Electronics World

MAY, 1963 50 CENTS

HOW TOUGH ARE THE PROPOSED CB REGULATIONS?

LATEST ADVANCES IN TOUCH CONTROL

14-WATT TRANSISTOR HI-FI AMPLIFIER

Directory of:

IMPORTERS AND MANUFACTURERS OF JAPANESE TRANSISTOR RADIOS

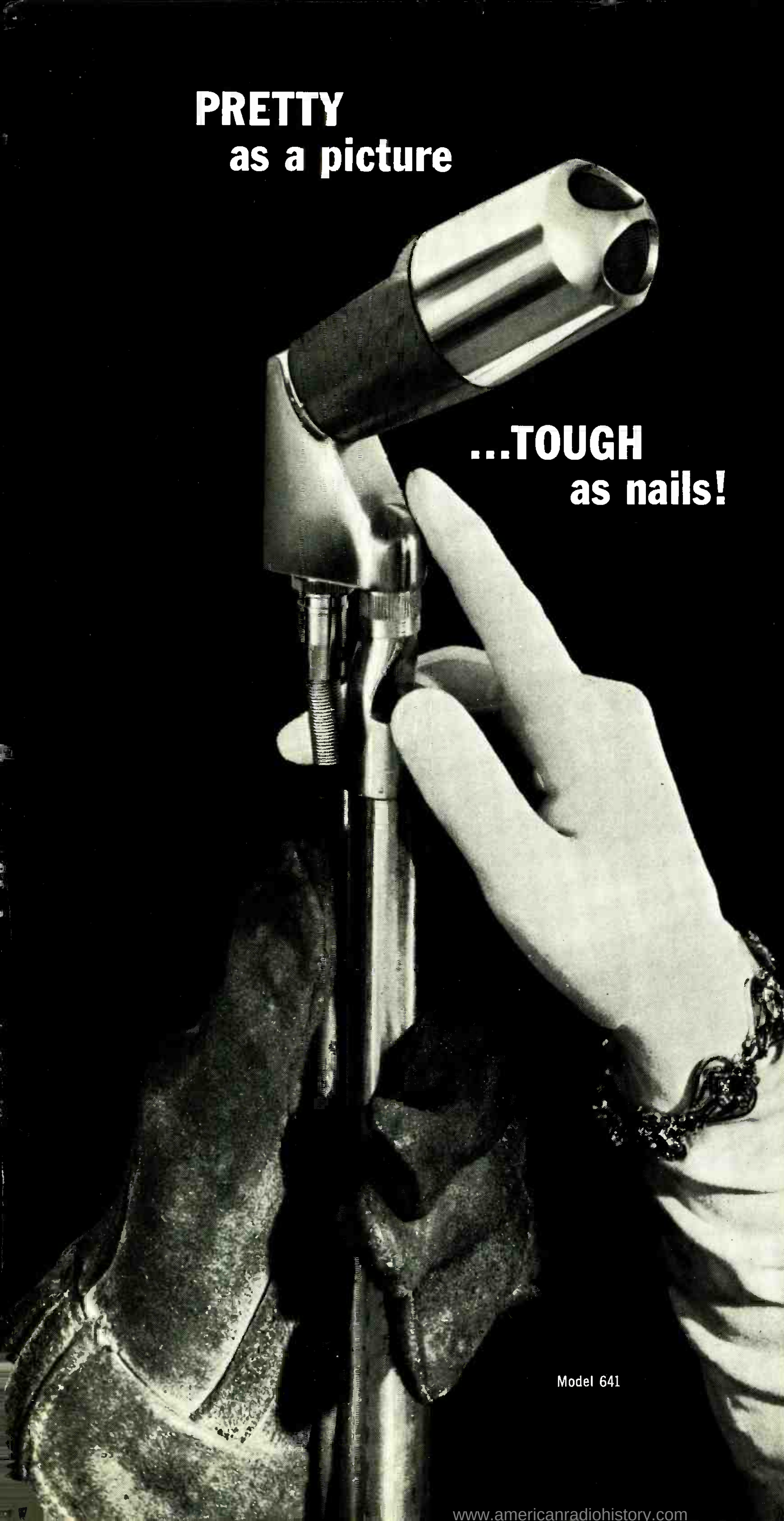
Marine Radar Scan Conversion

Aviation Radar Scan Conversion

Railroad Car Classification

Applications of Dual-Gun Write-Read Recording-Storage Tubes

A ZIFF DAVIS PUBLICATION



SETTING NEW STANDARDS IN SOUND

THE NEW ELECTRO-VOICE MODEL 641 AND 634 UTILITY MICROPHONES

Now! An exciting new answer to your most demanding microphone needs! The Electro-Voice Model 641 and 634 utility microphones. Handsome new style wedded to rugged, dependable performance. Looks good anywhere...sounds great everywhere!

Specify the Model 641 for floor or desk stand use in school sound systems, tape recorders or industrial applications. Choose the Model 634 for custom mounting on boom or gooseneck in language laboratories, paging systems or wherever semi-permanent mounting is required.

Identical except for mounting, the 641 and 634 both feature a precision dynamic element with remarkable E-V Acoustalloy® diaphragm for smooth, peak-free response and unparalleled reliability despite high shock, moisture or heat. The generous diameter plus a high-energy magnetic structure offers excellent sensitivity for every application.

The precision dynamic element is carefully "packaged" in modern, unbreakable Cycolac* plastic combined with a satin-chromium finished, high-density die casting that soaks up abuse yet stays attractive for years. Handy on-off switch is included. Choice of high- or balanced low-impedance models.

In every way these fresh new dynamics set new standards of appearance and performance . . . yet the price is surprisingly low! The result of advanced engineering plus the most modern and efficient production facilities in the industry! Make the Electro-Voice Models 641 and 634 your new standards of utility microphone excellence, today!

*T. M. Borg-Warner

Model 634

SPECIFICATIONS: Response 70-10,000 cps. Omni-directional. Sensitivity -57 db (Hi-Z, ref. 0 db = 1 volt/dyne/cm²). Available Hi-Z or balanced 150 ohms. 641: 5/8"-27 mounting, 6-foot cable with connector at microphone. $35.00 List. 634: 5/8"-27 thread at back, 6-foot cable coaxial with mounting thread. $31.50 List. (Normal trade discounts apply).

Electro-Voice®

ELECTRO-VOICE, INC.
Dept. 532N, Buchanan, Michigan

ELECTRONICS WORLD is published monthly by Ziff-Davis Publishing Company at 434 South Wabash Avenue, Chicago 5, Illinois. Subscription rates: one year United States and possessions $5.00; Canada and Pan American Union countries $5.50; all other foreign countries $6.00. Second Class postage paid at Chicago, Illinois and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada and for payment of postage in cash. May 1963: Vol. 69, No. 5.

← CIRCLE NO. 113 ON READER SERVICE PAGE

New Super-Sensitive SCOTT FM Stereo Tuner

Multiplex Version of the Famous 310 Tuner Selected for "Telstar" Experiment

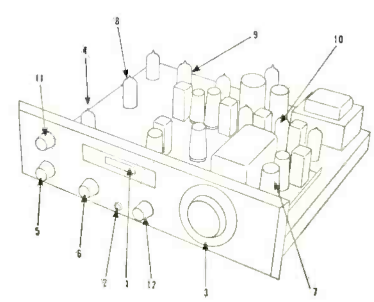
Now the world famous 310 tuner is fully equipped for Stereo Reception. The 310 is considered the most outstanding FM tuner available. It is used for commercial applications and critical broadcast relay work throughout the world. Its extreme sensitivity, selectivity and low distortion make it the logical choice for the most critical installations. The new 310E is equipped with the famous Time-Switching multiplex circuitry, pioneered by Scott, and universally accepted as the best way for achieving optimum stereo separation. Here is a tuner of broadcast quality, suggested for use in critical reception areas where its extreme sensitivity, excellent capture and low distortion are required. It is also recommended for the audio enthusiast who requires the very finest tuner possible at the present state of the art.

310E Technical Specifications

IHFM Sensitivity 1.9 microvolts; Drift .02%; Capture Ratio 2db; Selectivity (adjacent channel) 50 db; FM Detector Bandwidth 2 mc; FM Limiting Stages, 3; FM IF Stages, 4; Frequency Response (± 1 db) 30 to 15,000 cps (IHFM limits); Harmonic Distortion less than 0.5%; Spurious Response Rejection 85db; Separation 35 db. Controls: Main Tuning, Interstation Noise Suppressor, Level, Sub-Channel Filter. Size in accessory case: 15½W x 5¼H x 13¼D. Price: $279.95 *

310E FM Stereo Tuner Outstanding Features:

1. Sensitive illuminated tuning meter for optimum orientation and station selection. **2.** Convenient front-panel recorder output jack. **3.** Laboratory-type precision vernier tuning control. **4.** Auto-Sensor circuitry for fully automatic operation. **5.** Mode Control with these positions (FM Monophonic, FM Stereo, FM Stereo Automatic). **6.** Interstation noise suppressor. **7.** Silver plated RF Cascode front end. **8.** Scott's unique "Time Switching" multiplex circuitry. **9.** 2 megacycle wide-band detector. **10.** Three limiting stages, assuring fully quieted performance on even the weakest signals. **11.** Power/Filter (with these positions: Off, On, Sub-channel Filter, Stereo Filter). **12.** Stereo Threshold.



SCOTT®

H. H. SCOTT INC., 111 Powdermill Rd., Maynard, Mass.
Export: Morhan Exporting Corp., 458 Broadway, N.Y.C.
Canada: Atlas Radio Corp., 50 Wingold Ave., Toronto

** Slightly higher west of the Rockies. Subject to change without notice. Accessory cases extra.*

H. H. Scott Inc.
111 Powdermill Rd., Dept. 160-05
Maynard, Mass.

Please rush me complete specifications on the new Scott 310E FM Stereo Tuner.

Name ______________________

Address ______________________

City ______________ Zone ___ State ______

Send name and address of interested friends.

CIRCLE NO. 138 ON READER SERVICE PAGE

Electronics World CONTENTS MAY 1963 / VOL. 69 NO. 5

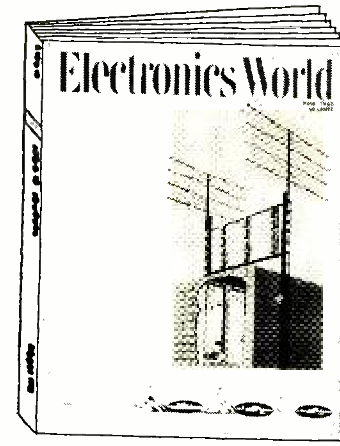
MONTHLY FEATURES

THIS MONTH'S COVER shows a cutaway view of a new Raytheon dual-gun Recording-Storage Tube. Visual information is written into this special cathode-ray tube, stored, and is then read out immediately or at some later time. One use of these tubes is to convert PPI radar displays showing harbor and air traffic into TV pictures having high uniform brightness and the ability to show target motion. Information storage is another use. Bottom display shows storage of pictures of railroad cars entering a freight yard. For complete story, see page 21. (Illustration: Otto E. Markevics)

ZIFF-DAVIS PUBLISHING COMPANY

Publisher
PHILLIP T. HEFFERNAN
Editor
WM. A. STOCKLIN
Technical Editor
MILTON S. SNITZER
Service Editor
SIDNEY C. SILVER
Associate Editor
P. B. HOEFER
Editorial Consultant
OLIVER READ
Industrial Consultant
WALTER H. BUCHSBAUM
Art Editor
MILTON BERWIN
Art and Drafting Dept.
J. A. GOLANEK
Advertising Sales Manager
LAWRENCE SPORN
Advertising Service Manager
ARDYS C. MORAN

COMING NEXT MONTH



HOW WILL U.H.F. TV AFFECT YOU?
The forthcoming u.h.f. TV boom was triggered when a law was passed mandating that all receivers, beginning in April, 1964, must be able to receive all channels. How will this affect the viewer, the broadcaster, and the service technician? What problems are involved? Many of the answers, involving TV translators, have already been worked out—offering encouragement to all interested parties.

COLUMN LOUDSPEAKER SYSTEMS
Although popular in Europe for many years, it is only recently that these unique sound-reinforcing public-address speakers have found acceptance in the U.S. Their ability to do the job depends on a number of related factors which are discussed in detail by G. L. Augspurger.

NEW CITIZENS BAND CIRCUITS
Another article in our current series of analyses of new developments in CB equipment. A transistorized 5-watt transceiver by Cadre, a mike-conversion kit from Shure, and a handy CB service instrument by Seco are discussed.

MAKING ETCHED CIRCUIT BOARDS
R. W. Bailey of Ohio State University's Department of Physics describes a simple technique, suitable for small laboratories and pilot operations, for making high-quality printed boards using readily available materials. He gives details on the processing of both single- and double-sided boards.

HIGH-PERFORMANCE TRANSISTOR IGNITION SYSTEM
The design and construction of a thoroughly tested system which features good performance, low-cost, minimum battery drain, and minimum ignition maintenance. The circuit can be used with either positive- or negative-ground automotive battery systems.

SELECTIVE CALLING FOR 2-WAY RADIO
Martin Golden of Hammarlund discusses the causes of interference in two-way radio communications systems and describes how tone-squelch techniques can be used to reduce noise when signals are not being received. Systems, as developed by Motorola, General Electric, RCA, and Hammarlund, are carefully analyzed.

All these and many more interesting and informative articles will be yours in the JUNE issue of ELECTRONICS WORLD ... on sale May 21st.

ZIFF-DAVIS PUBLISHING COMPANY

William B. Ziff
Chairman of the Board (1946-1953)

William Ziff
President

W. Bradford Briggs
Executive Vice President

Hershel B. Sarbin
Vice President and General Manager

M. T. Birmingham, Jr.
Vice President and Treasurer

Robert P. Breeding
Circulation Director

Charles Housman
Financial Vice President

Stanley R. Greenfield
Vice President

Phillip T. Heffernan
Vice President

ZIFF-DAVIS PUBLISHING COMPANY
Editorial and Executive Offices
One Park Avenue, New York 16, New York
ORegon 9-7200

MIDWESTERN and CIRCULATION OFFICE
434 South Wabash Avenue, Chicago 5, Illinois
WAbash 2-4911
Midwestern Advertising Manager, Gilbert J. Jorgenson

WESTERN OFFICE
9025 Wilshire Boulevard, Beverly Hills, California
CRestview 4-0265
Western Advertising Manager, Bud Dean

FOREIGN ADVERTISING REPRESENTATIVE
D. A. Goodall Ltd., London, England

Member Audit Bureau of Circulations

Radio & TV News • Radio News • Radio-Electronic Engineering Trademarks Reg. U.S. Pat. Off.

SUBSCRIPTION SERVICE: All subscription correspondence should be addressed to Electronics World. Circulation Dept., 434 South Wabash Ave., Chicago 5, Ill. Please allow at least six weeks for change of address. Include your old address as well as new—enclosing if possible an address label from a recent issue.

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

DID **YOU** EARN $6,000.00 TO $8,000.00 LAST YEAR?

THESE MEN DID—AFTER COMPLETING GRANTHAM TRAINING

Here, in a nutshell, are their success stories:

"I was a grocery clerk . . ."
(Max D. Reece, Seattle, Washington)

He says: "Before I took the course, I was a grocery clerk." He states that the Grantham course enabled him to gain employment in electronics. (His salary is now over $6,000.00 a year.)

"money saved . . ."
(David R. Karn, Spokane, Washington)

He says: "I worked for Boeing and Lockheed . . . due to Grantham training. With the money I saved from electronics employment, I am now able to attend college." He says the course was "invaluable" in deciding his career.

"test given by employer . . ."
(Douglas E. Evers, Seattle, Washington)

He says that Grantham training ". . . helped greatly in obtaining a high score on the test given by my employer." (Employed in electronics by a large airplane manufacturer. Salary: $7,000.00 a year.)

"would not have been hired . . ."
(Robert F. Henke, Carnegie, Penna.)

He says: "Without Grantham training, I would not have been hired. My job is more satisfying, interesting, and pays much more." (He is engineer at Radio Station KQV. Salary: Over $7,000.00.)

"able to move in . . ."
(E. W. Hale, Arlington, Virginia)

He says: "Was able to move into this job after having Grantham training." (Now employed by a large airline at over $7,000.00 a year. He maintains radio equipment.)

"amazed . . ."
(Douglas S. Atkins, Las Vegas, Nevada)

He says: "I was amazed . . ." at how complete the course is. He credits Grantham with preparing him for his last two promotions. (Earns $6,500.00 plus $3,500.00 in bonus and overtime.)

"wages tripled . . ."
V. Godoshian, Pontiac, Michigan)

He says: "My wages have tripled (since completing the course) . . ." What influence did the course have? "My job depended on it." (He is employed at a radio station. His salary: Over $7,000.00 a year.)

"a classmate told me . . ."
(Antone J. Mello, Grand Rapids, Mich.)

He says that a classmate told him about the opening that led to his present job. (Employed by radio-TV station. Salary: Over $8,000.00 a year. Says GSE training got him his job.)

