☐ SN74S182 | 2.50 | 2 for 2.51 |

## LITRONICS-MONSANTO-OPCOA LED Readouts

All fit 14-pin IC sockets, 5V 10 to 20 mils, 0-to-9 numerals, plus letters & decimal. With spec sheets. (*Monsanto Equal. **MAN-1 Specs. †35-Diode Array.)

MAN-1, MAN-2, MAN-3, MAN-4, MAN-5, MAN-8, SLA-7, 707

| Type | Character Size: | Color Display: | Decimal | Driver | Each | Special |
|---|---|---|---|---|---|---|
| ☐ MAN-1* | .27 | Red | Yes | SN7447 | 4.50 | 3 for $12. |
| ☐ MAN-2* | .32† | Red | Yes | 2513 | 8.88 | 3 for $24. |
| ☐ MAN-3* | .115 | Red | Yes | SN7448 | 2.25 | 3 for $6. |
| ☐ MAN-3* | .115 | Red | No | SN7448 | 1.49 | 3 for $3. |
| ☐ MAN-4* | .190 | Red | Yes | SN7448 | 2.95 | 3 for $8. |
| ☐ MAN-4* | .190 | Red | No | SN7448 | 1.79 | 3 for $5. |
| ☐ MAN-5* | .27 | Green | Yes | SN7447 | 8.88 | 3 for $24. |
| ☐ MAN-8* | .27 | Yellow | Yes | SN7447 | 8.88 | 3 for $24. |
| ☐ LITRONICS 707** (MAN-1) | .33 | Red | Yes | SN7447 | 3.50 | 3 for $9. |
| ☐ OPCOA** SLA-7 (MAN-1) | .33 | Red | Yes | SN7447 | 3.50 | 3 for $9. |
| ☐ OPCOA** SLA-7 (MAN-1) | .33 | Red | No | SN7447 | 1.95 | 3 for $5. |

## HOBBY — EXPERIMENTAL "LED" KORNER

| | |
|---|---|
| ☐ 5-MAN-3* "The claw", some segments missing, hobby use, readout | $1.00 |
| ☐ 1-MAN-4* some segments missing, hobby use, readout | $1.00 |
| ☐ 1-SLA-7 Opcoa's MAN-1, 1-segment missing | $1.49 |
| ☐ 1-SLA-7 Opcoa's MAN-1, hobby, some segments missing | $1.00 |
| ☐ 10-LED HOBBY SURPRIZE! asst. types, no-test | $1.00 |
| ☐ 5-MONSANTO's Opto Coupler surprise, asst. no-test | $1.00 |
| ☐ 3-PC. KIT, MAN-1, MAN-3, MAN-4, some segments missing | $1.49 |

## ALLEN BRADLEY 'TRANSISTOR' POTS

Type F. Screwdriver adjust. **Any 4 for $1**

| Ohms | |
|---|---|
| ☐ 75 | ☐ 7.5K |
| ☐ 100 | ☐ 10.0K |
| ☐ 200 | ☐ 20.0K |
| ☐ 250 | ☐ 25.K |
| ☐ 500 | ☐ 50.K |
| ☐ 750 | ☐ 75.K |
| ☐ 1.0K | ☐ 100K |
| ☐ 2.5K | ☐ 250K |
| ☐ 5.0K | ☐ 2 Meg |
| | ☐ 5 Meg |

## ALLEN BRADLEY 'MICRO-POTS'

Type G, 1/2" dia., 1/2" high. Mounts 1/4" hole, with shaft, linear, immersion-proof high freq. **2 for $1**

| Ohms | | |
|---|---|---|
| ☐ 75 | ☐ 2.5K | ☐ 25.K |
| ☐ 100 | ☐ 5.0K | ☐ 75.K |
| ☐ 500 | ☐ 7.K | ☐ 100.K |
| ☐ 2.0K | ☐ 10.K | ☐ 5 Meg |
| | ☐ 20.K | |

We stock Locknut Bushing & Screwdriver types at same low prices.

☐ 6-DIGIT MAN-3A MUX'D PC BOARD **$2.95**

Clock DCMs, VTVM, DVM, calculators, multiplexed.

☐ 6-MAN-3A's for above board. $9.50.

Terms: add postage. Rated: net 30
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield, Mass. (off Water Street) C.O.D.'S MAY BE PHONED

☐ 15¢ CATALOG on Fiber Optics, 'ICs', Semi's, Parts

**POLY PAKS**

P.O. BOX 942R, LYNNFIELD, MASS. 01940

*Circle 94 on reader service card*

**ELECTRONIC organ kits, keyboards** and many components. Independent and divider tone generators. All diode keying, I.C. circuitry. With our kits you can build any type of size organ desired. 25¢ for catalog. **DEVTRONIX ORGAN PRODUCTS**, Dept. B, 5872 Amapola Dr., San Jose, Calif. 95129

**COLLECTORS** Records of Dallas presents the largest oldies record catalogue. Over 6000 records listed for sale, 50¢ to $150.00 years 1948 to 1972. Cost of 60 page catalogue is $3.00 refundable with the first order. Send to **COLLECTORS RECORDS**, POB 44017 B, Dallas, Texas 75234

**WHOLESALE** prices on electronic parts. Large discounts. Free catalog. **DONLYN ELECTRONICS**, 2217 North 24th Street, Phoenix, Arizona 85008

**JAPANESE** new products monthly! $1.00. Refundable. **DEERE**, 10639 Riverside, North Hollywood, CA

**REGULATED LOGIC & OP AMP POWER SUPPLIES**
5V @ 500 mA ..$22. 5V @ 1A .......$29. ±15V @ 100 mA $22. LAB MODELS available, 3-wire cord, toggle switch, 5-way binding post posts. 5V @ 500 mA ......$36. ±15V @ 100mA ...$36.
All units are precise, preset voltage sources. Epoxy cased (2.5"x3.5"x1.2") Made for commercial standards. FREE Adjustable current source (0-10mA) plan kit with each purchase.
**INSTANT INSTRUMENT INC.**
306 RIVER ST. HAVERHILL, MASS. 01830
(617)373-9260

DIGITAL:THEORY,DESIGN, CONSTRUCTION
*LOGIC NEWSLETTER* ©
SAMPLE COPY $ 1.00
LOGIC NEWSLETTER
POB 252
WALDWICK,N.J. 07463

**SURPLUS** and new electronics. Man-1 type led read-out $3.95. miniature 4.0V 40mA incandescent lamps 11 for $1. .1uF 400V black beauty cap 12 for $1. order or 8¢ stamp for list. **TRI-TEK, INC.**, Box 14206R, Phoenix, Arizona, 85063

**METAL film registors**—½ watt—5% tolerance—only 5¢ each—semiconductors also at similar prices. Send post card for catalog. **SOLAR ELECTRONICS ENTERPRISES**—Box 778-Edmonton, Alberta, Canada. T5J 2L4

**BEAUTIFUL** catalog. Free! Professional Line of Guaranteed Metal Detectors. Find Coins, Jewelry, Relics. **FISHER**, Room 927-Q, Box 490, Belmont, Ca. 94002

**SEMICONDUCTOR** and parts catalog. **J. & J. ELECTRONICS**, Box 1437, Winnipeg, Manitoba, Canada

**WIRE** wrapping tool $1.00 **XYCON** Box 9341, 9341 Phoenix, AZ 85020

**PARTS! CORNELL TUBES!**
FREE Send For FREE CORNELL'S New Color Catalog 48 Pgs. New Items
33¢ per tube — 36¢ per tube
ORDER FREE IF NOT SHIPPED IN 24 HOURS!
IN LOTS OF 100
4215 E UNIVERSITY AVE. SAN DIEGO, CALIF. 92105

## 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. C, Yellowstone Trail, Valparaiso, Indiana 46383

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services). $1.00 per word . . . minimum 10 words.
NONCOMMERCIAL RATE (for individuals who want to buy or sell personal items) 70¢ per word . . . no minimum.
FIRST WORD and NAME set in bold caps at no extra charge. Additional bold face at 10¢ per word. Payment must accompany all ads except those placed by accredited advertising agencies. 10% discount on 12 consecutive insertions, if paid in advance. Misleading or objectionable ads not accepted. Copy for November issue must reach us before August 31.