"by far the best . . ."
(Michael J. Mitchell, Seattle, Washington)

He says: "Your course did help me . . . it is by far the best in its field." (He earns $6,800.00 plus overtime. Also, his part-time electronics company nets him an additional $1,500.00.)

What about other Grantham graduates?

Many others, like these men, have greatly improved their positions after getting their first class F.C.C. licenses through Grantham training. Frequently, these men write to us or drop in at one of our schools to let us know how much the training and the license means to them. And, if we don't hear from them before very long, we write them, to learn what they have been doing since graduating from our school.

As a matter of fact, it wasn't very long ago that we sent out a questionnaire form to a number of our graduates. We wish you could see their replies. Actually, in many cases, these men plainly stated that they could not have advanced so rapidly in their jobs, in both prestige and in salary, if they had not taken our course of training. And, as we expected, this survey proved that the turning point in a man's career often comes when he obtains his first class F.C.C. license.

We are encouraged by their successes. There is no better proof, we feel, that the Grantham course can do big things for others. It can do big things for you. Why not look into it? We invite your inquiry. Use the coupon below and we will send you our brochure by return mail.

A Word About the Course of Instruction:

When you receive our brochure, you will see that Grantham offers *both* home study instruction and resident (classroom) instruction. You will see how these training programs are conducted, the length of time necessary for completion of the course, and all other pertinent information.

The brochure will tell you, for example, that the resident course can be completed in just 12 weeks. It will tell you how you can estimate the length of time necessary for completion of the home study course. And, it will tell you that Grantham School is an accredited member of the National Home Study Council.

GRANTHAM SCHOOL OF ELECTRONICS

1505 N. Western Ave. Hollywood 27, Calif. (HO 7-7727)	408 Marion Street Seattle 4, Wash. (MA 2-7227)	3123 Gillham Road Kansas City 9, Mo. (JE 1-6320)	821-19th Street, NW Washington 6, D. C. (ST 3-3614)

(Mail coupon for complete details)

To: GRANTHAM SCHOOL OF ELECTRONICS
NATIONAL HEADQUARTERS OFFICE
1505 N. Western Ave., Hollywood 27, Calif.

Upon receipt of this coupon, the School will send complete details by return mail. There is no obligation, and no salesman will call. (Please indicate the division of the School in which you are interested.) ☐ Hollywood classes, ☐ Seattle classes, ☐ Kansas City classes, ☐ Washington classes, ☐ Home Study.

Name ______________________ Age ______
(PLEASE PRINT)

Address ______________________

City ______________________

State ______________________

36-E

For the record

WM. A. STOCKLIN, EDITOR

LASERS AND THEIR FUTURE

ALTHOUGH the basic theory of laser operation has been known for some time, it wasn't until 1960 that Dr. T. H. Maiman, then with *Hughes Aircraft Company*, demonstrated the first working model. Since that time, only three years ago, over 400 companies in the electronics industry have entered the field of laser development and research.

No one really knows when this unprecedented drive will stop, but we do know that the laser will have a greater influence, not only on the electronics industry but on all mankind, than any development in recent years. In fact, many experts foresee a multi-billion-dollar industry in the making.

There are good reasons for this optimism. Never before has a light beam as powerful as that of the laser been produced. Some models have been able to produce an intensity equivalent to that of a million 100-watt light bulbs. The light beam produced by a laser may be no thicker than a lead pencil; what is more this beam does not diffuse like that of an ordinary flashlight.

The most unique property of the laser beam is its "coherence." This means that the energy waves forming the light are all in phase. The laser thus generates a single frequency or narrow band of frequencies much like an r.f. oscillator but in the infrared and visible light portions of the spectrum. This "light oscillator" can be modulated for transmission of communications without undue difficulty.

MIT and *Raytheon* scientists demonstrated some time ago that a laser beam of light could be directed to the moon and reflected back to earth, while other experiments have shown that this same type of light ray can cut metal and be used in delicate surgery. Although these are exciting applications, they do not represent a fraction of the laser's potential. More practical applications will be found in the areas of communications and military weapons.

General Telephone & Electronics Laboratories recently demonstrated the transmission of a TV picture on a microwave subcarrier that was modulated onto a laser beam. Since the laser operates at such high frequencies, a very large amount of information can be carried. For example, a laser beam communications system can handle more than 100,000 telephone channels or more than 160 TV programs compared to the maximum capacity of present microwave systems of only 600 telephone channels or 10 TV programs.

Unfortunately, this light beam is affected by atmospheric conditions, but it can be piped, with optical devices used to deviate the beam from a straight-line path. At high altitudes, however, this same light beam could be used for static-free, and certainly confidential, communications between satellites and to other planets.

In the military area, the laser offers many interesting possibilities. It seems likely, at some future date, that a laser with increased power could be used to destroy unwanted satellites, planes, and enemy warheads. It has also been suggested that it could be used as a destructive light ray, aimed like a giant searchlight at enemy ground forces.

Because of its extremely sharp beam, the laser can be employed as a navigational aid operating with much greater accuracy than is possible with conventional radar.

Sperry Rand has within the past few weeks demonstrated its use as a gyroscope, having potentially better accuracy and without any of the mechanical limitations and problems of conventional gyros.

The original concept of the laser, *i.e.*, the development of a coherent light beam, is without a doubt one that should be credited to the electronics industry. This is because the majority of the companies doing original research in lasers are electronically oriented and its major applications are in the field of electronics. It should be acknowledged that most of the early development work in this field was done by scientists and engineers in the fields of optics, quantum mechanics, physics, mathematics, and chemistry. Now that the basic concept has been laid down, it will be the responsibility of electronically oriented personnel to develop practical applications.

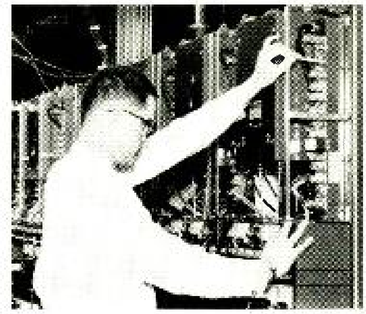
This combined effort by purely electronics scientists and engineers with those trained in other sciences is a form of diversification and a trend which began with the development of the transistor. Such cooperation represents a formidable combination that cannot be beat. ▲

Pick the course for your career...

Electronics Technology

A comprehensive program covering Automation, Communications, Computers, Industrial Controls, Television, Transistors, and preparation for a 1st Class FCC License.

Electronic Communications



Mobile Radio, Microwave and 2nd Class FCC Preparation are just a few of the topics covered in this "compact" program . . . Carrier Telephony too, if you so desire.

First Class FCC License

If you want a 1st Class FCC ticket quickly, this streamlined program will do the trick and enable you to maintain and service all types of transmitting equipment.

Broadcast Engineering

Here's an excellent studio engineering program which will get you a 1st Class FCC License and teach you all about Program Transmission and Broadcast Transmitters.

Get A Commercial FCC License ...Or Your Money Back!

A Commercial FCC License is proof of electronics skill and knowledge. Many top jobs require it . . . every employer understands its significance. In your possession, an FCC Commercial Ticket stamps you as a man who knows and understands electronics theory . . . a man who's ready for the high-paid, more challenging positions.

Cleveland Institute home study is far and away the quickest, most economical way to prepare for the FCC License examination. And that's why we can make this exclusive statement:

> The training programs described above will prepare you for the FCC License specified. Should you fail to pass the FCC examination after completing the course, we will refund *all* tuition payments. You get an FCC License . . . or your money back!

Before you turn this page, select the program that fits your career objective. Then, mark your selection on the coupon below and mail it to us today. We'll send you . . . without obligation . . . complete details on our effective Cleveland Institute home study. Act NOW . . . and insure *your* future in electronics.

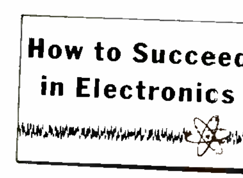
Cleveland Institute of Electronics

1776 E. 17th Street, Dept. EW-77
Cleveland 14, Ohio

Accredited Member

Mail Coupon TODAY For FREE Catalog

Cleveland Institute of Electronics
1776 E. 17th St., Dept. EW-77
Cleveland 14, Ohio



Please send FREE Career Information prepared to help me get ahead in Electronics, without further obligation.

CHECK AREA OF MOST INTEREST—

- ☐ Electronics Technology
- ☐ Industrial Electronics
- ☐ Broadcast Engineering
- ☐ First Class FCC License
- ☐ Electronic Communications
- ☐ ______ other

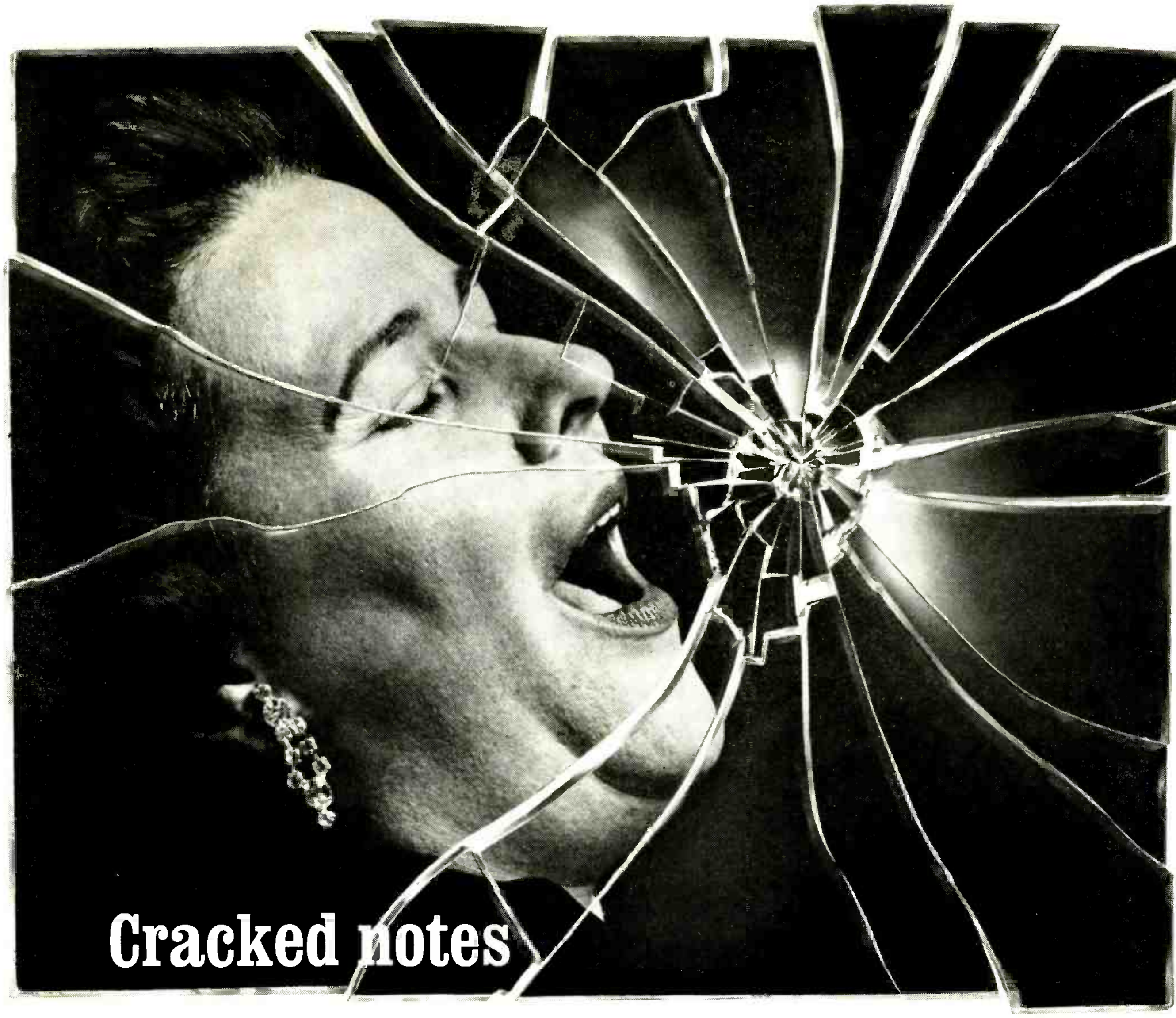
Your present occupation ______

Name ______ (please print) Age ______

Address ______

City ______ Zone ___ State ______

Approved for Veteran's Training under Korean GI Bill. EW-77



in your aria?

...then "bargain" recording tape's no bargain!

Trouble with cheap tape with an unknown name is simply this: You can't *see* much difference between it and fine-quality tape. But you sure *hear* the difference when tiny imperfections are magnified into shattered sound . . . a danger greater than ever with today's four-track stereo, where each track of recording takes less than a quarter of the tape's width.

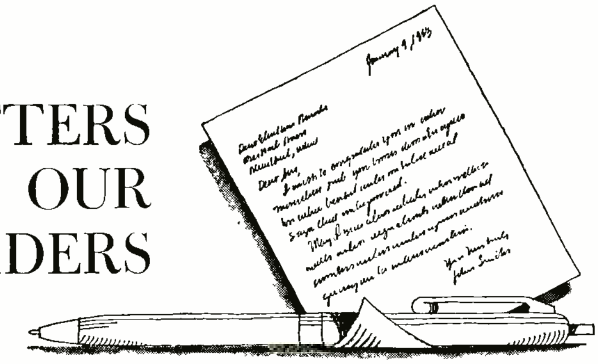
Surest way to record sound crystal clear, enjoy maximum performance from your equipment is to rely on "SCOTCH" BRAND Recording Tapes. They are required by 3M to pass more than 100 quality tests to ensure inch-after-inch uniformity. Result: identical recording characteristics—full frequency sensitivity, wide dynamic range—throughout each reel, reel after reel.

High potency oxides in "SCOTCH" Recording Tapes make possible thinner, more flexible coatings that assure intimate head-to-tape contact for sharp resolution. Exclusive Silicone lubrication that lasts the life of the tape assures smooth tape travel. It protects against recorder head wear, extends tape life. So for genuine "money's worth" in performance, step up to the tape professionals prefer: "SCOTCH" BRAND.

On SCOTCH® BRAND Recording Tape, you hear it crystal clear!

Magnetic Products Division 3M COMPANY

LETTERS FROM OUR READERS



COLOR-PATTERN GENERATORS

To the Editors:

I have read with interest the article in your March issue entitled "Color-Pattern Generators." It appears to me that the article is accurate in its statements but misses the point regarding keyed (gated) rainbow generators. In my opinion, there is a world of difference between a rainbow generator and a keyed-rainbow type. As a matter of fact, I do not think that the "side-lock" type generator should be called "keyed rainbow" at all. It really fits the specifications of NTSC phase as far as colors are concerned and has a zero-reference burst on the sync pulse to trigger the oscillator. Because of this, we have found that the side-lock or keyed-rainbow generator will perform all tests satisfactory to service that are recommended in TV manufacturers' service literature.

In our opinion, the NTSC color-bar generator is an accurate laboratory-type unit and has its place in a large service shop. However, it appears that the keyed rainbow or side-lock type will be adopted for service use throughout. This latter type of generator is easy to use, portable, less expensive, and has less to go wrong. Further, it is the type used by *RCA Service Co.* which has been in the color business the longest. Keyed rainbow patterns are now being included on all new *Sams'* "Photofact" schematics.

R. H. Bowden, Pres.
Sencore, Inc.
Addison, Illinois

° ° °

SOVIET LASERS

To the Editors:

The article "Lasers and Their Uses" in your December issue was one of the finest I have ever read on the subject.

A couple of days after I read it, I noted an article in the "New York Times Magazine" by W. E. Knox, President of the *Westinghouse Electric International Co.*, reporting on a recent interview with Nikita Khrushchev. The Premier showed Knox a plaque 6" in diameter and ¼" thick labeled "1970." This was a reminder of a promise by scientists that "by 1970 all new TV receivers in the Soviet Union will be no larger than this model."

Then a 6" steel ruler was shown to the businessman. When held up to the light, a number of very fine holes were seen in the steel. Khrushchev said that these holes were made by light beams produced by lasers, and that he was convinced that Soviet scientists were ahead of those in the U. S. in laser development.

J. B. Baylor
Yorktown Heights, N. Y.

° ° °

DIGITAL VOLTMETERS

To the Editors:

I was interested in reading the letter of Paul McEldridge in the January, 1963 issue of Electronics World, referring to the John R. Collins article on the digital voltmeter in your September, 1962 issue. I must agree that if digital voltmeters must cost over $1000 then they are certainly "gilding the lily."

Our company, which is familiar to most of your readers from our *B & K Manufacturing Division*, is now manufacturing a completely transistorized unit to sell for under $400. By limiting the specifications only slightly so that our accuracy is .1% instead of the .01% available in the best units, we were able to cut the cost down to the point where it is now practical to use these instruments on production lines, in laboratories, and quality-control departments where they never could be economically justified before.

Regarding Mr. McEldridge's comment on the use of government funds, I must say that our instrument was developed solely with our own funds by our own engineering department.

Carl Korn, Pres.
Dynascan Corp.
Chicago, Ill.

To the Editors:

The usefulness of the digital voltmeter lies neither in the fact that the readings are in visual digital form, nor that each reading can take far less time for full balance, but in the fact that the output is of a digital nature. Hence, it is capable of being recorded on punched cards or tape many times a second, a necessity in certain critical industrial jobs where high speed quality control is of the utmost importance.

Without some means of high-speed

NOW *EVERYONE* CAN QUICKLY

Set up and Service Color TV

1 PATTERN DISPLAY STANDARD
Shows correct pattern in window viewer for visual guide

2 PATTERN SELECTOR
Produces each pattern individually for quick, easy convergence

3 AUTOMATIC DECONVERGENCE
Simplifies static and dynamic convergence. No digging into set

4 COLOR SELECTOR
Produces each color one at a time for accurate color set-up

5 COLOR GUN KILLER
Automatically enables the technician to actuate any combination of the 3 guns

6 DEMODULATOR ALIGNMENT
Makes alignment extremely simple, without going into the color set

New! B&K Model 850 COLOR GENERATOR

Most Complete, Most Versatile, Portable Instrument for Use in the Home and in the Shop
Makes Color TV Set-up and Service Easier, Faster than ever!

Now every service technician can be ready to set-up and service color TV with amazing new ease and speed! New advanced design simplifies the entire operation, saves time and work in every installation. Eliminates difficult steps in digging into the color TV set. Gives you new confidence in handling color.

Produces Patterns, Burst, and Colors Individually—Provides dot pattern, crosshatch, vertical lines, horizontal lines, burst signal, and individual colors—one at a time—on the TV color set—for fastest, easiest check. Unique window-viewer on front of the instrument panel shows you each pattern and color as it should be—gives you an exclusive display standard to use as a sure guide for quick, visual comparison.

Provides Accurate, Individual Color Display—Produces Green, Cyan, Blue, B—Y, Q, Magenta, R—Y, Red, I, Yellow, and Burst—one at a time. All colors are crystal-controlled and are produced by a precision delay-line for maximum accuracy. Each color is individually switch-selected—no chance of error.

Provides Accurate NTSC-Type Signal—Color phase angles are maintained in accordance with NTSC specifications.

Makes Convergence and Linearity Adjustments Easy—Highly stable crystal-controlled system with vertical and horizontal sync pulses, assures the ultimate in line and dot stability.

Simplifies Demodulator Alignment—The type of color display produced by this instrument provides the ultimate in simplicity for precise demodulator alignment.

Provides Automatic Deconvergence—Eliminates the necessity for continual static convergence adjustments. The instrument automatically deconverges a white into a color dot trio without digging into the color set to mis-adjust the convergence magnets. It also deconverges a white horizontal or vertical line into red, green and blue parallel lines. This greatly simplifies dynamic convergence adjustments.

Provides Exclusive Color Gun Killer—Front-panel switch control makes it easy to disable any combination of the three color guns. Eliminates continuous adjustment of the background or screen controls, or connection of a shorting clip inside the receiver. The switch also selects the individual grids of the color tube and connects to a front-panel jack to simplify demodulator alignment.

Provides Switch-Selected R.F. Signals—Factory-tuned, for channels 3, 4, and 5—for open channel use in your area.

Model 850 also includes other features that make it invaluable for home and shop use. Net, $199.95

See Your B&K Distributor or Write for Catalog AP20-N

B&K

B & K MANUFACTURING CO.
Division of DYNASCAN CORPORATION
1801 W. BELLE PLAINE AVE. • CHICAGO 13, ILL.
Canada: Atlas Radio Corp., 50 Wingold, Toronto 19, Ont.
Export: Empire Exporters, 253 Broadway, New York 7, U.S.A.

data logging, environmental testing for our space program would become impossible. In such a case, the DVM is nothing more than an analog-to-digital converter with the extra added attraction of a direct visual readout.

Mr. John Collins' article gave many advantages for the DVM. They have their place in industry just as the $50,000-per-month digital computer.

HOUSTON A. BROWN, JR.
Sherman Oaks, Calif.

* * *

METER BATTERY TROUBLE

To the Editors:

ELECTRONICS WORLD has recently printed a brief item I submitted entitled "Meter Battery Trouble" in which I have described trouble encountered in using an *Eveready* 950 "D" cell in a *Simpson* Model 260 volt-ohm-milliammeter.

I have received information from the *Simpson Electric Company* in regard to the problem which I believe will be of interest. Here is a portion of their letter:

"Apparently, you have a Series II 260, since this is the series that used the spring-loaded battery contact.

"We had not given any consideration to the possible problems that would be encountered on our older units due to the *Eveready* shape. Our Series III unit has been in production for a number of years and was not affected by the 'dimple' on the *Eveready* battery, so no one gave it much thought.

"Our next field service letter that is sent out to our representatives and repair stations will have a caution note about this battery."

RICHARD A. GENAILLE
Winston-Salem, N. C.

Author Genaille, in a brief item in our January issue (p. 75) gave a simple remedy for intermittent battery contact that resulted in erratic readings on the low-resistance scales of the v.o.m. Evidently, the remedy would not be required in the latest Series III of the Simpson 260.—*Editors.*

* * *

KUDOS FROM SERVICE-SHOP OWNER

To the Editors:

Your magazine, which I have been reading for years, is one of the most informative and interesting of them all. Your illustrations are worth a million words—hats off to your artists. And just because a reader confines his source-of-income interests to radio and television, likely as not, he is more keen about the odd-ball subjects that you manage to wedge into your abundant pages. This reader is particularly delighted to find out what's new in the microminiaturization field and other solid-state developments. Let us feast upon more of those delicacies.

DAVID VAN IHINGER
President, Town & Country TV
Toronto, Ont.

Thanks to service-shop owner Van Ihinger for the compliments. We intend to keep the "delicacies" coming.—Editors.

* * *

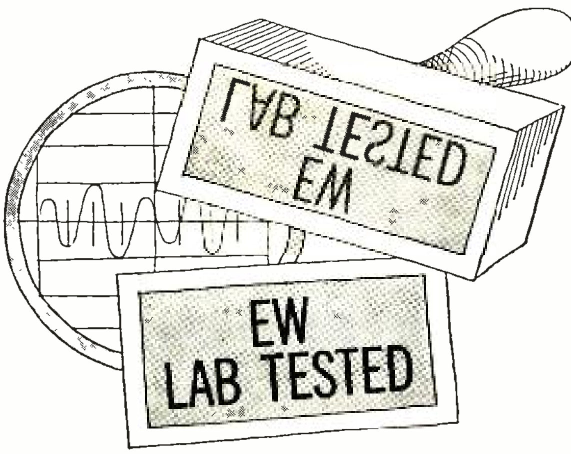
VARIABLE VOLTAGE SUPPLY

To the Editors:

In your December issue, a "Variable-Voltage Regulated Power Supply" was offered by Mr. James P. Rodgers. I have built this power supply and met with some very poor results. Is there an error in the parts list or schematic?

JAMES E. FREISINGER
La Crosse, Wisconsin

Quite a few of our readers have already found a drafting mistake in the circuit diagram on page 47. Both resistor R4 and the suppressor grid of V6 should be connected directly to the cathode of this tube. Once this has been done, the circuit should operate properly as shown.—Editors. ▲



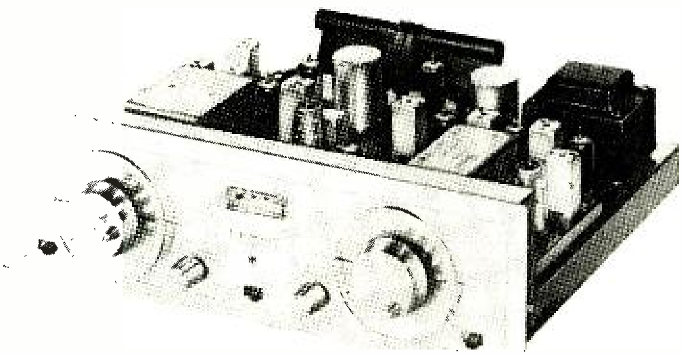
HI-FI PRODUCT REPORT

TESTED BY HIRSCH-HOUCK LABS

Scott 333 AM-FM-MPX Tuner
Acoustic Research Turntable/Arm (page 16)

Scott 333 AM-FM-MPX Tuner

For copy of manufacturer's brochure, circle No. 59 on coupon (page 17).



THE *Scott* 333 is an unusually flexible stereo tuner, offering a choice of AM or FM mono reception, FM multiplex stereo, and AM-FM stereo, if such transmissions are still on the air.

The FM tuner portion is basically similar to the company's Model 350 FM tuner. It has the silver-plated, shielded front end used in all *Scott* FM tuners, with a 6BQ7A cascode r.f. stage and a 6U8 mixer/oscillator. Two 6AU6A i.f. amplifiers and a 6HS6 limiter drive a wide-band diode ratio detector.

The multiplex demodulator uses two four-diode switches gated on alternately by a 38-kc. oscillator, which is synchronized by the transmitted 19-kc. pilot carrier. A useful feature is the "Sonic Monitor," which offers a positive indication of stereo broadcasts, and also serves as an aid to correct stereo tuning. The "Sonic Monitor" is put into operation by a front-panel switch, which disables the main channel signal, shifts the frequency of the 38-kc. oscillator slightly, and beats it against the second harmonic of the pilot carrier. An audio tone is heard in the speakers when stereo is being received, and when the receiver is tuned for clearest sound, it is set for best stereo reception. If there is no pilot carrier, as when receiving mono broadcasts, only a slight rushing sound is heard. Unlike some visual indicators, the "Sonic Monitor" cannot give a spurious indication.

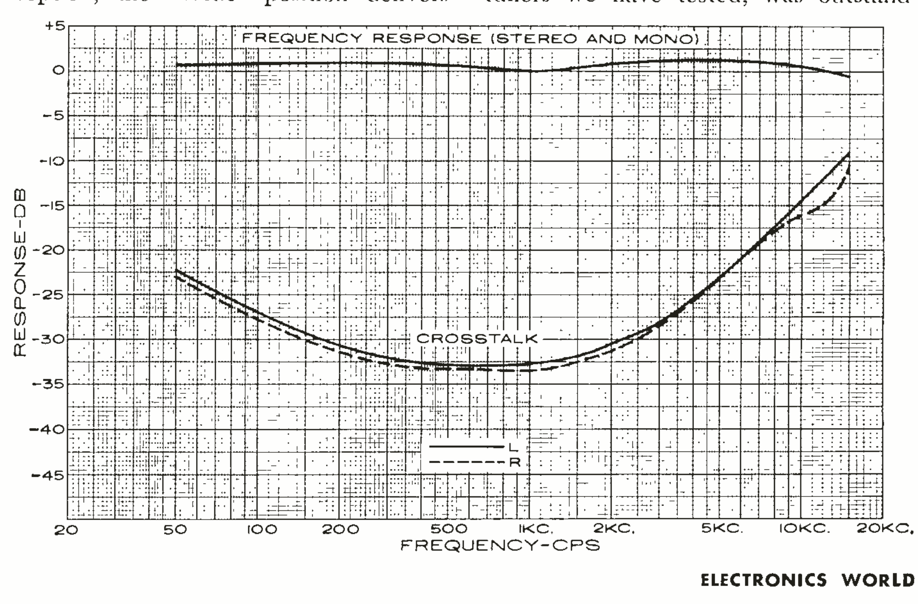
The left- and right-channel signals (or the de-emphasized mono signal) go through individual feedback audio amplifiers to the output jacks. There are level controls for each channel (and AM) in the rear of the tuner, as well as two pairs of output jacks so that a tape recorder can be driven directly from the tuner.

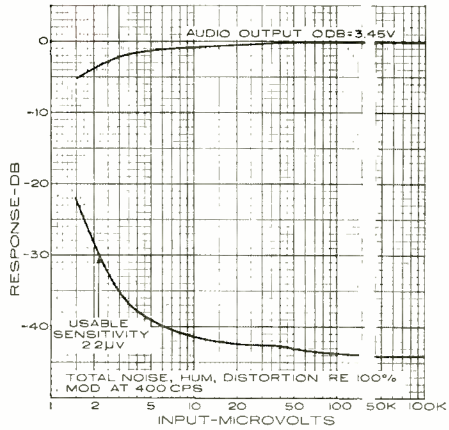
The AM tuner, completely separate from the FM section, offers a choice of two i.f. bandwidths. The narrow ("Normal") position of the AM selectivity switch gives lowest noise for reception of weak stations. For clear-channel reception, the "Wide" position delivers quality more nearly comparable to that of FM. A 10-kc. whistle filter removes interstation beats. There is a built-in ferrite-core AM antenna and provision for connecting an external long-wire antenna.

Either AM, or FM mono or stereo can be selected from the front panel. If AM-FM stereo broadcasts are available, a switch on the chassis disables the multiplex circuits and feeds the AM and FM signals to the output jacks when the tuner is set for stereo. Even if such broadcasts are not available, this tuner allows simultaneous reception of an AM and an FM station.

The FM section of the tuner had a measured IHFM usable sensitivity of 2.2 μv. The distortion was a low 0.63% at 100% modulation for signals stronger than 100 μv. The available audio output was 3.45 volts and the excellent limiting characteristics result in essentially constant output from 10 to 100,000 μv. Hum was 57.5 db below 100% modulation. The stereo separation was about 32 at middle frequencies, reducing to 16 db at 10,000 cps. The frequency response, in either mono or stereo, was ± 1 db from 50 to 15,000 cps. Drift was negligible.

The AM tuner, like earlier *Scott* AM tuners we have tested, was outstand-





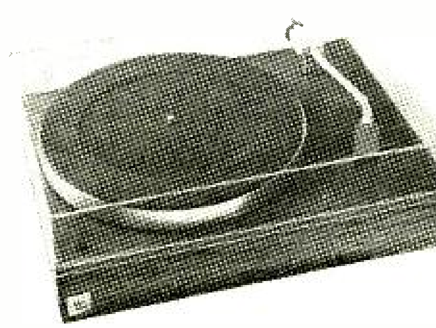
ingly good. Its quality was remarkably close to that of FM, lacking only the extreme high frequencies. In the "Normal" selectivity position, the frequency response rolled off above 2 kc., but in "Wide" it was down only 5 db at 8 kc. The whistle filter put a 30-db notch in the response at 10,000 cps.

The AM usable sensitivity, at which point the noise and distortion were 20 db below 30% modulation level, was 47 µv. in the "Wide" selectivity position. It would be somewhat better in "Normal," but no serious high-fidelity listening would be done in that condition.

The 333 is one of the most flexible tuners made. It ranks with the best FM stereo tuners and is the finest AM tuner we know of on the current market. The price is $259.95 less case. A metal enclosure is available for $13.95 and a wooden cabinet for $22.50. ▲

Acoustic Research Turntable/Arm

For copy of manufacturer's brochure, circle No. 60 on coupon (page 17).



THE NEW *Acoustic Research* turntable, their first venture outside the loudspeaker field, very successfully overcomes the usual objections to lightweight designs. The turntable, constructed in two sections, weighs over 3 pounds. Eighty per-cent of its driving torque is supplied through a flexible belt from a permanent-magnet synchronous motor, operating at 400 rpm. This type of motor has considerable running torque, but requires an outside "push" to get started. A small 600-rpm synchronous clock-type motor is belt-coupled to the pulley on the main motor. This has good starting torque, but has low running torque and is easily stalled. It puts the system into operation, and supplies 20 per-cent of the total running torque.

The final result is a turntable that comes up to speed reasonably fast (a couple of seconds) and operates at exact speed, without slippage, up to the point where it is stalled by excessive drag. It operates at a single speed, 33⅓ rpm.

The *AR* unit is more than just a turntable, however. The turntable comes complete with tonearm, mounted in isolators, and with a walnut base. The unit is ready to play after installation of a cartridge.

The arm and turntable are mounted on the ends of a rigid I-beam, loosely suspended on springs from the metal motorboard. The motors are rigidly mounted to the motorboard, and contact the turntable only through the flexible drive belt. The combined arm/turntable system has a resonant frequency of about 3.5 cps, so it is unlikely to be affected by acoustic output from speakers or by floor vibrations.

Since the arm and turntable are rigidly coupled, any vibration which does reach them will act equally on both. As long as the arm and turntable do not move relative to each other, there can be no output from the cartridge; hence the rumble is very low and acoustic feedback is practically impossible to induce.

The arm is simple, but of excellent quality. It is an aluminum tube, with an adjustable brass counterweight at one end and a light plastic plug-in cartridge holder at the other end. The overhang of the stylus, beyond the turntable spindle, can be adjusted by sliding the tube in its pivoted spindle. No springs are used, all adjustment of tracking force being by means of the counterweight. The vertical pivots are only ¼" above the record surface, which minimizes wow from warped records. A unique viscous damping system, affecting only the vertical motion of the arm, causes it to drop slowly when released, yet is automatically disengaged when the stylus reaches the record. The four-foot output cables, fitted with molded plugs, have a capacitance of only 135 pf., so that any cartridge may be used without loss of high-frequency response.