## CLASSIFIED ADVERTISING ORDER FORM

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 |

No. of Words ______ { @ .70 Non-Commercial Rates / @ $1.00 Commercial Rate } =$____
No. of Words in bold face @ .10 =$____
Total Enclosed $$________
Insert______time(s)
Starting with__________Issue
Payment must accompany order unless placed through accredited advertising agency 28

NAME________________
ADDRESS________________
CITY__________STATE__________ZIP______
SIGNATURE________________
MAIL TO: RADIO-ELECTRONICS, CLASSIFIED AD DEPT., 200 PARK AVE. SOUTH, NEW YORK, N.Y. 10003

## International Electronics Unlimited

Special of the Month

**5001 LSI Calculator Chips**
Data Included — Only $5.95 ea.
**MM5312 clock chip 24 pin any readout 4 digit (1 PPS output BCD)** — Only $8.99

**TTL**

| | | | | | |
|---|---|---|---|---|---|
| 7400 | $.25 | 7443 | 1.25 | 7493 | 1.05 |
| 7401 | .25 | 7444 | 1.30 | 7494 | 1.10 |
| 7402 | .25 | 7445 | 1.25 | 7495 | 1.05 |
| 7403 | .25 | 7446 | 1.45 | 7496 | 1.05 |
| 7404 | .29 | 7447 | 1.45 | 74121 | .55 |
| 7405 | .27 | 7448 | 1.50 | 74123 | 1.15 |
| 7406 | .55 | 7450 | .29 | 74145 | 1.25 |
| 7408 | .29 | 7451 | .32 | 74151 | 1.05 |
| 7409 | .29 | 7453 | .32 | 74153 | 1.45 |
| 7410 | .25 | 7460 | .30 | 74154 | 1.75 |
| 7411 | .35 | 7470 | .50 | 74155 | 1.35 |
| 7413 | .95 | 7473 | .55 | 74157 | 1.50 |
| 7420 | .25 | 7474 | .55 | 74161 | 1.65 |
| 7423 | .37 | 7475 | .95 | 74164 | 2.95 |
| 7425 | .39 | 7476 | .55 | 74165 | 2.95 |
| 7430 | .25 | 7483 | 1.25 | 74175 | 2.95 |
| 7432 | .30 | 7485 | 1.20 | 74181 | 4.50 |
| 7437 | .50 | 7486 | .55 | 74192 | 1.65 |
| 7440 | .25 | 7489 | 3.25 | 74193 | 1.65 |
| 7441 | 1.25 | 7490 | 1.25 | 74194 | 1.65 |
| 7442 | 1.15 | 7492 | 1.05 | 75195 | 1.15 |

**Low Power Devices**

| | | | | | |
|---|---|---|---|---|---|
| 74L00 | .40 | 74L30 | .40 | 74L85 | 1.25 |
| 74L02 | .40 | 74L71 | .55 | 74L86 | .95 |
| 74L04 | .40 | 74L72 | .55 | 74L90 | 1.75 |
| 74L10 | .40 | 74L73 | .75 | 74L93 | 1.75 |
| 74L20 | .40 | 74L74 | .75 | 74L95 | 1.75 |

**Linear**

| | | |
|---|---|---|
| LM300 Positive Volt Reg. | (TO5) | .95 ea. |
| LM301 Hi Performance Amp | (TO5) | .45 ea. |
| LM302 Voltage Follower | (TO5) | .95 ea. |
| LM304 Neg. Volt Reg. | (TO5) | 1.25 ea. |
| LM305 Positive Volt Reg. | (TO5) | 1.25 ea. |
| LM307 Super 741 (mini Dip) | (TO5 | .45 ea. |
| LM308 Micro Power op amp | (TO5) | 1.25 ea. |
| LM309H 5V Reg | (TO5) | 1.25 ea. |
| LM309K 5V-1A power supply | (TO3) | 1.95 ea. |
| LM311 Comparator | (TO5) | 1.25 ea. |
| LM320-5.2V or-12 V or -15 Choose | (TO3) | 1.95 ea. |
| LM380 2 watt audio amp | (Dip) | 1.95 ea. |
| 709 Op Amp | .29 ea. or 10/ | 2.50 |
| 723 Volt Reg. | .75 ea. or 5/ | 3.25 |
| 741 Freq Comp. | .45 ea. or 10/ | 3.95 |
| 747 Dual 741 | .95 ea. or 4/ | 3.95 |
| NE565 Phase Lock Loop | | 2.95 ea. |
| NE566 Function Generator | | 2.95 ea. |
| NE567 Tone Decoder | | 2.95 ea. |

**Memories—Are Made of—**

| | |
|---|---|
| 1101 256 Bit Ram Mos. | 2.95 ea. |
| 1103 1024 Bit Ram Mos. | 7.95 ea. |
| 7489 64 Bit Ram TTL | 3.25 ea. |
| 8223 Programmable Rom | 6.95 ea. |
| Data Included with Memories | |

5005 LSIFour function calculator with extra storage register for constant memory application chain calculations add, subtract, divide, multiply with complete data $11.95 ea.
Data only (Refundable with purchase) 1.00 ea.

**LED's**

| | |
|---|---|
| Data Lite 707 (type) (Pin for Pin Man 1 replacement) | 3.75 ea. |
| Man III (type) 2.45 ea. or 3 or more | 1.95 ea. |
| Man IV (type) 2.95 ea. or 3 or more | 2.75 ea. |
| MV50 (type) Red Emitting .29 ea. or 4/ | 1.00 |
| MV5020 (type) Large Red .39 ea. or 4/ | 1.00 |
| MV10B Visable Red TO18 .39 ea. or 3/ | 1.00 |
| ME4 Infra Red (TO18) | .69 ea. |
| Opto Iso MCA 2-30 Darlington | .95 ea. |
| MCD 2 Diodes | 1.95 ea. |
| MCT 2 Transistor | 1.45 ea. |

MOS Shift Registers Choose or Mix — 4/1.00

| | | | | | |
|---|---|---|---|---|---|
| 2502 | 2504 | 2506 | 2509 | 2510 | .30 ea. |
| 2511 | 2518 | 1519 | 2521 | 2522 | .30 |
| 2524 | 2525 | 2527 | 2528 | 2533 | .30 |

Note: 2500 MOS untested factory seconds

TTL Grab Bag Special — 12 for 1.00
Assorted mix 12/bag
Note: TTL untested factory seconds

DTL Grab Bag Special — 15 for $1.00
Assorted Mix 15 DTL Dip Pkg.
Note: DTL untested factory seconds

Satisfaction guaranteed. All items except where noted are fully tested. Minimum order $5.00 Prepaid in U.S. Calif. residents add sales tax. Orders filled within 3 days after receipt. Please add .50 per spec, sheet for items priced at less than $1.00 ea.

**INTERNATIONAL ELECTRONICS UNLIMITED**
P.O. BOX 2238
WALNUT CREEK, CALIF. 94595
*Circle 92 on reader service card*

## 12-DIGIT "CALCULATOR CHIP" SALE

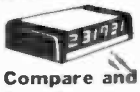
Similar to Mostek 5001. Outperforms Texas 8-digit TMS1802. A 40-pin DIP. Adds, multiplies, subtracts, and divides. Use with 7-segment readouts, Nixies, and LED's. We include schematics, instructions to build calculator.

**$9.95** ☐ 3 for $27.

☐ CT5005 — Same as above with MEMORY — $14.95

## NATIONAL EQUALS ON "DIGITAL CLOCK on a CHIP"

Any "Chip" ☐ **$12.88**

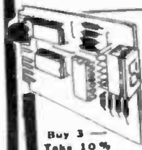


| Mfrs # | Description | Sale |
|---|---|---|
| ☐ 5311 | 28-pin, ceramic, any readout, 6-digits: A-B-D | $12.88 |
| ☐ 5312 | 24-pin, ceramic, any readout, 4-digits: C-D | $12.88 |
| ☐ 5313 | 28-pin, ceramic, any readout, 6-digits: A-C | $12.88 |
| ☐ 5314 | 24-pin, plastic, LED and incandescent readouts, 6-digits: A-B | $12.88 |

Code: A—Hold Count. C—1 PPS Output. B—Output Strobe. D—BCD

* Compare and Save!
* Money Back Guarantee!
* With Spec Sheet!

## LED MITY DIGITS "DCM'S"



Digital Counting Modules ☐ **9.99**

Buy 3 — Take 10%

INCLUDES P.C. EDGE CONNECTOR — FREE!

Kit includes: 3 x 2" printed ckt board, with fingers too! Side-mounting socket, MAN-4 resistors, 7448, 7475, 7490, booklet.

Will outperform any other DCM on the market today, not gaseous, not incandescent, but a device that will READ almost for life. MAN-4, Monsanto equal.

## WORLD FAMOUS SEMI-KON Dollar Stretchers

- ☐ 2 – 6000 PIV 50 mil epoxy rectifiers, axial leads* ... $1
- ☐ 10 – BENDIX 25 WATT "pellet" power transistors, silicon* ... $1
- ☐ 1 – PHOTO ELECTRIC FET, 10,000 uhmos, n channel ... $1
- ☐ 4 – 80 WATT, 2N1488, silicon, TO3, 60 Vco, npn ... $1
- ☐ 1 – 2N3055 npn, 100W, 15A, TO-3, transistor ... $1.
- ☐ 5 – ER900 TRIGGER DIODES for SCRs & Triacs ... $1.
- ☐ 2 – FET'S 2N5457 N channel 5000 umhos, TO-92 plastic ... $1.
- ☐ 10 – 1N914 fast switch diodes, silicon, 4 nanoseconds ... $1.
- ☐ 2 – 6 AMP TRIAC 200 PRV, TO-5 ... $1.
- ☐ 40 – ITT MICRO MINI RECTIFIERS silicon porcelain to 1KV* ... $1.
- ☐ 30 – WORLD'S SMALLEST RECT. & zeners, 1W, assorted volts* ... $1.
- ☐ 4 – 2N4269 Nixie tube driver transistors 100V, npn ... $1.
- ☐ 2 – PUTS, prog. uni-transistors, similar to GE-D13T ... $1.
- ☐ 2 – 2N5296 35-WATT NPN PLASTIC TRANSISTORS, for NE-540 ... $1.
- ☐ 2 – 2N6109 40-WATT PNP PLASTIC TRANSISTORS, for NE540 ... $1.
- ☐ 2 – 2N3819, Texas, N channel, 6500 umho TO-18 ... $1.
- ☐ 3 – 2N2646 UNIJUNCTIONS, plastic transistors, Texas ... $1.
- ☐ 5 – 2N107, GE, most commonly used pnp, germanium ... $1.
- ☐ 50 – SILICON, glass rectifiers, computer, axial leads ... $1.
- ☐ 50 – GERMANIUM, glass rectifiers, signal, axial leads* ... $1.
- ☐ 5 – 2N170, GE, RF, germanium, npn, transistors, TO-22 ... $1.
- ☐ 6 – 1-AMP 1000 PIV, epoxy, submini, silicon rectifiers ... $1.
- ☐ 30 – 500MW ZENERS, axial 4, 6, 9, 10, 12V rectifiers ... $1.
- ☐ 4 – 2N3055, HOBBY, 40W npn silicon transistors, TO-3 ... $1.
- ☐ 30 – 3-AMP RECTIFIERS, silicon, epoxy, assorted V, axial* ... $1.

- ☐ 1 — PHOTO TRANSISTOR, with darlington amp filter, lens ... $1
- ☐ 2 — PHOTO TRANSISTORS, with darlington amp, 2N5777, GE ... $1
- ☐ 4 — PHOTO CELLS, Clairex, pancake, 30K-70 ohms ... $1

- ☐ 4 – 1000 HFE DARLINGTON Transistors, TO-18 case ... $1.
- ☐ 1 – 2N5036 HI-PWR plastic trans 100 veeo, 7 amp 85 watts ... $1.
- ☐ 4 – 2N5296 HOBBY, 35 watts, plastic powers, NPN ... $1.
- ☐ 4 – 2N6109 HOBBY, 40 watts, plastic powers, PNP ... $1.
- ☐ 5 – PLASTIC 35W powers, npn, silicon, hobby 2N6121 ... $1.
- ☐ 5 – PLASTIC 35W powers, pnp, silicon, hobby 2N6124 ... $1.
- ☐ 2 – MOS FETS, N channel 10K umos 3N128, TO-18, RCA ... $1.
- ☐ 2 – MOS FETS, DUAL GATE, N chan, 3N187, TO-18, RCA ... $1.
- ☐ 2 – MOS FETS, DUAL GATE, N chan, 3N140, TO-18, RCA ... $1.
- ☐ 4 – RCA 2N3600 NPN, UHF transistors, tv-fm, TO-18, 1000mc ... $1.
- ☐ 1 – 300V PLASTIC POWER TAB transistors, 6W ... $1.
- ☐ 10– TO-5 Case 536, 540, 565, 567, 741* ... $1.

*Untested, guaranteed satisfaction

## "EYE C" SPECIAL EKONOMY BARGAINS!

- ☐ 5-MOS REGISTERS, 5013-17, mini dips, no-test ... $1.
- ☐ 5-MOS REGISTERS, 501-6, etc., TO-5, no-test ... $1.
- ☐ 5 – SN7441N, hobby, BCD-to-Nixie driver IC, DIP* ... $1.
- ☐ 10 – LINEAR AMPS, 709, 710, 711, 741, TO-5 ... $1.
- ☐ 10 – 709 LINEAR AMPS, 741's too, DIP'S* ... $1.
- ☐ 5 – HOBBY MEMORY CELLS, SN7481, up to 16-cell, DIP* ... $1.
- ☐ 10 – RCA CA-3000 OP AMPS, TO-5 case* ... $1.
- ☐ 5 – 723 VOLTAGE REGULATORS, TO-5* ... $1.
- ☐ 4 – PHASE LOCK LOOPS, hobby 565, 560, 561* ... $1.
- ☐ 10 – MINI DIPS phase lock loops, 709, 741, 301, 307, hobby* ... $1.
- ☐ 2 – VOLTAGE REGULATORS, LM309K, hobby, TO-3* ... $1.
- ☐ 10 - SIGNETIC OP AMP, 531, 533, 536, 550, 555, DIPs, TO-5* ... $1
- ☐ 1 - 5311-14 CLOCK ON A CHIP, 4-or-6 digit, 24-or-28-pin* ... $1
- ☐ 1 - CALCULATOR ON A CHIP, hobby, exp. 40-pin, specs* ... $1
- ☐ 4 - DECADE COUNTER, hobby special, SN7490, DIP pak* ... $1
- ☐ 1 - 2516 CHARACTER GENERATORS, hobby, for MAN 2* ... $1
- ☐ 1 - 2513 CHARACTER GENERATOR, Hobby for MAN-2 ... $1
- ☐ 10 - 555 HOBBY TIMER special, in the mini DIP paks* ... $1
- ☐ 10 - NATIONAL 301 and 307 HOBBY OP AMP SPECIAL TO5* ... $1
- ☐ 15 - NATIONAL & SIGNETIC TTL dip special, all marked* ... $1

*Untested, guaranteed satisfaction

## SUPER ECONOMY $1 PARTS "DOLLAR STRETCHERS"

- ☐ 10 —SLIDE SWITCHES, SPDT, DPST, DPDT, 115/1/60, 3A ... $1
- ☐ 30 —ALLEN BRADLEY MICRO MINI 1/8 watt resistors, asst. ... $1
- ☐ 1 —VU METER, 0 to 20, for checking decibels, 1" ... $1
- ☐ 1 —BALANCING METER for 8-track recorders, 1" ... $1
- ☐ 30 – POWER RESISTORS, 3-to-25m, square, vitreous, asst. vals. ... $1.
- ☐ 10 – MICRO REED SWITCHES, 1" long, transistor work ... $1.
- ☐ 1 – $25. SURPRISE PAK, resistors, caps, transistors, etc. ... $1.
- ☐ 50 – TERMINAL STRIPS, 1-to-8 screw & tie lugs ... $1.
- ☐ 30 – SQUARE DISCS, 85mmf, to 01mf, space-savers ... $1.
- ☐ 75 – PRE-FORMED DISCS, condensers, printed circuit ... $1.
- ☐ 60 – TUBE SOCKETS, receptacles, plugs, audio, etc. ... $1.
- ☐ 100 – PREFORMED RESISTORS, 1/2 watt, printed circuit ... $1.
- ☐ 50 – COILS & CHOKES, if, rf, ant, peaks, osc, parasitic ... $1.
- ☐ 60 – PRECISION RESISTORS, 1/8, 1/2, 1 & 2w, 1% asst. vals. ... $1.
- ☐ 60 – TUBULAR CONDENSERS, to .5mf, to 1kv, molded too ... $1.
- ☐ 30 – POLYSTYRENE CONDS, finest caps made, asst. values ... $1.
- ☐ 10 – PANEL SWITCHES, 110VAC, micro, rotary, thermal, slide ... $1.
- ☐ 10 – VOLUME CONTROLS, to 1 meg, duals too, some w/switch ... $1.
- ☐ 40 – MICRO MINI RESISTORS, 1/8w, 100 ohm to 1 meg, 5% ... $1.
- ☐ 40 – MICRO-MICRO-MINI CONDENSERS, to .05mf cerafil ... $1.
- ☐ 5 – IBM COMPUTER BOARDS, trans, caps, res, coils, etc. ... $1.
- ☐ 10 – ELECTROLYTIC COND's, FP's, & tubular, 2 & 3 sect. too ... $1.
- ☐ 6 – TRIMMER POTS, 100, 500, 2K, 5K, 10K, 25K, 1/8w, snap-in ... $1.
- ☐ 4 – MICRO POTS w/knob, snap-in, 1/5w, 25k, 50k, 100k, 1 meg ... $1.
- ☐ 30 – YELLOW PACKET MYLARS, assorted values & sizes ... $1.
- ☐ 10 – POWER TRANSISTOR SOCKETS, for TO-3, asst. types ... $1.
- ☐ 64 – PLASTIC TRANSISTORS TO-18, printed circuit ... $1.