Our tests confirmed the outstanding performance of the turntable as well as its specifications, with the minor exception of tracking error. The wow and flutter were 0.05% and 0.02% respectively, the lowest we have measured on any turntable. The rumble, measured according to NAB standards, was –38 db including both lateral and vertical components, and –40 db with vertical com-

(Continued on page 77)

READER SERVICE PAGE

Please use the coupon at the bottom of this page to obtain more information about products advertised in this issue.
Simply circle the number on the coupon that corresponds to the number at the bottom of the advertisement in which you are interested.

Additional information on items mentioned in **"New Products & Literature"** can also be obtained by following this same procedure.

PRINT your name and address on the coupon and mail it to:

ELECTRONICS WORLD
P.O. BOX 7842
PHILADELPHIA 1, PA.

ELECTRONICS WORLD
P.O. BOX 7842
PHILADELPHIA 1, PA.

TOTAL NUMBER OF REQUESTS [ ] **N**

Please send me additional information concerning the products of the advertisers whose code numbers I have circled.

100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179

NEW PRODUCTS & LITERATURE 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 36 37 38
39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

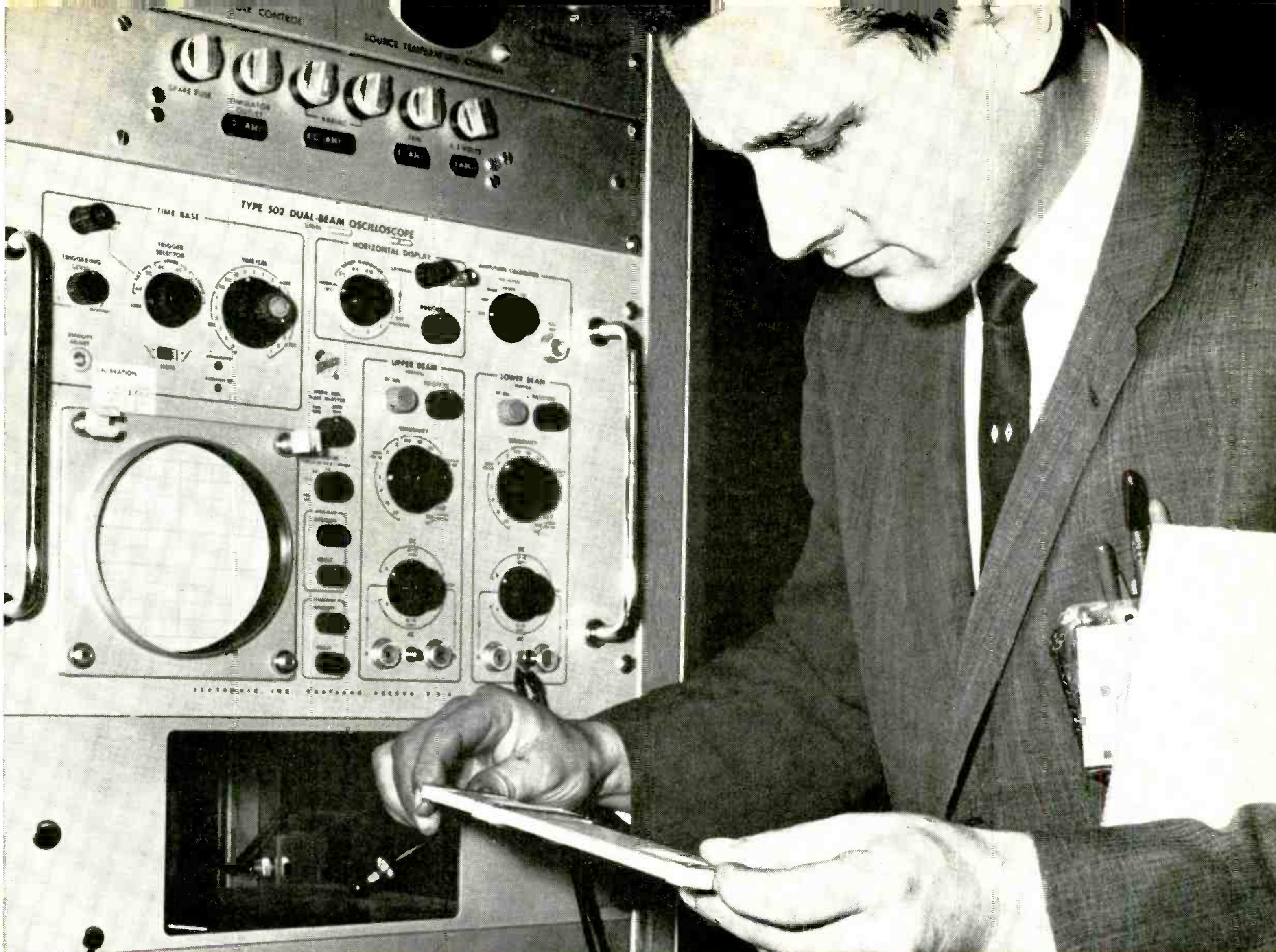
(Key numbers for advertised products also appear in Advertisers Index)

NAME *(PRINT CLEARLY)* ____________________

ADDRESS ____________________

CITY ____________________ ZONE ______ STATE ____________

VOID AFTER MAY 31, 1963 **5**



A CREI Program helped Edward W. Yeagle advance to project engineer at Barnes Engineering Co., Stamford, Conn.

Are you standing still in electronics while this man advances?

Find out why and do something about it if you have the ambition to want a career instead of just a job

Experience alone is no guarantee of success in electronics today. In this rapidly changing, increasingly complex field, employers demand advanced, up-to-date technical knowledge and this can't be learned on the job. Success comes to men who back up their experience with advanced education in modern electronics. CREI provides this education through industry-recognized home study programs that emphasize immediate application of knowledge acquired. The material a CREI man studies *today* will help him *tomorrow*—as well as in the years ahead.

If you are working in electronics, send for Free 58-page book. It explains how CREI Programs can help you as they have Edward W. Yeagle and thousands of other CREI men in every phase of electronics. Use coupon or write: CREI, Dept. 1105-A, 3224 Sixteenth St., N.W., Washington 10, D. C.

Send for free 58-page book

CREI Founded 1927
Accredited Member of the National Home Study Council

The Capitol Radio Engineering Institute
Dept. 1105-A, 3224 Sixteenth St., N.W., Washington 10, D.C.

Please send me FREE book describing career opportunities and CREI Programs in advanced electronics. I am employed in electronics and have a high school education.

Name .... Age ....
Address ....
City .... Zone ...... State ....
Employed by ....
Type of Present Work ....
Check: ☐ Home Study ☐ Residence School ☐ G. I. Bill

EICO 369 tv-fm sweep & post injection marker generator

FOR TV and FM alignment work, the new EICO 369 can't be beat. Clear markers, vital to accurate fast alignment are no problem. The EICO 369 feeds a sweep signal only to i.f. strip being aligned. At the output end of the circuit, demodulator cable picks off the signal, demodulates it, and feeds the demodulated signal to a mixer stage inside the generator where the markers are added. Then this combined signal is fed to the oscilloscope. What does this mean? It means . . . the marker signals are not affected by the receiver circuitry . . . traps in the receiver will not reduce or eliminate the marker . . . and you can align TV and FM i.f. strips faster and more accurately than ever before.

The EICO 369 has an increductor sweep circuit. This electronic arrangement has no mechanical parts to wear and give trouble later. The sweep generator is independent of the marker generator. It has five ranges: 75–316 mc; 32–85 mc; 16–40 mc; 7.5–10 mc and 3.5–9 mc. All five ranges are fundamentals and tuning the desired frequency is simplified by a 6:1 vernier dial and a 330° scale. Output impedance is 50 ohms. The horizontal blanking circuit uses the negative portion of the power transformer output through a diode and applied to the agc circuit to cut off the oscillator. A three-stage agc circuit keeps the level of the swept signal constant over its entire frequency range, even when the widest sweep width of 20-mc is being used. A phasing control at the rear of the EICO 369 adjusts the horizontal sync signal fed to the scope.

The marker generator in the EICO 369 has 4 ranges covering 2–225 mc. The highest range, 60–225 mc, is the third harmonic of the next lower range. All other ranges are fundamentals. As a rapid check of marker-generator alignment a 4.5 mc crystal is supplied with each generator. When plugged into a front panel socket, it automatically turns on a fixed frequency marker oscillator. The 4.5 mc signal produced by this oscillator is mixed with the variable frequency marker.

The combined sweep marker signal and horizontal sweep sync signal are fed to the oscilloscope through a dual shielded cable. Separate level controls adjust marker and sweep generator signals independently. Kit, **$79.95**; Wired, **$129.95.**

PUT THE BEST ON YOUR BENCH

EICO 667 dynamic conductance tube and transistor tester will earn money for you by catching the bad tubes an emission tester would miss. The EICO 667 combines a mutual conductance test with a peak emission test to give a single reading of tube quality. Bad transistors can be spotted easily. Gain and leakage tests will find the defective ones.

TESTS ALMOST EVERY DOMESTIC OR FOREIGN RECEIVING TUBE MADE. The EICO 667 checks 5 and 7-pin Nuvistors; 9-pin Novars; 12-pin Compactrons; 7, 9 and the new 10-pin miniatures; 5, 6, 7 and 8-pin subminiatures; octals and loctals. It will also check many low-power transmitting and special purpose tubes, voltage regulators, cold-cathode regulators, electron ray indicators, and ballast tubes. And by inserting pilot lamps into the special output in the center of the Novar socket you get an instant good-bad test of these lamps.

TESTS MADE UNDER ACTUAL TUBE OPERATING CONDITIONS. When one section of a multi-purpose tube is being tested, all sections are drawing their full rated current. Pentodes are tested as pentodes rather than combining all the elements for a simple emission check. Leakage between tube elements is read directly on a 4½-inch meter in ohms.

EICO 667 NEVER WILL BE OUTDATED. A new rollchart is prepared periodically, and if a technician wants to add data on one or two individual tubes, he unsnaps the windows over the chart and inserts the data.

TRANSISTORS CHECKED IN TWO STEPS. First for leakage, then for beta or current amplification factor. Both are read directly off the meter dial and both n-p-n and p-n-p transistors can be checked. Price, **$79.95**, kit; **$129.95**, wired.

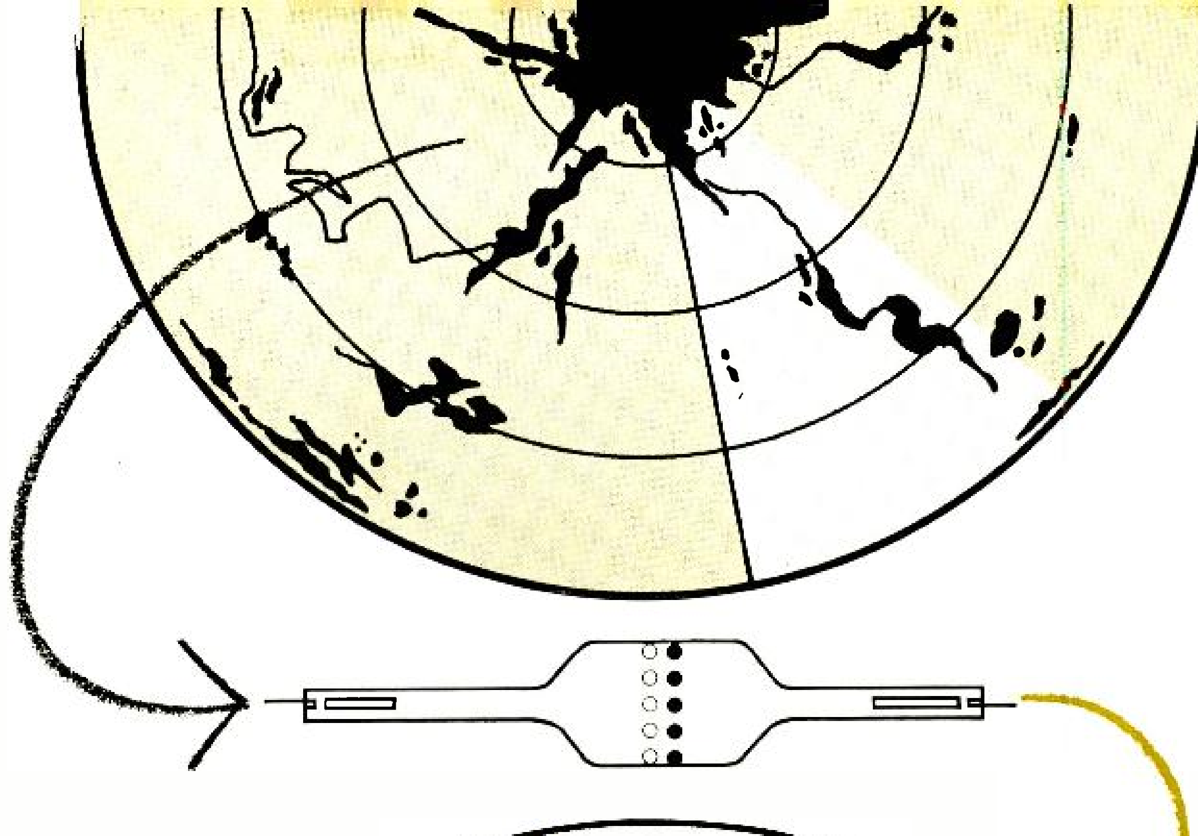
See the new EICO 369 and 667 at your distributor. For complete catalog of over 108 EICO kits and wired units—test equipment, hi-fi, CB and ham gear, write, Dept. EW-5.

EICO

EICO ELECTRONIC INSTRUMENT CO. INC., 3300 Northern Blvd., L. I. C. 1, N. Y.

Add 5% in West.

CIRCLE NO. 111 ON READER SERVICE PAGE



RECORDING STORAGE TUBES AND THEIR APPLICATIONS

Operating principles and uses of these special cathode-ray tubes in which visual information may be written into tube, stored, and then read immediately or at some later time. Tubes are employed for bright-display radar pictures in harbor and air-traffic control and for information storage.

By ALVIN S. LUFTMAN / Display Devices Product-Line Mgr., Industrial Components Division, Raytheon Co.

RECORDING-STORAGE TUBES are being used today in a large number of seemingly unrelated applications. By use of these tubes, the FAA air-traffic controllers are now guiding planes to safe landings and departures in a number of airports throughout the country. The Coast Guard is able to transmit a televised picture of its New York harbor radar to all commercial shipping in the harbor that have u.h.f. television sets. This means that a commercial vessel can see the radar picture of the complete harbor, can identify themselves on this picture, and can see all other ships and their courses—even in darkness and fog. In another application, railroads may be able to substantially improve the handling of freight traffic by having a controller watch a televised series of stills of each car as it enters a yard.

These applications, and many more, are made possible by the ability of storage tubes to stop motion, to scan-convert information, for example, from a radar-type scan to television, to integrate information so that weak signals can be seen better, and to cause erasure of stored pictures either gradually or abruptly, as desired, even while new information is being added to these pictures. Electronic storage serves a function similar to photography, permitting enhancement of weak signals by using time exposures, conversion of a picture which is continually decaying into one of uniform brightness, and permitting study of that picture for several minutes. Another capability of the storage tube not realized photographically is that an electric output can be obtained such that the stored picture can be presented to many monitors simultaneously. The storage tube can be slow-scanned to reduce all frequency components in the scanned picture to low enough values to permit their transmittal over various types of narrow-band communications systems, such as over conventional telephone lines and circuits.

Operation of Tube

The principles of the Recording-Storage Tube were discovered at *Raytheon Co.* by Dr. R. C. Hergenrother and Mr. B. C. Gardner in 1948. Since that time the design has passed through many stages and undergone improvements.

The element in a storage tube which actually provides the time storage of information is a fine-mesh metal screen with a million holes per square inch and coated on one side with a dielectric material. A scanning electron beam is directed against the dielectric surface and, depending on the voltage of that surface at any instant of time, this beam serves to charge the dielectric either positively or negatively.

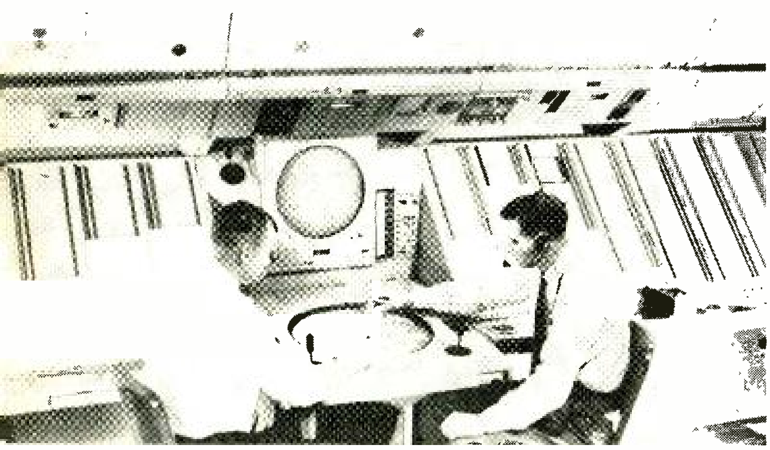
Fig. 1 is a typical secondary-emission curve. When the voltage of the storage surface is lower than a certain critical value (electrons are striking that surface at slow speeds), the secondary emission ratio will be less than unity, *i.e.*, fewer electrons will leave the dielectric surface than strike it, therefore, the surface will charge in a negative direction toward cathode potential. On the other hand, if the dielectric surface is initially at a voltage higher than critical potential, each electron striking will knock off more than one secondary electron and the surface will charge in a positive direction. It continues to charge as long as the voltage field directly before that surface is sufficiently positive to draw off the secondary electrons thus emitted. Utilizing this phenomenon of being able to charge the dielectric either positively or negatively depending on the d.c. voltage of the surface, the tube can be cycled through the modes of prime (erase), write, and read.