## Lowest Prices — Largest Selection TTL IC's

Buy 3 or more, 10% discount

Brand New • "DIP" Packages Order by type number! Spec sheets on request "ONLY"

Money Back Guarantee — Buy 100 — Take 20%

| Type | Sale | Type | Sale | Type | Sale | Type | Sale |
|---|---|---|---|---|---|---|---|
| ☐ SN7400 | $0.30 | ☐ SN7438 | .60 | ☐ SN7481 | 1.50 | ☐ SN74145 | 1.40 |
| ☐ SN7401 | .30 | ☐ SN7440 | .30 | ☐ SN7482 | .95 | ☐ SN74151 | 1.25 |
| ☐ SN7402 | .30 | ☐ SN7441 | 1.40 | ☐ SN7483 | 1.50 | ☐ SN74153 | 1.60 |
| ☐ SN7403 | .30 | ☐ SN7442 | 1.25 | ☐ SN7485 | 1.41 | ☐ SN74154 | 2.10 |
| ☐ SN7404 | .35 | ☐ SN7443 | 1.35 | ☐ SN7486 | .55 | ☐ SN74155 | 1.55 |
| ☐ SN7405 | .32 | ☐ SN7444 | 1.35 | ☐ SN7489 | 3.75 | ☐ SN74156 | 1.55 |
| ☐ SN7406 | .55 | ☐ SN7445 | 1.35 | ☐ SN7490 | 1.50 | ☐ SN74157 | 1.55 |
| ☐ SN7407 | .55 | ☐ SN7446 | 1.65 | ☐ SN7491 | 1.50 | ☐ SN74158 | 1.55 |
| ☐ SN7408 | .35 | ☐ SN7447 | 1.65 | ☐ SN7492 | 1.10 | ☐ SN74160 | 1.95 |
| ☐ SN7409 | .35 | ☐ SN7448 | 1.50 | ☐ SN7493 | 1.10 | ☐ SN74161 | 1.95 |
| ☐ SN7410 | .30 | ☐ SN7450 | .35 | ☐ SN7494 | 1.10 | ☐ SN74162 | 1.95 |
| ☐ SN7411 | .35 | ☐ SN7451 | .35 | ☐ SN7495 | 1.10 | ☐ SN74163 | 1.95 |
| ☐ SN7413 | .95 | ☐ SN7453 | .35 | ☐ SN7496 | 1.10 | ☐ SN74164 | 3.50 |
| ☐ SN7415 | .55 | ☐ SN7454 | .50 | ☐ SN74100 | 1.49 | ☐ SN74165 | 3.50 |
| ☐ SN7416 | .55 | ☐ SN7455 | .35 | ☐ SN74104 | .55 | ☐ SN74180 | 1.20 |
| ☐ SN7417 | .55 | ☐ SN7460 | .35 | ☐ SN74105 | .55 | ☐ SN74181 | 4.50 |
| ☐ SN7420 | .30 | ☐ SN7464 | .50 | ☐ SN74106 | 1.25 | ☐ SN74182 | 1.20 |
| ☐ SN7421 | .35 | ☐ SN7465 | .50 | ☐ SN74107 | .60 | ☐ SN74184 | 2.50 |
| ☐ SN7422 | .35 | ☐ SN7470 | .50 | ☐ SN74108 | 1.25 | ☐ SN74185 | 2.50 |
| ☐ SN7426 | .37 | ☐ SN7472 | .50 | ☐ SN74112 | 1.25 | ☐ SN74192 | 1.95 |
| ☐ SN7430 | .30 | ☐ SN7473 | .65 | ☐ SN74113 | 1.25 | ☐ SN74193 | 1.95 |
| ☐ SN7432 | .30 | ☐ SN7474 | .65 | ☐ SN74114 | 1.25 | ☐ SN74194 | 1.95 |
| ☐ SN7437 | .60 | ☐ SN7475 | 1.30 | ☐ SN74121 | .70 | ☐ SN74195 | 1.35 |
| | | ☐ SN7476 | .75 | ☐ SN74122 | .75 | ☐ SN74198 | 2.65 |
| | | ☐ SN7478 | .95 | ☐ SN74123 | 1.20 | ☐ SN74199 | 2.65 |
| | | ☐ SN7480 | .75 | ☐ SN74140 | .50 | ☐ SN74200 | 9.99 |

• Factory Marked!

## KRONOS $47.

With Cabinet

**'TIME STANDARD' CHRONOMETER**

Designed by our Scientific Device engineers as the most advanced digital timing device in the consumer "time" field. One radio-and-TV station engineer tells us, "Not a change of a second in 3 months." It is so accurate we use it as our standard. KRONOS KR100 Series, in the new sleek all-purpose walnut-and-black modern design cabinet, enhances any office, home, den, etc. It becomes a "visible-action conversation piece" wherever it is placed. Has modern LSI National Clock Chip, and 8-page brochure chock-full with pictorials and easy-to-understand, step-by-step instructions. This kit is COMPUTER SIMPLIFIED making do-it-yourself easy! Other features include 3 setting controls, 1 hour per second, 1 minute per second, and hold button. Easy-to-change from 12 to 24 hours, 4 to 6 digits, 50 to 60 hz operation. Your choice of different type readout systems: ☐ MAN-3 Type LED, ☐ MAN-1 Type LED (the larger character size), ☐ MAN-1 Type LED, ☐ 7-Segment Nixie Type Tubes. Kit includes POLAROID filter.

Size of cabinet: 6" x 5¼" x 6" deep

- ☐ KR101 7-Segment MAN-3 Type LED, 6 Digits ... $47.00
- ☐ KR102 7-Segment MAN-1 Type LED, 6 Digits ... $69.95
- ☐ KR103 7-Segment MAN-1 Type LED, 6 Digits ... $57.00
- ☐ KR104 7-Segment Nixie Type Tubes ... $47.00

Buy 3 — Take 10%

## PHILCO 11 TRANSISTOR AM RADIO CHASSIS

Use as:
- Mike amplifier
- Phone amplifier
- Tape amplifier

☐ Only **$5.95**

One of the most versatile AM Radio and multi-purpose amplifiers we have seen at Poly Paks famous "Economy" price. Measures only 4½" x 3" x 2" high. With tuning capacitor, IF circuitry, loopstick, ant., volume control with switch, AC and phono-mike jacks. Separate switch for changing from AM radio to amplifier. Uses either 110V plug-in adapter (not with unit) and a 9-volt battery power. Exceptional sensitivity and power. Feeds into 16 ohm speaker. Complete with spec sheets, diagrams, and hookup ideas. AC or DC

## AC-DC CHARGER-CONVERTER —

☐ Only $1.98

Converts 11-and-8-transistor chassis from 9VDC to 110VAC. Easy to hook in. Use as "NICAD" battery charger too (with instructions). Size: 2"x1¼"x1¼". 1-lb.

5-ounce ceramic, cylindrical magnet. Twin voice, coil, 4 and 8 ohms. 50-16,000 cycles. Shpg. wt. 3 lbs.

5-IN. "HI-FI" PM SPEAKER ☐ Only $1.98

## 8 TRANSISTOR AMPLIFIER CHASSIS

Shpg. wt. 1-lb.

☐ Only **$3.95**

Same as above, except no AM radio section. Completely wired! With built-in preamp, mike, phono and tape inputs. Color-coded wires with diagram and hookups. Works off 9VDC transistor battery. Excellent fidelity.

## LINEAR Op Amps

• FACTORY GUARANTEED — FACTORY TESTED — • FACTORY MARKED

Buy Any 3 PAKS — Take 10% Discount

| | | |
|---|---|---|
| ☐ 531 | Hi slew rate op-amp (TO-5) | $2.50 |
| ☐ 532 | Micro power 741 (TO-5) | 2.50 |
| ☐ 533 | Micro power 709 (TO-5) | 2.50 |
| ☐ 536 | FET input op amp (TO-5) | 3.95 |
| ☐ 537 | Precision 741 (TO-5) | 2.50 |
| ☐ 540 | 70W pwr driver amp (TO-5) | 2.50 |
| ☐ 550 | Precision 723 voltage reg. (DIP) | 1.17 |
| ☐ 555 | Timer 2 uSeconds to 1-hr (A) | 1.00 |
| ☐ 556 | 5 Times faster than 741C | 2.10 |
| ☐ 558 | Dual 741 (mini DIP) | 1.00 |
| ☐ 560 | Phase lock loops (DIP) | 3.25 |
| ☐ 561 | Phase lock loops (DIP) | 3.25 |
| ☐ 562 | Phase lock loops (DIP) | 3.25 |
| ☐ 565 | Phase lock loops (A) | 3.25 |
| ☐ 566 | Function generator (A) | 3.25 |
| ☐ 567 | Tone generator (A) | 3.25 |
| ☐ 595 | Four quadrant multiplier | 3.10 |
| ☐ 702C | Hi-grain, DC amp (TO-5) | .49 |
| ☐ 703C | RF-IF, amp, 14 ckts (TO-5) | 1.00 |
| ☐ 709C | Operational amp (A) | .49 |
| ☐ 709CV | Op amp (mini DIP) | .49 |
| ☐ 710C | Differential amp (A) | .49 |
| ☐ 711C | Dual diff. comp (A) | .49 |
| ☐ 723C | Voltage regulator (A) | .95 |
| ☐ 733 | Diff. Video Amp | 1.75 |
| ☐ 741C | Frequency compensator 709 (A) | .49 |
| ☐ 741CV | Freq. comp 709 (Mini DIP) | .49 |
| ☐ 747C | Dual 741C (A) | 1.25 |
| ☐ 748C | Freq. adj. 741C (A) | .49 |
| ☐ 748CV | Freq. adj. 741C (mini DIP) | .49 |
| ☐ 753 | Gain Block | 1.75 |
| ☐ 709-709 | Dual 709C (DIP) | 1.00 |
| ☐ 739-739 | Dual stereo preamp | 1.98 |
| ☐ 741-741 | Dual 741C (A) | 1.00 |
| ☐ CA3065 | Video Audio system | 1.50 |

(A) TO-5 or DIP dual in line pak

## NATIONAL 'OP' AMPS

BUY ANY 3 — TAKE 10%

| Type | Description | Sale |
|---|---|---|
| ☐ LM-300 | Super 723 V. reg. | $1.49 |
| ☐ LM-301 | Hi-performance amp | .49 |
| ☐ LM-302 | Voltage follower | 1.49 |
| ☐ LM-304 | Neg. V. reg. | 1.49 |
| ☐ LM-305 | Pos. V. reg. | 1.49 |
| ☐ LM-307 | Super 741 | .59 |
| ☐ LM-308 | Super gain op amp | 1.50 |
| ☐ LM-309H | 5V 200 mil V. reg. | 1.50 |
| ☐ LM-309K | 5V 1-amp V. reg.* | 2.25 |
| ☐ LM-311 | Comparator | 1.50 |
| ☐ LM-320 | Minus 5V 1-amp V.R.* | 2.95 |
| ☐ LM-320 | Minus 12V 1-amp V.R.* | 2.95 |
| ☐ LM-320 | Minus 15V 1-amp V.R.* | 2.95 |
| ☐ LM-350 | Dual peripheral driver | .59 |
| ☐ LM-370 | AGC squelch op amp | 1.49 |
| ☐ LM-371 | R-F, I-F, op amp | .69 |
| ☐ LM-380 | 2-watt audio amplifier | 1.95 |

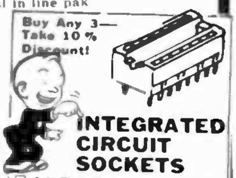
*TO-3 case, — others TO-5

## "How's Your MEMORIES For 1973"

| | | |
|---|---|---|
| ☐ 1101 | 256 Bit RAM MOS | $3.50 |
| ☐ 1103 | 1024 Bit RAM MOS | 8.50 |
| ☐ 2513 | Character Gen. ROM | 12.50 |
| ☐ 2516 | Character Gen. ROM | 12.50 |
| ☐ 7489 | 64 Bit RAM TTL | 3.50 |
| ☐ 8223 | Programmable ROM | 7.95 |

## INTEGRATED CIRCUIT SOCKETS

Buy Any 3— Take 10% Discount!



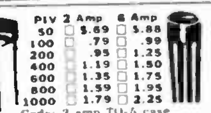
- ☐ 14-Pin, DIP ... $.45
- ☐ 14-Pin, Wire Wrap ... .59
- ☐ 14-Pin, Side Mount ... 1.00
- ☐ 16-Pin, DIP ... .50
- ☐ 16-Pin, Wire Wrap ... .59
- ☐ TO-5, 8 or 10-Pins ... .29

## LOWEST PRICES EPOXY SILICON RECTIFIERS

*microminiature

| PIV | 2Amp* | 2Amp | 3Amp |
|---|---|---|---|
| 50 | ☐ $.05 | ☐ $.05 | ☐ $.08 |
| 100 | ☐ .06 | ☐ .06 | ☐ .12 |
| 200 | ☐ .07 | ☐ .07 | ☐ .15 |
| 400 | ☐ .09 | ☐ .09 | ☐ .22 |
| 600 | ☐ .12 | ☐ .12 | ☐ .28 |
| 800 | ☐ .15 | ☐ .15 | ☐ .39 |
| 1000 | ☐ .18 | ☐ .18 | ☐ .45 |

## EPOXY FULL WAVE SILICON BRIDGE RECTIFIERS



| PIV | 2 Amp | 6 Amp |
|---|---|---|
| 50 | ☐ $.69 | ☐ $.88 |
| 100 | ☐ .79 | ☐ .99 |
| 200 | ☐ .95 | ☐ 1.25 |
| 400 | ☐ 1.19 | ☐ 1.50 |
| 600 | ☐ 1.35 | ☐ 1.75 |
| 800 | ☐ 1.59 | ☐ 1.95 |
| 1000 | ☐ 1.79 | ☐ 2.25 |

Code: 2 amp TO-5 case; 6 Amp ½ x ½ x 3/16 sq

Terms: add postage Rated: net 30
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield, Mass. (off Water Street) C.O.D.'S MAY BE PHONED