In the table of Fig. 2, the applied voltages are shown for each mode of operation as well as the direction that the storage surface will charge during the priming and writing modes. In the priming mode, the storage screen is set to a voltage below the critical potential of the dielectric material and so, when the surface is scanned with a d.c. beam, it charges negatively to cathode potential. Any previously written signals are thereby erased and the surface is made ready for subsequent writing. For the write mode, the storage screen voltage is elevated substantially above critical potential. If sufficient d.c. current were scanned across the surface, it would charge to a value equivalent to the storage screen voltage. In practice, however, a video-modulated beam is used of such amplitude that even peak currents charge the dielectric only part way toward the equilibrium value. Using the typical numbers shown in the table, this would mean that different regions of the dielectric surface would be at potentials between 270 and 285 volts depending on the amplitude of signal written in each region.

The third mode of operation, reading, is attained by switching the storage screen voltage to a value such that the front surface of the dielectric is sufficiently negative to prevent electrons from passing through the storage screen toward the collector or output electrode. In regions where the dielectric surface is less negative than the cut-off value of voltage, a portion of the electron beam that is a function of the voltage of that surface will be allowed to pass through the storage screen and produce an output signal at the collector electrode.

In Fig. 3 we see a schematic diagram of one of the early Recording-Storage Tubes. As shown, the electron gun in this type is a simplified version of a typical cathode-ray tube gun. It has only three basic elements—cathode, control grid, and anode. The electron beam generated by this gun is focused onto the storage screen by use of an electromagnetic focus coil identical in design to commercial television focus coils but with a shell of homogeneous Swedish iron to minimize astigmatism. The deflection yoke required will depend on the scanning pattern. If a picture to be written and read uses television scan, a commercial television yoke can be used. If, however, the writing scan is of radar type and the reading scan is a raster, then the yoke will have to be designed to insure good operation in both fast and slow scanning speeds.

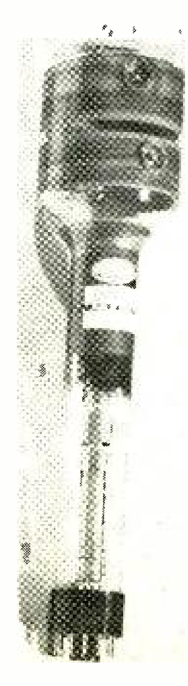
Another important design feature of the storage tube is



(Above) A new bright-display system is shown here being used by controllers at Indianapolis Air Route Traffic Control Center.

(Below left) Bright display with electronic map overlay showing air traffic in eastern Massachusetts. Artist's arrows indicate some planes in flight. Trails show previous positions.

A typical single-gun Recording-Storage Tube, Raytheon type CK7571/QK685.



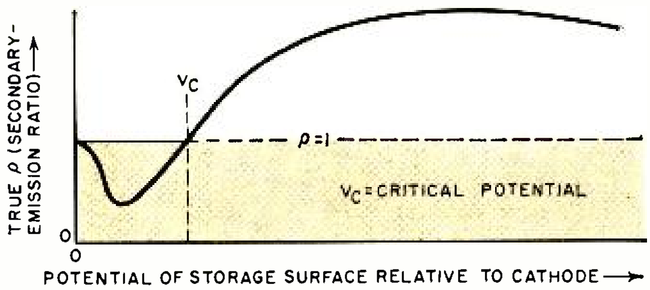


Fig. 1. Secondary-emission characteristics of storage screen.

the collimating lens system composed of the anode, anode coating, lens shield, and decelerator (first) screen. This lens is designed so that the beam strikes the storage screen at right angles regardless of initial scanning angle. The next element in the tube, the storage screen, has already been described. The final element, the collector, simply collects any portion of the electron beam which reaches it. The output signal is derived by passing the current received at the collector through a suitable value of load resistance and then amplifying the resultant voltage.

The specific qualities of most interest in storage tubes are: (1) resolution, (2) ability to maintain gray shades, (3) writing and erasing speed capabilities, and (4) the ability to use the device for scan-conversion. Resolution, or the ability to discriminate between objects that are close together, is properly described by plotting a curve showing the number of parallel lines written across the diameter as a function of the output response. If only a few lines are written, full amplitude response can be obtained whereas, if a very large number of parallel lines are written across the tube, the output may appear such that you can just barely discern that they are separate lines. Fig. 4 shows typical resolution curves.

The capability of storage tubes most commonly utilized is their ability to scan-convert. This capability has been enhanced still further in the latest storage tube design—a dual-gun kiloline Recording-Storage Tube. With such a tube it becomes unnecessary to rapidly switch between writing and reading operations since both the writing and reading guns can be operated independently and simultaneously. Moreover, deflection circuitry gets simpler, as does the design of the deflection yoke required, since the same circuitry and yoke need not be capable of passing different scan forms.

New Dual-Gun Storage Tube

In the cross-section drawing of the CK7702 dual-gun storage tube shown on the cover, we can see that one-half of the storage tube appears identical to the single-gun version. That is, we have an electron gun, a collimating lens system, a decelerator screen, and the storage screen. The collector or output electrode is, in this case, a screen rather than a solid plate. The electron gun is no longer a simple triode assembly but now contains a second grid and an electrostatic focus assembly. This change in gun design was dictated by the requirement for substantially higher resolution. Magnetic deflection and focusing are usually used but, in order to obtain uniform spot size across the complete storage area, the new gun also has the capability of providing a dynamic correction with scanning angle by use of electrostatic focusing.

The reading-beam signal is collected on the output electrode (collector) and, simultaneously, a portion of the writing signal strikes this same screen. The crosstalk expected in such a situation is eliminated by r.f. modulating the reading beam and using an r.f. amplifier for the output signal.

In the modern single-gun and dual-gun storage tube we have a resolution capability in excess of 1000 lines-per-diameter. For a point of comparison, the normal home television receiver uses 525 scanning lines but has the equivalent of only 350 lines resolution. The storage tube is able to write a complete gamut of gray shades as seen in a television picture. It can maintain these gray shade distinctions after hours of storage or after continuous reading for several minutes.

In the single-gun version of the storage tube, a picture can be written in the equivalent of the time for one television frame—1/30th second. Dual-gun tubes are only slightly slower than this. In either type of tube, picture information can be totally erased in one second or less.

Scan-Converted Radar

In its most important present application of scan-conversion, we convert radar PPI (plan-position indicator) data into a TV-type presentation to obtain the advantages of constant brightness, gradual decay for the generation of target trails, and integration of weak returns so that they will show more noticeably on the screen. The shortcomings of radar result from the fact that the persistence of the phosphor used in the standard display tube is insufficient to keep radar targets bright for the complete rotation necessary before the antenna is again pointed in their direction. Thus, the area of the screen immediately behind the location of the sweep is always quite bright, whereas the areas farther behind are considerably dimmer. Moreover, the brightness of most of the picture is so low as to require viewing the indicator in a completely darkened room if weak returns are to be seen.

MODE	STORAGE SCREEN	DIELECTRIC SURFACE
PRIME (ERASE)	30V.	30V. ↓ 0V.
WRITE (INPUT SIGNAL)	300V.	270V. ↓ 285V. ↓ 300V.
READ (ASSUMING -13V. CUT-OFF)	17V.	-13V. ↓ 0V. ↓ +17V.

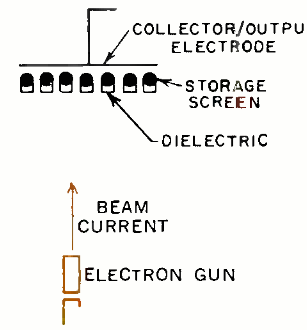


Fig. 2. Screen potentials for the various operating modes.

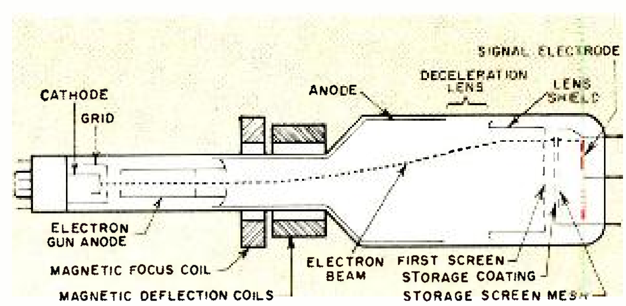


Fig. 3. Schematic of CK6835/QK464A, an early storage tube.

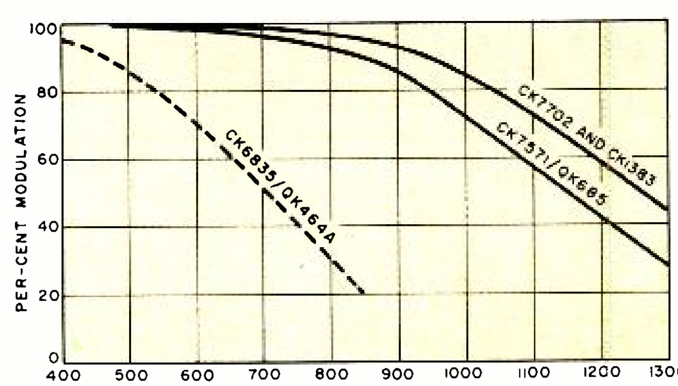
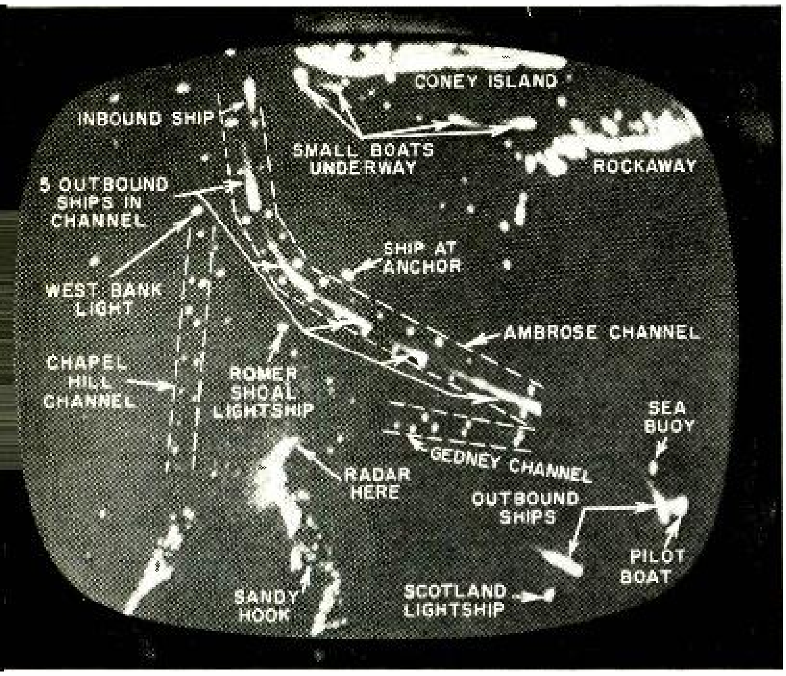
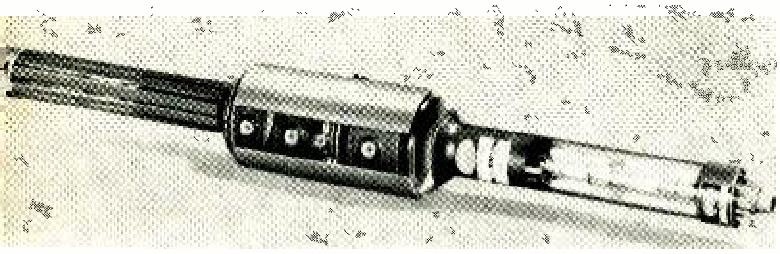


Fig. 4. Typical resolution curves of early and recent tubes.



"RATAN" televised radar presentation of New York harbor approach. Note particularly the trails on the 5 outbound ships in channel.



The dual-gun Recording Storage Tube type CK7702.

To overcome these shortcomings of PPI radar displays, all the information received by a radar in a 360° antenna rotation can be stored in a Recording Storage Tube. Using a dual-gun storage tube, this information can be scanned-out simultaneously and the output scanning can be a TV raster. The output presentation will show the full 360° of radar information in constant brightness. Moreover, since the display tube in the TV receiver is being scanned at a 60-field-per-second rate as in television, individual elements of phosphor are being energized very frequently and the picture becomes much brighter than a normal radar. Thus the term "bright display" is used for such a system, since daylight viewing of the display is possible.

Using another characteristic of the dual-gun storage tube, the ability to gradually fade old information while continuously writing and reading, we can generate a picture which is composed of signals received during a number of antenna rotations. In this situation, a moving target will appear as a series of dots with the most recently written dot very bright, forming a trail which shows the direction of the target's motion and, from a simple visual analysis of the distance between dots, a good approximation of the target's speed. The gradual-erase rate is adjustable over a range such that it is possible to make the target trails as long or as short as desired. We thus have a display system where target information is self-plotted so that an observer can view the directions of motion of a large number of targets simultaneously and can determine at any instant whether these targets are on collision course or, in a military situation, whether they are taking evasive action, such as turning sharply.

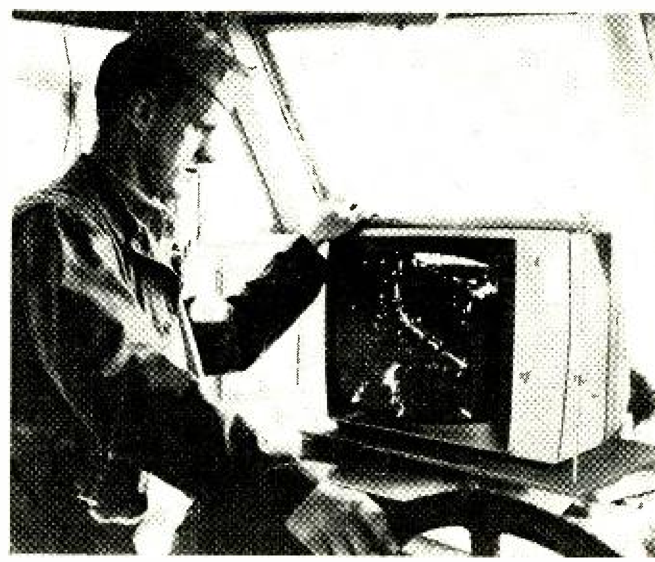
Air-Traffic Control

In the congested areas near large airports, hundreds of airplanes must be controlled and directed into traffic patterns at different altitudes. This requires a number of FAA air-traffic controllers continuously watching radar screens and talking the planes in and out. Using scan-converter equipment, it can be arranged that each controller has his own TV display of the radar or, if so desired, different controllers can be shown only the portion of the radar screen in which they are interested. For example, one controller may be concentrating on planes in the northeast sector and can be shown, on his TV monitor, only that area. Going a step further in the possibilities available with the scan-converter equipment, an electronic map overlay can be presented simultaneously with the radar picture so that the various targets are seen with reference to certain ground locations.

In addition to displaying stored radar video signals, the equipment now being produced for the FAA makes possible simultaneous display of radar-beacon information. The signals from beacon transponders in planes, in addition to enhancing the radar returns, can transmit altitude and identity data.

Coast Guard "RATAN" System

In the Coast Guard application mentioned at the beginning of this article, scan-converter equipment is hooked to the



"RATAN" broadcast being picked up by Coast Guard Patrol Boat.

Coast Guard radar at Sandy Hook, New Jersey. This radar continuously surveys lower New York harbor and monitors all incoming and outgoing shipping traffic. In normal usage the radar presentation does not usually show all the buoys marking the channels since buoys make poor reflectors of radar signals because of their small size. With the scan-converter equipment, however, the weak signals integrate on the storage surface and so the returns from buoys become accentuated. Using the gradual-fade characteristic of the storage tubes, each ship shows a trail or wake that clearly indicates its direction of motion.

Another novel technique used by the Coast Guard in this installation is that they not only convert the stored presentation into a television signal, but actually broadcast this television signal over New York u.h.f. television channel 47. Thus their own Coast Guard cutters and, in fact, any small boat in the harbor with a suitable TV set, can continuously see the radar presentation. This system is called "RATAN" (*R*adar *A*nd *T*elevision *A*id to *N*avigation).

Another type of scan-converter using Recording-Storage Tubes is designed for transmitting video information over narrow-band communications channels. A normal television picture contains frequencies up to 4 mc. High-quality dis-

(*Continued on page* 78)

TOLERANCE CALCULATOR

By ROBERT K. RE

Useful chart that can be employed to determine plus and minus values of a number within the tolerance limits of +100% to −75%.