☐ 15¢ CATALOG on Fiber Optics, 'ICs', Semi's, Parts

**POLY PAKS**

P.O. BOX 942R, LYNNFIELD, MASS. 01940

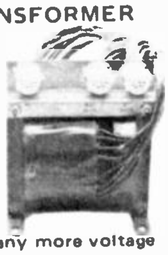
*Circle 94 on reader service card*

# ADVERTISING INDEX

**RADIO ELECTRONICS does not assume responsibility for any errors which may appear in the index below.**


| READER SERVICE CARD NO. | | PAGE |
|---|---|---|
| 21 | Arrow Fastener Co., Inc. | 82 |
| | Bell & Howell Schools | 46-49 |
| 14 | B & K, Division of Dynascan Corp. | 32 |
| 69 | Brooks Radio & TV Corp. | 97 |
| 1 | Castle TV Tuner Service, Inc. | Cover II |
| 19 | Channellock Inc. | 80 |
| 72 | Chapman Manufacturing Co., Inc. | 99 |
| 15 | Cleveland Institute of Electronics | 36-39 |
| | CREI, Division of the McGraw-Hill Continuing Education Co. | 18-21 |
| 12 | Crown International | 30 |
| 7 | Delta Products, Inc. | 16 |
| 74 | Edmund Scientific Co. | 110 |
| 65 | EICO, Electronic Instrument Co. | 92 |
| 29 | Electronic Chemical | 88 |
| 77 | Electronic Distributors, Inc. | 103 |
| | EMC, Electronic Measurements Corp. | 99 |
| 68 | E & L Instruments Inc. | 96 |
| 28 | Enterprise Development Corp. | 88 |
| 83-84 | Finney Company | 101 |
| 26 | Fordham Radio Supply Co. | 86 |
| 67 | GC Electronics | 95 |
| 64 | Grantham School of Electronics | 91 |
| | GTE Sylvania Electronic Components | 25 |
| | GTE Sylvania Electronic Components | 83 |
| 100 | Heath Co. | 26-27 |
| 24 | Hug Electronics | 86 |
| 16 | ICS School of Electronics | 74-77 |
| 62 | Indiana Home Study Institute | 89 |
| 11 | International Components Corp. | 98 |
| 17 | International Crystal Mfg. Co. | 78 |
| 18 | Jerrold Electronics | 79 |
| 81 | Kay-Townes, Inc. | 22 |
| 88 | Lafayette Electronics | 93-94 |
| 13 | Leader | 31 |
| 87 | Lectrotech, Inc. | 100 |
| 22 | National Camera Co. | 82 |
| | National Radio Institute | 8-11 |
| | National Technical Schools | 56-59 |
| 5 | Olson Electronics | 13 |
| 30 | Oneida Electronic Mfg. Co., Inc. | 100 |
| | Panasonic-Parts Division | 15 |
| | Panasonic HI-FI | Cover IV |
| 23 | PTS Electronics, Inc. | 85 |
| 71 | Quietrole Co. | 98 |
| | RCA Electronic Components Semiconductors | 28 |
| 80 | RCA Parts & Accessories | 7 |
| 73 | Rectifier Components Corp. | 102 |
| 66 | Rye Industries, Inc. | 92 |
| 2 | Sams & Co., Howard W. | 1 |
| 75 | Sansui | Cover III |
| 25 | Schober Organ | 86 |
| 3 | Shure Bros. | 2 |
| 9 | Sony Corp. of America | 23 |
| 20 | Southwest Technical Products | 81 |
| 10 | Sprague | 24 |
| 27 | Tab Books | 87 |
| 82 | Tektronix, Inc. | 29 |
| 63 | Telematic | 90 |
| 61 | Tri-Star Corp. | 89 |
| 4 | Tuner Service Corp. | 5 |
| 76 | TV Tech Aids | 103 |
| | M. Weinschenker Elec. | 103 |
| 8 | Winegard | 17 |
| 6 | Xcelite Inc. | 14 |
| | **MARKET CENTER** | |
| | ATV Research Corp. | 104 |
| 89 | Babylon Electronics | 104 |
| | Barta | 104 |
| | Command Productions | 104 |
| | Cornell Electronics | 106 |
| 90 | Delta Electronics | 109 |
| 91 | Digi-Key | 109 |
| | Gateway Electronics | 104 |
| | Instant Instruments Inc. | 106 |
| 92 | International Electronics Unlimited | 106 |
| | Lakeside Industries | 104 |
| | Logic Newsletter | 106 |
| | Lesco Electronics | 108 |
| 93 | Meshna Electronics, John Jr. | 109 |
| 94 | Polypaks | 105 |
| 94 | Polypaks | 107 |
| | Solid State Sales | 108 |
| | Sollee Enterprises | 108 |
| | Yeats Appliance Dolly Sales Co. | 104 |
| | **SCHOOL DIRECTORY** | |
| | Valparaiso Technical Institute | 106 |

## MULTIPLE VOLTAGE REGULATED TRANSFORMER



7 voltages, 15V @10A. 36 V. @ 5A. 10 V. @ 5 A., 20V @2A. ct., 36 V @5 A., 42 V. @ 5A., 36 V. @4A.Resonant primary regulated.(no change in output voltage for up to 20% change in primary.).5¼"x4¾"x6". Complete with regulating capacitor and data for many more voltage combinations. Wt. 20 lbs.

STOCK NO.F9584 12.50 ea. 2/22.00

## 5 VOLT, 1 AMP. REGULATED POWER SUPPLY KIT

Consists of line cord, pilot light, on-off switch, bridge rectifier, filter, fuse holder transformer, LM309 5 volt regulator,and complete instructions. Transformer has additional winding for NIXIE type read-out tubes.Ideal for all TTL circuits.

STOCK NO.J5097 9.50 ea. 3 kits, 25.00

**G.E. FLUORESCENT READOUT TUBE**

G.E. Y4075 7 segment fluorescent vacuum tube. Operates with 1.2 volts AC or DC on filament, 25 to 55 volts on anodes. Flying leads, mounts on PC board, or TO-5 IC socket. All digits and right hand decimal point. .375" dia. x 1⅝". 10 pages of applications & data.

Stock No. F5026 1.95 ea. 6/11.00

Include sufficient postage, excess refunded. Send for new 56 page catalog, loaded with bargains. MINIMUM ORDER $3.00

**DELTA ELECTRONICS CO.**
BOX 1, LYNN, MASSACHUSETTS 01903
Phone (617)388-4705

*Circle 90 on reader service card*

**FREE catalog** Electronic Parts Bargains, **JK PRODUCTS** P.O. Box 527-R Norris Tennessee 37828

**JAPANESE transistors,** Wholesale Prices, Free Catalog. **WEST PACIFIC ELECTRONICS,** Box 25837, W. Los Angeles, Calif. 90025

**PRINTED circuits made. REED ENGINEERING** 1140 N. Lemon Orange Calif. 92667

**MANUALS** for Govt. surplus radios, test sets, scopes. List 50¢. **BOOKS,** 7218 Roanne Drive. Washington, D.C. 20021

## TUBES

**RECEIVING** a industrial tubes, transistors. All Brands—Biggest Discounts. Technicians, Hobbyists, Experimenters—Request free Giant Catalog and save **ZALYTRON,** 469 Jericho Turnpike, Mineola, NY 11501

**RADIO** & TV Tubes 36¢ each. One year guaranteed. Plus many unusual electronic bargains. Free Catalog. **CORNELL** 4217-E University, San Diego, CA 92105

**75%-80%** Discount. Surplus Receiving, Industrial, Military, Obsolete. Free List. **A&G ELECTRONICS** 10062 Cunningham, Westminster, Calif. 92686

**SAVE** money on parts and transmitting-receiving tubes, foreign-domestic. Send 25¢ for Giant Catalog. Refunded first order. **UNITED RADIO COMPANY,** 56-R Ferry Street, Newark, NJ 07105

## PLANS & KITS

**FREE** catalog. Most unusual electronic kits available. Music accessories, Surf, Wind Synthesizers, Wind Chimes, many others. **PAIA ELECTRONICS,** Box 14359, Oklahoma City, OK 73114

**P.C.** Board Design, Layout, and Fabrication. Instrument Design. For quote send requirements to **DERCO** 55 Industrial Road, Berkeley Heights, N.J. 07922

**ELECTRONIC garage door opener.** Complete building plan, installation details $2. **AUTOMATIC DOOR CONTROL** Box 114 Roslyn Heights, New York 11577

**DIGITAL speedometer** with numeric readout Plans $7.50 **KIMTRON,** Box 80134, Chamblee, Georgia 30341

**BUILD** your own **telephone answering service.** Detailed plans $3.90. **TONSCOPE-C** 400 Third Ave Satellite Beach Fla 32937

**RADIO**-Television Diagrams, Service Information. Give description, request quotation. **BEITMAN,** 1760 Balsam, Highland Park, Illinois 60035

**ELECTRONIC** combination lock solid state plans, $2.00, kit $29.95 **RICHARD MEUSE,** 9 Appleton Terr, Everett, Mass. 02149

**DIGITAL** Tachometer Kit $49.95 **KEL-TRONICS** Box 1623, Cedar Rapids, Iowa 52406

## FIGHT CANCER WITH A CHECKUP AND A CHECK

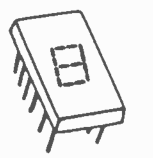
**AMERICAN CANCER SOCIETY**

## 15 AMP CHARGER KIT

Brand new GE transformer with solid state rectifier. Assembled in minutes and ready to charge any 12 volt battery up to 15 amps.
— #PK-4 $7.50

## POWER AMP TRANSFORMER

115 VAC Input. Output 70 VCT at 3 amps. Makes a mignificent power amp.
#73S-43 $7.50



7 Segment LED display, similar to MAN-1 $3.50
7 Segment LED display, similar to MAN-3 2.00
7 Segment LED display, similar to MAN-4 3.50
LED (red) 3 for $1.00 **
LM 309K $2.00
PA234 1 watt audio amp $1.25
PA264 5 watt up to 25 volt regulator 1.25
PA265 5 watt up to 37 volt regulator 1.50
GE THYRECTOR 20 amp peak, 30 volt surge protector 5/$1.00
709 OP AMP TO-5 3/$1.00
DUAL 709 OP AMP .75

## HOW'S YOUR MEMORY

RCA MEMORY STACK ultra compact 32x32x9 $50.00
MEMORY STACK 32x32x16x9 frames 100.00
SINGLE PLANE 64x64 10.00
SINGLE PLANE 32x32x16 15.00

## AM-FM RADIO $5.50

Fully built, with AC supply, no cabinet, no speaker. Send for free catalog. Postage extra on above items.