MANY times during circuit testing and troubleshooting it is necessary to compute the tolerance of a component or parameter to determine if it is within limits. Specified, usually, as a per-cent of a nominal value, these calculations require the use of a slide rule or pencil and paper, in addition to taking up valuable servicing time.

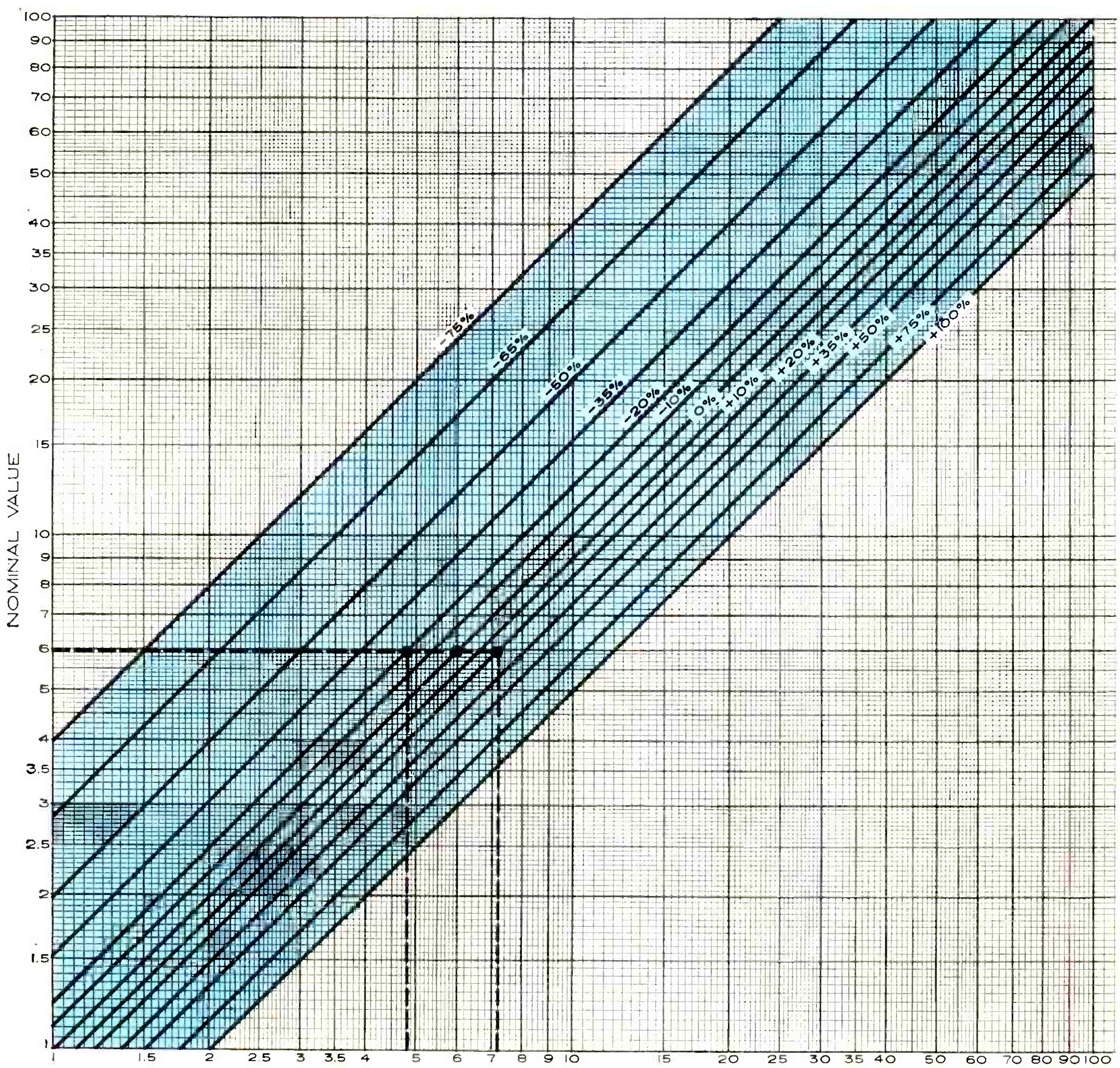
This tolerance calculator can minimize the time required for calculations giving the plus and minus values of a number within the tolerance limits of +100% to −75%.

Using the Graph

To use the calculator, find the number on the "Nominal Value" scale and go across to the ± % tolerance line desired. Drop down to the "Tolerance Value" scale and read the ± tolerance value. Thus the number 60 ±20% has tolerance limits of 48 and 72; this can apply to 6000 ohms, 600 kc., 0.6 mhy., $6.00, or just about any type of parameter or component value you may come across.

Don't worry about the decimal point: if you start out in kilohms, your answer will be in kilohms; if you start out in μf., your results will be in μf. (or their fractional parts).

Mounted on the wall near your bench, this calculator will always be ready to give you those tolerance values you require to help speed that servicing job. ▲



HOW TOUGH ARE THE PROPOSED CB REGULATIONS?

By R. L. CONHAIM, 19W7577

Neither too harsh nor unreasonable, the proposed rules are on the whole clarifications of those previously in force. The person using CB legitimately will be aided and only persistent violators will suffer.

Editor's Note: At the time this article was written, the rules discussed below were still in the form of an FCC proposal on which public hearings and comments were still being made. Since we feel there is a good chance that most, if not all, the proposed rules will actually go into force, we are presenting the following analysis of the most important of these rules and how they will affect future Citizens Band operations.

THERE have been many divergent opinions expressed about the proposed FCC Citizens Band Regulations. Whether the new rules are too stringent or not depends on your viewpoint. Looking at these proposed regulations from the viewpoint of the FCC, they are neither tough nor unreasonable, and in most cases are merely clarifications of rules already in effect. Due to the fact that the average Citizens Band user is not a professional communications person, familiar with FCC rule-writing techniques, there have been misunderstandings and misconceptions. Consequently the proposed rules in Part 19 will spell out in much greater detail what the FCC expects from users of the service.

Looking at the regulations from the user's standpoint, the proposed regulations seem excessively strict or not, depending on how any individual user is employing his Citizens Band equipment. If he is using it for business or personal business, as the service was intended, he has little about which to be concerned from the new regulations. They probably will affect him little, if at all. But, if he likes to gab, and uses CB to do it with, he is probably among the ranks of those who are proclaiming loud and long that the FCC is selling them down the river. From a close scrutiny of the regulations, the FCC is selling no one down the river. They are merely attempting to set things straight and make a try at bringing some order out of the chaos we refer to as the Citizens Band Radio Service.

In this article we will discuss some of the more important regulations and how they affect class D operation. The essence of proposed regulations is given first and the comments are those of the author. Anyone interested, however, should draw his own conclusions after reading all the proposed regulations in FCC Docket 14843. You probably won't be able to get a copy from the FCC, since only a limited number were printed. But, if your area has a good sized library, or an industrial organization that subscribes to the Federal Register, you'll find the complete proposed regulations in the November 22, 1962 edition. The proposals take almost eight pages of solid printed matter in the Federal Register. Obviously, we do not have space to show them all here in this article, let alone discuss them in any detail. But, since most are clarifications of already existing rules, let's discuss those which would seem to affect us most or about which there has been some controversy.

In the introductory remarks to the proposed regulations, the FCC points out the very large number of violations which they have monitored and the complaints received of interference from licensees. They point up the tremendous growth of the service from 40,000 stations in 1958 to 350,000 in November of 1962. They also emphasize the fact that abuses have occurred mainly between stations of different call signs, and some of the proposed regulations are intended to remedy this situation.

In discussing the more important new regulations, we'll indicate the "meat" of the Part 19 rules to see how this same paragraph is presently worded.

Paragraph 19.12 (a) eliminates unincorporated associations from eligibility to hold a class D license. This is modified by paragraph (b) allowing such an unincorporated association to hold a license provided it can show that the proposed radio operations are not feasible or may not be as efficient or economical when conducted under station licenses issued to individual members.

Comment: *This apparently is aimed at Citizens Band Associations, many of whom have applied for licenses in their association names. The regulation has evoked a number of protests, but seems to be quite harmless to the author. There are, of course, ways around such a regulation. In many states such associations can incorporate and, legally, there are many reasons why they would be better off as incorporated associations. The Dayton Area Citizens Radio Association, for example, is incorporated as a non-profit corporation under the laws of the state of Ohio and, as such, enjoys certain privileges under the law. In addition, the liability for debts of the association, on the part of individual members, is removed by such incorporation. An incorporated association is on much more solid footing than one formed by a few buddies as an informal thing.*

Paragraph 19.24 (b) spells out in detail the method of handling a change in permanent mailing address. It requires that the licensee notify the Engineer-in-Charge of his FCC District 30 days before or after such change of address of his new and old address and the fact that application for modification of his license has been filed with the Commission. Otherwise, he cannot operate his CB equipment. Having given this notice, and having filed an application for modification, he can continue to operate at the new location until a final determination with respect to his application for modification has been made by the Commission.

Comment: *This is a good rule for two reasons. One, it* *puts more emphasis on the necessity to notify of a change of address. This is something few CB-ers have done, especially those who cherish their low "W" numbers. It also gives the Commission the opportunity to review the licensee's need for CB and to examine his file to see if he has been one of those who has caused a large number of complaints.*

Paragraph 19.25 (c) provides in much greater detail the antenna height requirements. Specifically, this paragraph requires that the antenna shall not exceed 20 feet in height above ground level; or the antenna shall not exceed by more than 20 feet the height of any natural geological formation, tree, or man-made structure (other than an antenna supporting structure) on which it is mounted; or, if the antenna is mounted on the transmitting antenna structure of another authorized (such as an amateur) station, the antenna shall not exceed the height of that structure; or if the antenna is mounted on an antenna structure used solely for receiving purposes, the antenna shall not exceed 20 feet in height above the ground level, geological formation, tree, or man-made structure upon which such receiving antenna structure itself is located. In other words, we still have the 20-foot height restriction, but if you're using a tower, say for an amateur station, the top of your antenna cannot exceed the height of that tower. If you're using a tower for a television receiving antenna, the top of your receiving antenna cannot be any higher than 20 feet from whatever that tower is mounted on.

Comment: *Despite what you may have read, this clarification does not restrict the law-abiding CB user in any way. It only spells out for the chisler that he can't get around the 20-foot restriction by putting up a tower for a TV antenna or by going higher than the top of a tower used for a transmitter licensed in some other service.*

Paragraph 19.31 (d) outlines the frequencies available for class D service. It lists the same 23 channels we have been using, but it prohibits communications between stations of different call signs on all channels except channels 12, 13, 14, 15, and 23, except for Civil Defense or emergency communications.

Comment: *There have been loud wailings about this restriction. Some writers have claimed that the Commission has overlooked the fact that channels 9 and 11 have been used nationwide for legitimate communications between stations of different call letters. We are inclined to agree with this objection. There would be less confusion if two of the five channels chosen were channels 9 and 11. Another complaint is the fact that channels 12, 13, 14, and 15 are subject to diathermy whereas higher or lower channels are not. This is not a valid objection. As a matter of fact, all CB class D channels are subject to diathermy interference. The FCC requirements as outlined in section 18 of the Rules and Regulations, list one Industrial-Scientific-Medical frequency as 27.120 mc. ± 160.0 kc. Because of this large permissible tolerance, diathermy can legally exist on any frequency from 26.960 mc. to 27.280 mc., which covers the entire class D Citizens Band and more. No channel is immune from diathermy interference.*

Paragraph 19.32 modifies the requirements for station power, providing for class D transmitters a power input of 5 watts, measured at modulation peaks, and a power output of 3.5 watts.

Comment: *This is a perfectly reasonable requirement and is aimed at those who attempt to use trick circuits or overmodulation to punch their signal through. Normal efficiency of a good transmitter output is about 70% of its input power. Three and one-half watts is 70% of five watts, so the Commission requirement is within normal limits. However, few CB transmitters, measured by the author, provide such high efficiencies. It is not at all unusual to find one-watt output for five watts input. There are trick circuits, such as grounded-grid amplifiers with high driving powers, in which the driving power is added to the input power to produce so-called efficiencies approaching 100%. It is this kind of circuit which the Commission is trying to avoid and, in the author's opinion, rightly so.*

Paragraph 19.34 (d) permits the use of tone signals to actuate receiver circuits such as tone-operated squelch, but prohibits the use of tones for attracting attention or the control of remote objects or devices.

Comment: *A good rule, designed to eliminate those annoying "turkey-calls."*

Paragraph 19.61 outlines permissible communications. It includes the following:

1. Communications directly related to and necessary for the efficient conduct of the business or household of either or both licensees or to effectively control the movement of vessels, aircraft, vehicles, or persons.
2. Communications directly related to and necessary for the performance of civic functions such as the activities of volunteer fire departments, auxiliary police, and civil defense, or in connection with public events such as parades, etc.
3. Emergency communications.
4. Communications by a mobile station for the sole purpose of requesting routing directions, assistance to disabled vehicles, etc.
5. Upon specific Commission approval, shown on the license, necessary communications between CB stations at fixed points between which public telephone service is not installed.
6. A licensee of a class D station may operate a single unit for communications which are otherwise permitted under this paragraph to fulfill one-way communications requirements to receiving units or for communications with units of other stations.

Comment: *These rules actually clear up many misunderstandings and, in fact, make legal certain types of communications which have been interpreted as illegal in the past.*

Paragraph 19.62 now covers prohibited uses. Among those things where are now specifically prohibited are the following:

1. Discussion, comment, or advocacy of social, religious, or political doctrines.
2. Malicious interference with the communications of another station.
3. Superfluous communications such as transmissions which are not necessary to properly engage in communications which are otherwise permissible.
4. The use of the word MAYDAY or other distress signal unless a ship, aircraft, or vehicle is threatened by grave and imminent danger and requests immediate assistance.
5. Communications to stations of other licensees which relate to technical performance of any radio equipment including such things as signal strength or frequency stability reports.
6. For advertising, soliciting, or promoting the sale of any goods or services.
7. For transmitting messages in codes, ciphers, or *via* speech scramblers, except that conventional nationally or internationally recognized operating signals and abbreviations may be used.
8. Communications over a distance of more than 150 miles.
9. A licensee of a Citizens Radio station who is engaged in the business of selling CB equipment shall not allow a prospective customer to operate under his station license. In addition, all communications by the licensee for the pur-

PROPOSED CB REGULATIONS

pose of demonstrating such equipment shall consist only of brief messages that are addressed to other units of the same station.

Comment: *The author believes all of these restrictions are fair and detail specific things which have bothered CB users or have been the subject of conflicting interpretations. The 150-mile limit should bother no one since ground-wave transmissions rarely involve more than 20 or 30 miles except over water or in high terrain on a line-of-sight basis from mountain top to mountain top. The restrictions imposed upon sellers of CB equipment is a reasonable one, and certainly the honking of one's own horn about equipment, services, or religious or political doctrines are things that don't belong on the Citizens Band.*

Paragraph 19.64 (b) specifically limits an employee of a licensee to use the licensee's equipment solely for the licensee's business. Subparagraph (d) of this section provides that when a CB station license has been revoked, that individual shall not be permitted to operate any unit of the CB station of another person until such time as he has again been issued a valid station license in this service by the Commission.

Comment: *Both these regulations are good. In the past, employees who have been loaned transceivers for use in their cars have treated the equipment as though it were their personal property and have used the equipment for after-hours gabbing. The new regulation would eliminate this. As for the provisions in subparagraph (d), anyone who has violated the rules of the Commission so flagrantly as to have his license revoked, doesn't belong on the band.*

Paragraph 19.65 covers telephone answering services. In general, it permits a licensee to have one of his transmitters installed on the premises of a telephone answering service, for use only in communicating with the licensee. However, a station licensed to a telephone answering service cannot be used to relay messages or transmit signals to its customers.

Comment: *This section has been misinterpreted by some writers as setting up special privileges for telephone answering services which it does not. Rather, it provides for the convenience of allowing a small businessman to supply his telephone answering service with equipment solely for communicating with him and, as such, is a good thing.*

Paragraph 19.66 covers the length or duration of transmissions. Among other things, it specifically limits the use of tones to activate squelch devices to 5 seconds. It further limits conversations between different licensees of class D stations to 3 minutes or less, with a silent period of at least 5 minutes before any further transmissions are made. It should be noted that a station involved in such a 3-minute or shorter conversation must remain silent for 5 minutes thereafter, and cannot use his transmitter to call the same or any other station during this silent period. Conversations between stations of the same license are not so restricted, but are limited to the minimum practical time. If during the five-minute silent period, the station required to remain silent is called by another station, he may acknowledge the call, requesting the other station to stand by for the duration of the silent period.