MESHNA PO Bx 62,
E. Lynn, Mass. 01904

*Circle 93 on reader service card*

# IC PRICES SLASHED

**FACTORY FIRSTS**
NATIONALLY KNOWN BRANDS
SATISFACTION GUARANTEED

## DIGITAL TTL

| ITEM | 1-99 | 100-999* | ITEM | 1-99 | 100-999* |
|---|---|---|---|---|---|
| 7400N | 32¢ | 28¢ | 7472N | 40¢ | 35¢ |
| 7401N | 32¢ | 28¢ | 7473N | 52¢ | 45¢ |
| 7402N | 32¢ | 28¢ | 7474N | 52¢ | 45¢ |
| 7403N | 32¢ | 28¢ | 7475N | $1.00 | 85¢ |
| 7404N | 35¢ | 31¢ | 7476N | 60¢ | 55¢ |
| 7410N | 32¢ | 28¢ | 7487N | 60¢ | 55¢ |
| 7420N | 32¢ | 28¢ | 7490N | $1.00 | 85¢ |
| 7430N | 32¢ | 28¢ | 7492N | $1.00 | 85¢ |
| 7440N | 32¢ | 28¢ | 7493N | $1.00 | 85¢ |
| 7441N | $1.75 | $1.45 | 7495N | $1.30 | $1.15 |
| 7442N | $1.35 | $1.15 | 74107N | 55¢ | 50¢ |
| 7447N | $1.30 | $1.10 | 74121N | 70¢ | 60¢ |

*MIXED TTL PRICES

## LINEAR INTEGRATED CIRCUITS

| | | | |
|---|---|---|---|
| 709C MINIDIP | 60¢ | 10/$ 5.50 | 100/$ 51 |
| 723C DIP | $1.15 | 10/$11.50 | 100/$100 |
| 741C MINIDIP | 75¢ | 10/$ 7.00 | 100/$ 66 |
| 748C MINIDIP | 80¢ | 10/$ 7.50 | 100/$ 70 |
| 558C MINIDIP | $1.25 | 10/$12.00 | 100/$110 |
| NE565A DIP | $3.57 | 10/$30.00 | |
| LM309K TO-3 | $2.50 | 5/$11.25 | |

## GENERAL PURPOSE SILICON TRANSISTORS

| | | | | |
|---|---|---|---|---|
| 2N3638 | PNP | 20¢ | 10/$1.65 | 100/$15.00 |
| 2N3638A | PNP | 22¢ | 10/$1.80 | 100/$16.50 |
| 2N3641 | NPN | 23¢ | 10/$2.00 | 100/$17.50 |
| 2N3643 | NPN | 23¢ | 10/$2.00 | 100/$17.50 |
| 2N5133 | NPN | 15¢ | 10/$1.25 | 100/$10.00 |
| 2N5134 | NPN | 15¢ | 10/$1.25 | 100/$10.00 |
| 2N5137 | NPN | 18¢ | 10/$1.50 | 100/$13.65 |
| 2N5138 | PNP | 15¢ | 10/$1.25 | 100/$10.00 |
| 2N5139 | PNP | 15¢ | 10/$1.25 | 100/$10.00 |
| 2N3055 | NPN | $1 | 10/$9.50 | 100/$86.25 |

## 1 AMP SILICON RECTIFIERS

| | | | | |
|---|---|---|---|---|
| 1N4001 | 50PIV | 12/$1 | 100/$6 | 1M/$49 |
| 1N4002 | 100PIV | 11/$1 | 100/$6 | 1M/$51 |
| 1N4003 | 200PIV | 10/$1 | 100/$7 | 1M/$53 |
| 1N4004 | 400PIV | 10/$1 | 100/$8 | 1M/$55 |
| 1N4005 | 600PIV | 9/$1 | 100/$8 | 1M/$61 |
| 1N4006 | 800PIV | 7/$1 | 100/$9 | 1M/$75 |
| 1N4006 | 1000PIV | 6/$1 | 100/$10 | 1M/$83 |

## SILICON SIGNAL DIODES

1N4148 (1N914 equiv.) 20/$1 100/$4.50 1M/$35

## INTEGRATED CIRCUIT SOCKETS

14 PIN DIP SOLDER TYPE ........45¢
16 PIN DIP SOLDER TYPE ........50¢
14 PIN WIRE WRAP TYPE ........55¢
16 PIN WIRE WRAP TYPE ........60¢

## MOLEX IC SOCKET PINS

100/$1.00 200/$1.80 300/$2.60 500/$4.20 700/$5.80 1000/$8.20 ea addn 1000/$7.50

## DISPLAY DEVICES

5 VOLT 7 SEGMENT TUBE ........$3.75
DISPLAY KIT (TUBE+7447+7475+7490) $6.15 3/$17.50
7 SEGMENT LED (MAN-1 TYPE) ........$4.00
DISPLAY KIT (LED+7447+7475+7490+RESISTORS) ........$6.40 3/$18.25

## ¼ & ½ WATT 10% RESISTORS

¼W 5¢ 30/$1.20, 100/$3.00, 500/$13.75 as low as 1.7¢ ea in quantity-see catalog
½W 4¢ 30/90¢, 100/$2.50, 500/$11.25 as low as 1¢ ea in quantity-see catalog

COD orders accepted for same day shipment. Call 218 681 6674.

*Free Catalog—Large Quantity Discounts—Orders Less Than $10.00 Add 25¢—Others Postpaid*

**DIGI-KEY** PRICE PACESETTER FOR QUALITY IC'S
BOX 126H THIEF RIVER FALLS, MN56701

*Circle 91 on reader service card*

# LIVE IN THE WORLD OF TOMORROW...TODAY!

## A BETTER LIFE STARTS HERE

(And our FREE CATALOG is packed with exciting and unusual ecological & physical science items—plus 4,000 finds for fun, study or profit . . . for every member of the family.)

## 3-CHANNEL COLOR ORGAN KIT

Easy to build low-cost kit needs no technical knowledge. Completed unit has 3 bands of audio frequencies to modulate 3 independent strings of colored lamps (i.e. "lows"-reds, "middles"-greens, "highs"-blues. Just connect hi-fi, radio, power lamp etc. & plug ea. lamp string into own channel (max. 300w ea.). Kit features 3 neon indicators, color intensity controls, controlled individ SCR circuits; isolation transformer; custom plastic housing; instr.

Stock No. 41,831EH ........... $15.75 Ppd.

## LEARN POINTS OF ACUPUNCTURE

Ancient Chinese healing art made simple! Theory based on body's life energy flowing thru sub-skin meridians with vital points. Big 22 x 35" two-color chart vividly shows all the 14 meridians and their 500 to 800 points that acupuncturists must learn to pierce for healing and pain removal. Back, front & side views of body labeled with meridian descriptions; types of needles, complete bibliography. Heavy grey paper.

Stock No. 82,054EH ........................................ $2.95 Ppd.
10 OR MORE (SAME STOCK NO.) .............................. EA. $2.25 Ppd.

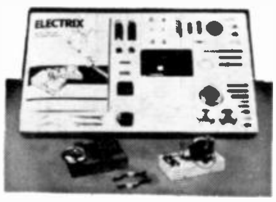
## KNOW YOUR ALPHA FROM THETA!

For greater relaxation, concentration, listen to your Alpha-Theta brainwaves. Ultra-sensitive electrode headband slips on/off in seconds—eliminates need for messy creams, etc. Atch'd to amplifier, filters brainwaves, signals beep for ea. Alpha or Theta wave passed. Monitoring button simulates Alpha sound; audio & visual (L.E.D.) feedback. Reliable, easy-to-use unit—comparable to costlier models. Completely safe. Comprehensive instruction booklet.

No. 1635EH (8x3x4"; 24 oz.) .. $124.50 Ppd.