Comment: *These restrictions apply to any and all persons and all channels. You can't, as many persons do now, transmit for a few minutes on one channel and then switch over to another channel for other conversations. You must remain silent after a three-minute conversation, no matter to whom you want to talk and no matter whether you are licensed to operate more than one station. The author believes this is a good restriction. It does not apply to emergency or Civil Defense communications. Really necessary communications rarely take more than a few seconds. It is amazing the amount of stuff you will hear on CB of such a trite nature that the persons involved would never even dream of using the telephone for such drivel.*

Paragraph 19.68 deals with the subject of station identification. It requires that stations identify themselves in English, using all their letters and numbers. Standard phonetic alphabets, nationally or internationally recognized, may be used, as well as any unit designator or special identification. The call sign must be given at the beginning and end of each transmission, or where conversations of longer than 3 minutes are permitted (such as between units of the same license) the call letters shall be transmitted at least every three minutes. This section also permits transmission to a person by name, if you don't know his call letters. For example, if you know the John Jones Company operates on channel 15, and you wish to communicate with them, you may call by saying "This is 19W7577 calling the John Jones Company." The station initiating the call must transmit the previously unknown call letters at the end of the message.

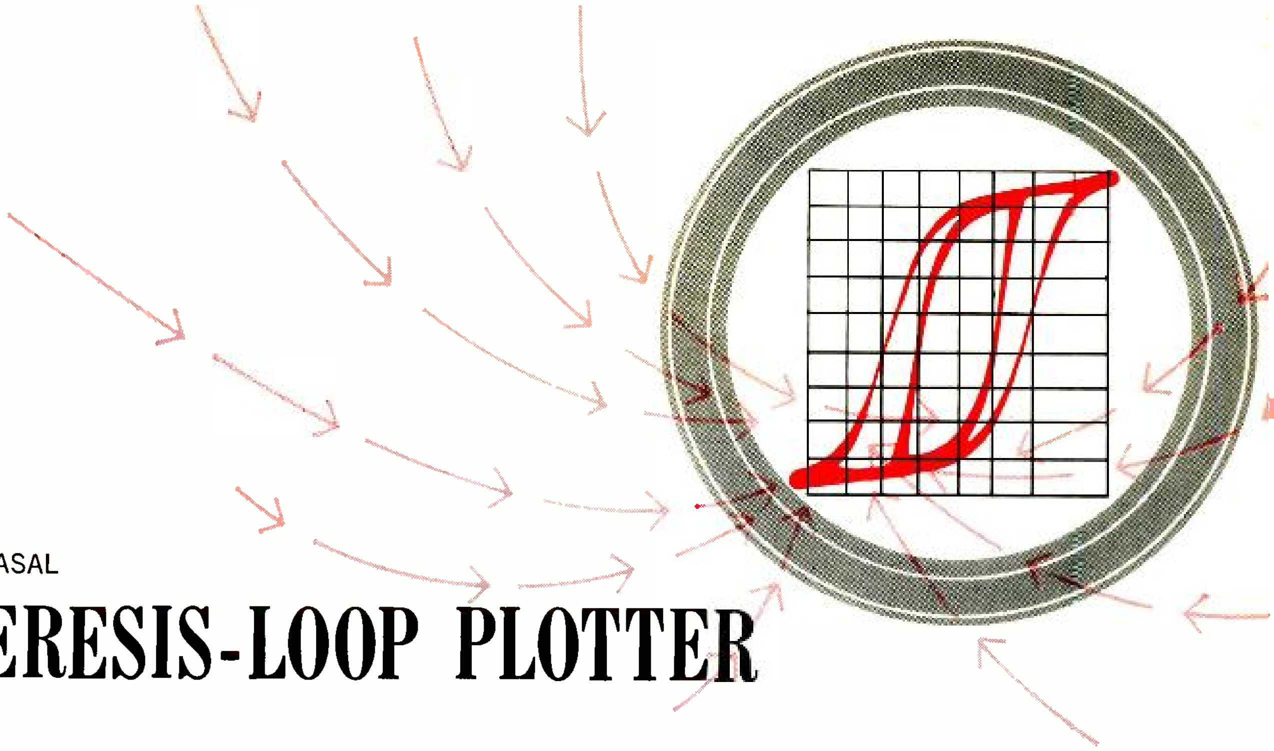
Comment: *This is actually a welcome relaxation of the rules. A mobile station going into a strange town may know that a certain motel has CB equipment, although he may not know the call sign. He may then call the motel by name using any of the five channels allotted for inter-station communications. Likewise a transmission intended for several members of an organized group such as a volunteer fire department or Civil Defense group may be directed to the group by name rather than to individual license call signs.*

Paragraph 19.71 covers operator license requirements. It specifically allows a CB-er to conduct tests of his transmitter providing that all of the following conditions have been met:

1. The transmitter must be crystal-controlled within the prescribed tolerance.
2. The transmitter shall either have been factory assembled or shall have been provided in kit form with *all* components and detailed instructions furnished by the kit manufacturer.
3. The frequency-determining elements of the transmitter, *including the crystals* and all other components of the crystal oscillator circuit, shall have been pre-assembled by the manufacturer, pre-tuned to a specific frequency, and sealed by the manufacturer so that replacement of any component or any adjustment which could cause off-frequency operation cannot be made without breaking such seal and thereby voiding the certification of the manufacturer.
4. The equipment shall be so designed that none of the adjustments or tests normally performed, may be reasonably expected to result in off-frequency operation, excessive input power, overmodulation, or excessive harmonics or other spurious emissions.
5. The manufacturer shall have certified in writing to the purchaser of the equipment that the equipment has been designed, manufactured, and furnished in accordance with the specifications contained in the foregoing subparagraphs of this paragraph.

Comment: *Note that these conditions apply only if the licensee wants to adjust the transmitter himself. Equipment not conforming to these specifications can still be used if adjustment or repair is done by or under the supervision of a person holding a first- or second-class commercial radiotelephone license.*

(Continued on page 82)



By JOHN H. FASAL

HYSTERESIS-LOOP PLOTTER

With this adapter the properties of magnetic materials can be displayed on a scope and evaluated for use as cores of chokes or transformers.

WHEN designing or experimenting with transformers and inductors, it is useful to be able to determine magnetic characteristics of the laminations. This hysteresis-loop plotter is a simple device that can be used with a low-frequency scope and a power supply with an output of 100 v. @ 25 ma. d.c., and 6.3 v. at 1 amp., a.c. Batteries may also be used instead of a power supply.

In spite of its simplicity, the loop plotter has many features, the most important of which are the following: (1). There is no need to specially prepare sample material as long as it has a ⅛" diameter hole. (2). Only a few laminations are necessary to obtain reliable results. (3). The hysteresis loop can be displayed on the scope face as a motionless Lissajous figure and may be easily copied or photographed. (4). The device may be calibrated for absolute measurements of magnetic-iron characteristics if the flux of the test sample is considered equally distributed over the whole magnetic path. Toroid coils are particularly suited for such absolute hysteresis measurements.

Principle of Operation

Refer to Fig. 1. In series with the primary of a one-turn transformer ($T2$) connected to a sinusoidal voltage e is a resistor, R, the voltage drop e_R across which is proportional to the magnetizing current i_m. This current produces in the laminations under test a magnetic flux that has an instantaneous value ϕ. The flux, ϕ, and the magnetizing current i_m are *not* proportional to each other; their relation is defined by what is called a "hysteresis loop."

Across the secondary of $T2$ will be a voltage e_o which is proportional to the instantaneous *rate of change* of the magnetic flux. It is beyond the scope of this article, but it can be shown mathematically that voltage e_o, when integrated, is proportional to the instantaneous value of the flux, ϕ. In practical terms this means that e_o after integration is proportional to the instantaneous value of the magnetic flux in the iron. To produce a hysteresis loop on the screen of the scope, the input to the horizontal amplifier is the voltage drop across resistor R, horizontal deflection at any moment is proportional to the magnetizing current, i_m, and the vertical deflection is proportional to the instantaneous flux ϕ, or induction.

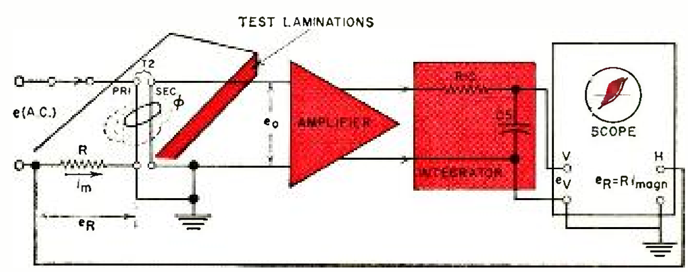
The integrator circuit ($R10$ and $C5$) is an RC network similar to a low-pass filter. There is an important condition that must be satisfied for the integrator to work properly. The capacitive reactance X_c of $C5$ relative to the lowest input frequency must be no more than 1/25th the value of the series resistor, $R10$. In this case $R10$ is 270,000 ohms. The capacitive reactance at 60 cps should therefore be no more than 10,000 ohms which would be the reactance of a capacitor of approximately .25 μf. A 1-μf. capacitor was chosen for the circuit to meet the requirement easily.

Construction of Transformer T2

The most complicated construction is transformer $T2$, which is shown in Fig. 2. Its magnetic circuit is the test laminations into which it must be able to be inserted and removed. To accomplish this, both its primary and secondary "windings" are "one turn" only and consist of a thin copper tube which is the secondary and an insulated coaxial wire pulled through the tube, which is the primary. Both primary and secondary are passed through the mounting holes of the test laminations so that the magnetic flux is distributed in the laminations near the hole in concentric circles around the conductors as in Figs. 1 and 3. The copper tube is soldered into a banana jack and the center contact is wired to the top of the secondary of $T1$.

The length of the copper tube should be approximately 2 to 2½ inches and its outside diameter ⅛". A stiff piece of 12-gauge copper wire approximately 3" long is then carefully covered with insulated sleeving. On the upper (right in the diagram) end of the wire, solder a small piece of copper

Fig. 1. A "transformer" (T2) with single turns samples the magnetic field in the core material and displays the loop.



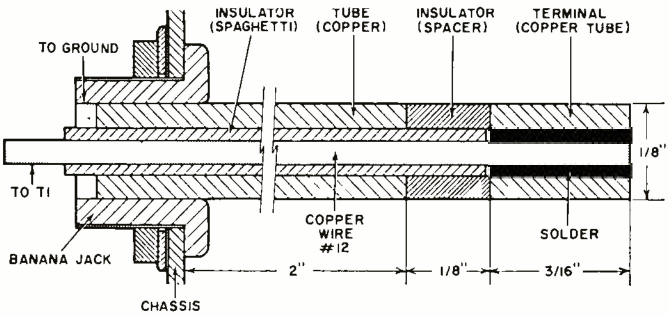


Fig. 2. Construction details for the sampling transformer.

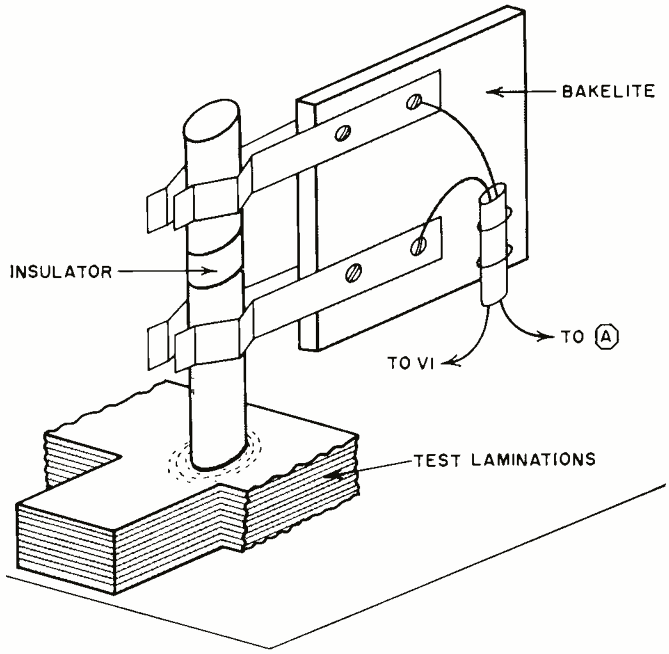


Fig. 3. Mounting of T2 and its insertion in test material.

tubing approximately 3/16" long. This will serve as a contact terminal and must be insulated from the larger copper tube by an insulating spacer of the same diameter as the tube ⅛" long and fitted over the insulated center wire. The prepared insulated inner wire is passed through the copper tube and adhered to it by means of a reliable adhesive (epoxy). After the adhesive hardens, the whole assembly should be sanded so its diameter will be uniform and the laminations will slide over it easily.

The magnetizing current is applied between the lower and upper contact of the inner wire. The induced secondary voltage appears between the lower end (ground) and the upper end (below the insulating spacer) of the exterior tube. The lower connections of both primary and secondary are permanently connected into the circuit in the banana jack. Contact to the upper part of the assembly is established by means of a removable clamp, with two pairs of contacts insulated from each other, and mounted on a small piece of Bakelite (see Fig. 3).

The complete schematic is shown in Fig. 4. The transformer that supplies the magnetizing current should be a small 50-va. transformer with a secondary voltage of at least 10 v. at 5 amp. (8 a. for short operation). The magnetizing current i_m can be adjusted to one of three values by connection through *R*3, *R*4, or *R*1. (You may use a tapped resistor instead of *R*3 and *R*4.) The current passes through the primary (inner wire of *T*2) and through *R*1. The voltage drop across *R*1 is applied to the horizontal input terminals of the scope. A 1-μf. capacitor (*C*1) connects one side of the primary of *T*1 to ground.

The input to the amplifier is the output of *T*2. From the plate of *V*1 to ground there is a 4000-μμf. capacitor (*C*2) which corrects for the phase shift between the horizontal and vertical outputs. The value of this capacitor must be determined by experiment so that the hysteresis loop is properly pointed on its extreme points and does not go over in small loops or have round corners. In Fig. 5A the loops in the end points are the result of undercompensation (*C*2 is too small). The loop (B) with the round corners and the larger area is caused by overcompensation (*C*2 is too large).

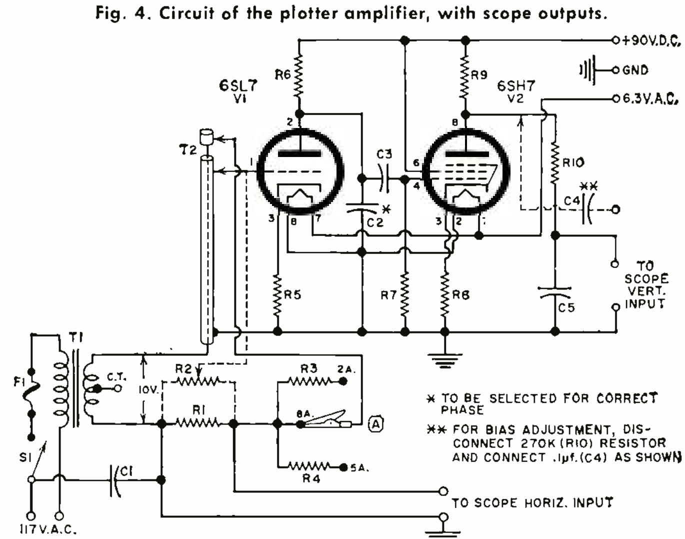
The high time constant of the coupling circuit (2 μf. and 1.2 megohms) assures high gain at 60 cps. The value of cathode resistor *R*8 is somewhat critical and should be adjusted for a low-distortion output. The Lissajous of a distorted hysteresis loop is shown in Fig. 6A. There is a simple way to check if the hysteresis loop is free of distortion. Instead of taking the input to the amplifier from the secondary of *T*2, you can take a small fraction of the horizontal output voltage as shown by the dotted line to *R*2, and apply it to the grid of *V*1. In doing this the input to the amplifier will be a sinusoidal voltage and therefore the output before integration will also be sinusoidal. This voltage may be obtained by disconnecting *R*10 and connecting *C*4 to the plate of *V*2 and the output terminal to the scope vertical input.

The pattern obtained for approximately equal vertical and horizontal deviations should be a straight line. With increasing input voltage to the amplifier, the straight line will become curved at its extremes. To be able to determine the beginning deformation it is necessary to reduce the vertical gain of the scope. If the bias (value of *R*8) is correct, the deformation should begin simultaneously at both ends of the straight line. This means the bias setting has placed the operating point in the middle of *V*2's characteristic curve, between cut-off and saturation. To determine the correct value for *R*8 use a resistance decade. If a narrow ellipse appears instead of a straight line, there is phase shift between the vertical and horizontal outputs which can be corrected by changing the value of *C*2.

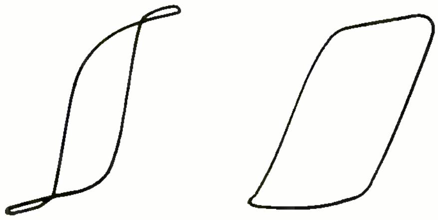
The integrated voltage across *C*5 may be fed directly to the input of the oscilloscope, if a blocking capacitor is incorporated in the instrument's input.

The following specifications, for the oscilloscope to be

Fig. 4. Circuit of the plotter amplifier, with scope outputs.