## 140 ELECTRICAL EXPERIMENTS!

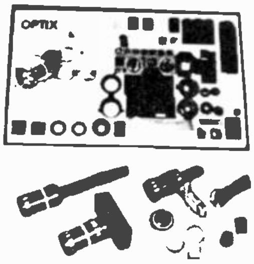
### SEE FEATURE ARTICLE IN JUNE ISSUE!



Explore the fun world of electricity, magnetism, telecommunications. Exciting new Electrix(R) Experiment Kit enables you to build a Morse code sender, receiving buzzer & printer; produce electricity with a real generator; assemble a working phone system; build an electric motor; 135 other projects. Illus. 112-pg. 8½ x 11" manual explains easy use of kit's 135 precision parts. Safety approved. Everything you need except 4 "C" cells.

Stock No. 71,647EH .... $17.95 Ppd.

## 130 EXPERIMENTS IN OPTICS . . .



and photography! Optix® Experiments Kit is a complete optical & photography lab for 130 exciting experiments. Lets you recreate the periscope, telescope, microscope, kaleidoscope! . . . Build a 35mm reflex camera with interchangeable lens system! Make, develop photographic film! Enjoy the fun and fascination of having your own optics lab. Fully illustrated 112-pg. manual, 8½"x11", clearly explains usage of this stimulating kit's 114 precision engineered components.

Stock No. 71,646EH ....... $21.00 Ppd.

## 3" ASTRONOMICAL TELESCOPE

See moon shots, orbits, stars, phases of Venus, planets close up. 60 to 180 power. New Improved, aluminized and overcoated 3" diameter f/10 primary mirror, ventilated cell. Equatorial mount with locks on both axes. Equipped with 60x eyepiece and mounted Barlow lens. 3x finder telescope, hardwood tripod. Included FREE: "STAR CHART", "HOW TO USE YOUR TELESCOPE" book.

Stock No. 85,050EH .......... $34.95 Ppd.
DELUXE 3" REFLECTOR TELESCOPE
Stock No. 80,162EH .......... $62.50 Ppd.
4¼" REFLECTOR TELESCOPE (45x to 270x)
Stock No. 85,105EH ....... $110.00 FOB
4¼" REFLECTOR TELESCOPE WITH CLOCK DRIVE Stock No. 85,107EH $145.00 FOB
6" REFLECTOR TELESCOPE Stock No. 85,187EH ................ $215.00 FOB
6" REFLECTOR W/(ELECTRIC) CLOCK DRIVE No. 85,086EH ......... $249.50 FOB

## MAIL COUPON FOR GIANT FREE CATALOG!

### 164 PAGES • MORE THAN 4,500 UNUSUAL BARGAINS!

Completely new '74 Catalog. Packed with huge selection of telescopes, microscopes, binoculars, magnets, magnifiers, prisms, photo components, ecology and Unique Lighting items, parts, kits, accessories — many hard-to-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 "EH"

Name____________________
Address____________________
City____________________
State______________Zip__________

## COMPLETE & MAIL WITH CHECK OR M.O.

EDMUND SCIENTIFIC CO.
300 Edscorp Building, Barrington, N.J. 08007

| How Many | Stock No. | Description | Price Each | Total |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

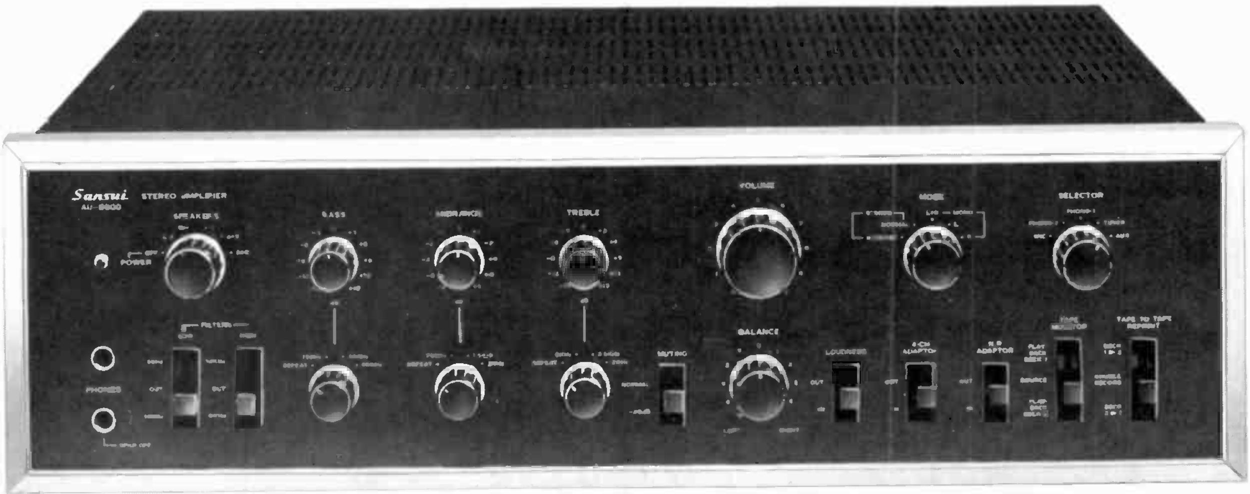
PLEASE SEND ☐ GIANT FREE CATALOG "EH"

MERCHANDISE TOTAL $
HANDLING CHARGE $1.00*
TOTAL $
*50¢ ON ORDERS OVER $5.00


I enclose ☐ check
☐ money order for $__________

NAME____________________
ADDRESS____________________
CITY______________STATE__________ZIP__________

*Circle 74 on reader service card*




# the Sansui AU9500: hottest-selling integrated amplifier in the field.

Here's the power amplifier that not only boasts 85 hefty watts per channel, but also boasts a host of other fantastic features. It's designed and made for people who want only the best—and are willing to pay for it. And, judging by the way the AU9500 is selling, there must be a lot of those folks around.

The new Sansui AU9500 is the most advanced stereo product we make. Its superior performance characteristics include total harmonic distortion and intermodulation distortion below 0.1% throughout the entire audio spectrum and well beyond. Power bandwidth is extremely wide (5-40,000Hz) and RMS true power, conservatively rated, is 85 watts per channel into 8 ohms.

Among the many exciting features of the AU9500 are a wide variety of conveniences, such as a 4-channel adaptor switch, for QS, SQ, or CD-4 add-on units, the ability to handle up to four tape decks, and provision for tape-to-tape dubbing. Triple tone controls allow even the fussiest listener to adjust the AU9500's response to his taste.

As eye-catching as it is functional, the AU9500's elegant front-panel styling is a standout in any audio display. And it has two counterparts, the AU7500 and AU6500, which offer many of the same features, the same quality engineering and manufacturing, but slightly less power. All three are powerful, quality units that are unequalled for fine high fidelity reproduction.

AU7500

AU6500

Sansui

**SANSUI ELECTRONICS CORP.**

Woodside, New York 11377 • Gardena, California 90247

SANSUI ELECTRIC CO., LTD., Tokyo, Japan • Sansui Audio Europe S. A., Antwerp, Belgium

*Circle 75 on reader service card*

# The Hi-Fi Eye. The only foolproof way to control 4-channel phasing, balance and signal levels.

Using your ears to check balance, phasing and signal level relationships is difficult in stereo. But it's virtually impossible in 4-channel.

With the Technics SH-3433 audio scope, it's easy to see and control those tricky proportions as well as other equally hard to detect phenomena, such as FM multipath.

The Hi-Fi Eye accepts both low and high level inputs. So it can be connected to a tape deck, preamp, decoder or directly to the speaker terminals of your amplifier. And a front-mounted switch allows instant selection of the desired signal.

There are a wide variety of visual displays available in either an acoustic field dimension or a waveform presentation. And the waveforms of each channel may be individually observed. The mode switch selects the desired acoustic pattern: discrete (2-channel or 4-channel) and matrix. And the matrix position accommodates any of the popular methods.

There are also front panel controls for all the necessary scope-type adjustments such as focus, gain, brightness, balance and position.

There is only one way to fully appreciate how precisely the SH-3433 reveals the subtleties and complexities of 4-channel. And that is to see it in operation. Eye to Eye.

The concept is simple. The execution is precise. The performance is outstanding. The name is Technics.

200 PARK AVE., NEW YORK, N.Y. 10017
FOR YOUR NEAREST AUTHORIZED
TECHNICS DEALER, CALL TOLL FREE
800 447-4700. IN ILLINOIS, 800 322-4400.

**Technics**
**by Panasonic**