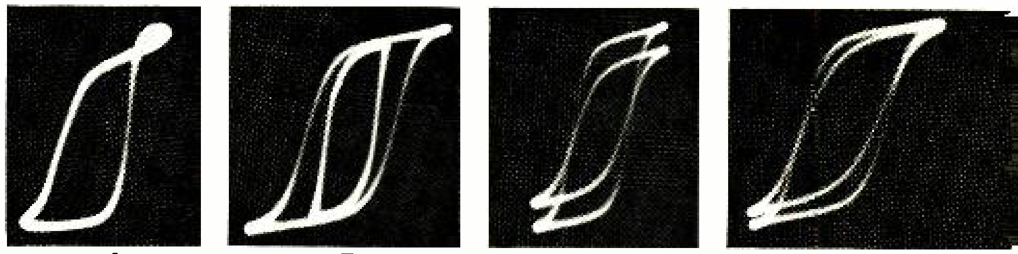


R1—1 ohm, 20 w. res.
R2—1000 ohm, 10 w. variable res.
R3—6 ohm, 20 w. res.
R4—4 ohm, 20 w. res.
R5—1500 ohm, ½ w. res.
R6—470,000 ohm, ½ w. res.
R7—1.2 megohm, ½ w. res.
R8—6800 ohm, ½ w. res.
R9—100,000 ohm, ½ w. res.
R10—270,000 ohm, ½ w. res.
C1—1 μf., 600 v. capacitor
C2—4000 μμf., 400 v. capacitor (see text)
C3—2 μf., 400 v. capacitor
C4—.1 μf., 400 v. capacitor (see text)
C5—1 μf., 400 v. capacitor
T1—Power trans. pri: 117.; sec: 10 v. c.t. @ 10 amp. (Stancor P-6461 or equiv.)
T2—See text
S1—S.p.s.t. spring-loaded toggle switch
F1—3 amp fuse
V1—6SL7 tube, V2—6SH7 tube



(A) (B)

Fig. 5. Display is phased correctly by adjusting value of C2. (A) Undercompensation (C2 is too small). (B) Value of C2 has been overcompensated.



A B C D

Fig. 6. (A) Display distorted by incorrect V2 bias. Adjust value of R2. (B) At saturation (larger loop) display spreads horizontally. (C) Another comparison of loops for two materials with different saturation points. (D) Loop enclosing larger area indicates greater iron losses. (B), (C), and (D) are double exposures.

used in conjunction with the plotter, are not hard to meet:

Vertical-channel a.c. input: approximately 30 mv./inch sensitivity.

Horizontal-channel sensitivity: 1 volt/inch.

Low-frequency limit: 5-10 cps for distortion-free and phase-correct amplification at 60 cps.

If the scope has a d.c. input, it should be used for the best frequency response. If the d.c. input is used, a large capacitor (2 μf. with a 1- or 2-megohm resistor to ground) has to be connected between the plotter output and the scope input in order to keep the d.c. component of the output voltage from being applied to the scope input.

Construction

All components are mounted on a metal chassis 9½" x 4½" x 1½" as shown in Fig. 7. Transformer *T2* is located on the left side of the chassis. Space for the largest sized test samples must be provided around *T2*. *T1* is mounted to the right of the 20-watt resistors (*R3* and *R4*).

These resistors become quite hot when the full current of 7-8 amperes (corresponding to 50-70 watts) passes through them. They must be located so that the heat will not affect other components. Full current should never be applied for longer than necessary since all component values are based on operation periods of 10-20 seconds. This is sufficient time for observing, tracing, or photographing the pattern. In order to avoid prolonged operation, the "on-off" switch is spring loaded so that it will automatically disconnect the transformer whenever it is released.

Using the Plotter

Connect the outputs of the plotter to the vertical and horizontal inputs of the scope and apply power. The laminations (a ½" to ¾" stack is sufficient for a good pattern) which are to be tested should be carefully lowered over *T2*, and the connecting clamp put in place. Take care in setting the clamp to make sure that there isn't a short between the primary and secondary windings.

There is no fixed rule about the number of laminations to be used since the height of the curve depends not only on the section of the magnetic circuit but also on the quality of the alloy.

After putting the clamp in place, wait for 1-2 minutes for the capacitors to charge and for the spot on the scope to be centered. Next, apply the magnetizing current and note the pattern on the scope screen. Its width and height has to be set conveniently by means of the gain controls on the scope. The value of the magnetizing current determines the saturation condition of a specific magnetic alloy. For a given current, the quantity of laminations under test has no influence on the appearance of the hysteresis loop. A larger number of laminations increases only the total iron sections, and in the same proportion the total flux, without changing the distribution of the magnetic flux in the lamination itself. The increase in the total flux increases the secondary voltage of *T2*. After integration this voltage is proportional to the flux and causes the vertical deflection of the hysteresis loop. For

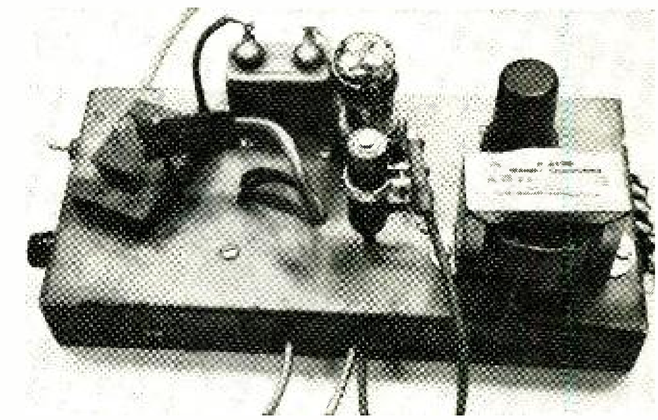


Fig. 7. In layout, leave space for samples around T2 (left).

comparative measurements of permeability or reluctance, the thickness of the test samples must be the same. The value of the magnetizing current however determines the intensity of the magnetic flux in each lamination and therefore the flux at which saturation occurs.

In order to compare the quality of two types of iron in terms of their saturation point, the magnetizing current has to be increased for each type of lamination until the hysteresis loop goes over in an almost horizontal line. In Fig. 6B two hysteresis loops were photographed superimposed. The smaller, inner loop is for a 5-amp magnetizing current, the larger loop was made with a current of 8 amps. Saturation at 5 amps has not yet occurred, however at 8 amps, the curve is just beginning to go over in a straight line at its extreme points indicating that the magnetic circuit has become saturated. Since the horizontal deflection is proportional to the magnetizing current (voltage across *R1*) the length of the horizontal deflection at the moment saturation begins is a direct measure of the magnetomotive force and the field strength. The vertical deflection permits a determination of the amount of magnetic flux at that point at which saturation takes place.

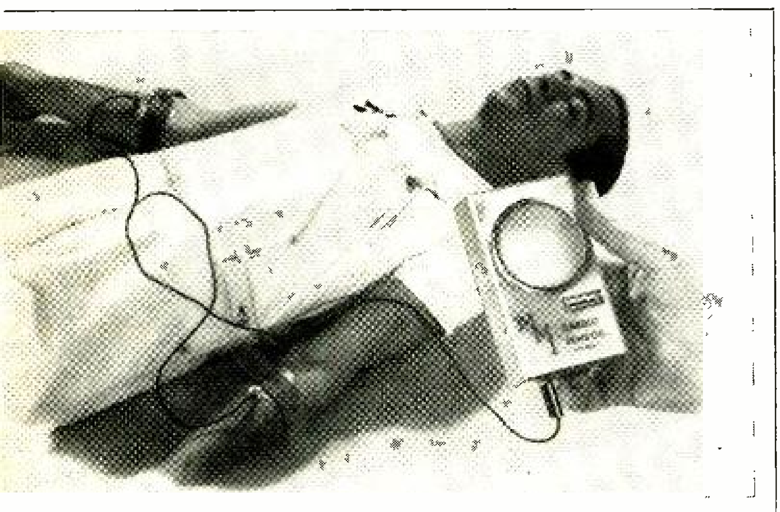
It is well known that the slope of the hysteresis curve is a direct measure of the permeability of the alloy. The higher the permeability, the steeper the slope. In order to compare two samples of iron, the scope vertical and horizontal gain controls must be set so that a full hysteresis loop can be displayed on the screen without readjustment of the controls.

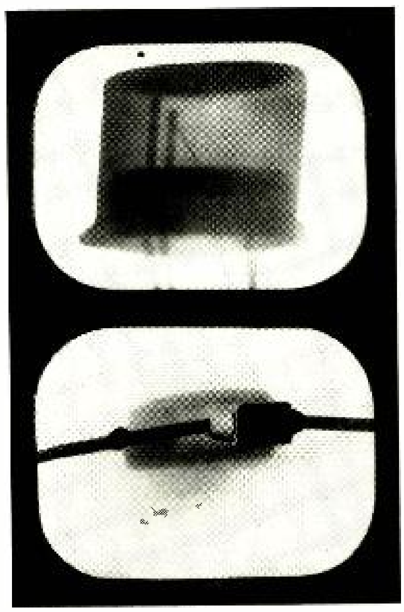
Two hysteresis loops of two different lamination samples having the same physical dimensions are shown in Fig. 6C. Both curves were made with the same current, therefore both samples were tested with the same magnetic potential. The smaller, less steep loop is that of iron with a lower saturation point and lower permeability. Notice that the widths of the two curves are identical.

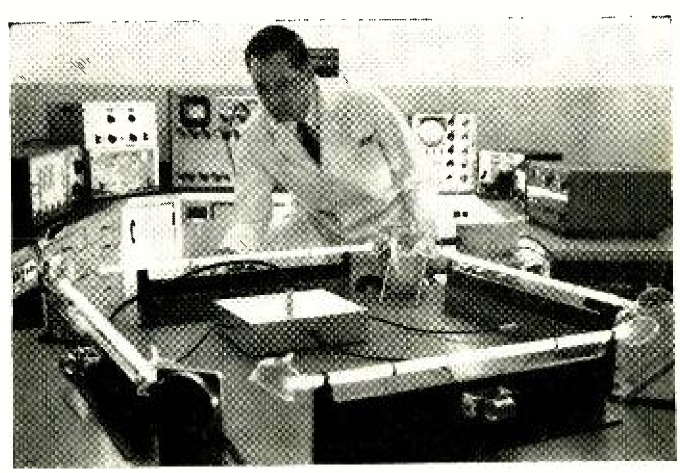
The losses in the iron are determined by the area enclosed by the hysteresis loop. In contradistinction to the first measurements of saturation and permeability, the scope setting for the comparative measurements of the losses has to be

(*Continued on page* 86)

RECENT DEVELOPMENTS in ELECTRONICS

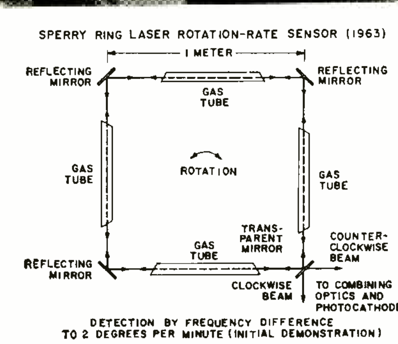




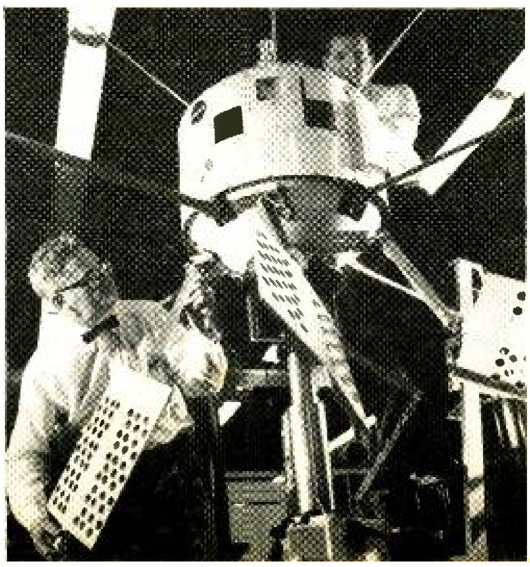


Portable Heart Monitor. (Above) An ultra-sensitive, transistorized instrument that picks up the electrical activity of the heart after the stethoscope has lost the heartbeat sound and the pulse has totally disappeared is shown above. The instrument, called the "Cardio-Sensor" by its manufacturer (Mastercraft Medical & Industrial Corp.), produces an audible tone and a meter indication of the heart signals. In many respects, the instrument performs some of the functions of the more complex and bulky electrocardiograph, except that written records are not made by the heart monitor for study and analysis. The unit, intended mainly for rescue work, costs just under $100.

X-ray Vidicon Camera Tube. (Above right) A new closed-circuit TV camera tube is sensitive to x-rays projected through small assemblies for non-destructive testing. It can also be used for certain biological studies. The tube, developed by Machlett Laboratories, captured the above analytical views of a transistor and a diode after encapsulation. Magnification up to 50 times can be accomplished without loss of definition. Wires visible in the televised x-ray of the transistor are actually .002" in diameter.... **Ring Laser Senses Motion.** (Right) A closed-circuit or ring laser that whirls oppositely rotating beams of infrared light around a ring to measure changes in direction may soon rival the gyroscope as an automatic guidance device for ships, planes, missiles, and space vehicles. Developed at the Sperry Rand Corp., the device uses the speed of light to sense motion rather than the much slower rotation of a small, machine-made wheel found in a mechanical gyro. One beam of light goes around the closed loop clockwise, while the other travels counterclockwise. If the entire system rotates, there will be a slight frequency shift due to Doppler effect. An audio frequency beat note results when the two light beams are combined in a phototube. The laser requires neither bearings nor other moving parts employed in mechanical gyros.



Storms Via "Tiros" TV. (Left) Some recent storm photographs transmitted by the television system of "Tiros VI" are shown here. Pictures depict dangerous swirling masses of clouds forming the vortex of a storm in the south Indian Ocean. The cloud movement was actually stretched out over thousands of miles. Well over 200,000 TV pictures of the earth's cloud cover have been transmitted by the meteorological satellite system since "Tiros I" was launched in April, 1960. Since that time, six such satellites have been launched and orbited successfully in six tries. Their average lifetime was more than twice the 90-day designed and projected operational life of each satellite. Currently, both the fifth and sixth RCA-built satellites are still operating and providing world-wide weather information.



Communications Satellite Ship. (Right) The first communications satellite ship, the USNS "Kingsport," heads for sea trials before joining the Military Sea Transportation Service. The ship is being used as a mobile terminal for the support of NASA's "Syncom" communications satellite. Although the first launch failed, another satellite is slated to be boosted into a 22,300 mile high "stationary" orbit. The ship's big ball is a 53-foot air-inflated radome, housing a 30-foot antenna. A helicopter landing platform is astern. The shipboard communciations equipment was developed by Bendix for the Navy's Bureau of Ships. The ship will be used to test world-wide satellite communications capabilities and provide data for developing new design concepts. . . . **Radio-Noise Satellite.** (Below right) Westinghouse engineers examine solar paddles and antennas of an engineering test model of the S-52 satellite structure being built by the company's air arm division for the National Aeronautics and Space Administration. S-52, a joint U.S.-United Kingdom project, will be used to measure galactic noise, the r.f. signals generated by stars and galaxies; the distribution of ozone in the atmosphere; and the quantity and size of micrometeoroids in space. British scientists will provide the instrumentation for the satellite. Following this model, two prototypes and two flight models will be built before S-52 is actually launched into space. The project is managed and technically supervised by NASA's Goddard Space Flight Center at Greenbelt, Md.

Mel Rose	Federal Allies Corp. 875 Broadway Brooklyn, N.Y.	
Mitsubishi	Lissner Trading Co. 1111 N. Cherry Street Chicago 2, Illinois	Mitsubishi Electric Co., Ltd. 3 Marunouchi 2-chome Chiyoda-Ku, Tokyo, Japan
Monarch	Spera Electronics 3710 33rd Street Long Island City, N.Y.	
Nanaola		Nanao Radio Co., Ltd. 1060 Shimomeguro 4-chome Meguro-ku, Tokyo, Japan

Tempest	Azad International 1133 Broadway New York, N.Y.	
Ten	Sanvo Trading Co. 149 Broadway New York, N.Y.	Nobe Nogyo Co. 7 Yaesu 3-chome Chuo-ku, Tokyo, Japan
3-Star (See Capri)		
Toptone	Alfred Toepfer 1 Broadway New York, N.Y.	Tokyo Optical & Radio Mfg. Co., Ltd. 407 Nukui-cho Nerima-ku, Tokyo, Japan

(*Continued on page 79*)

Directory of IMPORTERS and MANUFACTURERS of JAPANESE TRANSISTOR RADIOS

Repairing an unknown-brand transistor radio can be a first-class headache if the schematic cannot be found in any of the standard manuals. Check the alphabetical listing of

TWIN-T OSCILLATORS
design & application

By FRED MAYNARD / Motorola Semiconductor Products Inc.

Practical data on simple transistorized RC oscillators having many applications in the audio-frequency range.

THE twin-T oscillator is one form of pure *RC* oscillator which presents some interesting advantages over other types. Some of these advantages include simplicity, stability, variety of waveform, and ease of frequency adjustment.

There are many uses for stable oscillators in industrial and commercial applications in such areas as time-base generators, signalling, counting, clocking, tone generators, and remote-control devices.

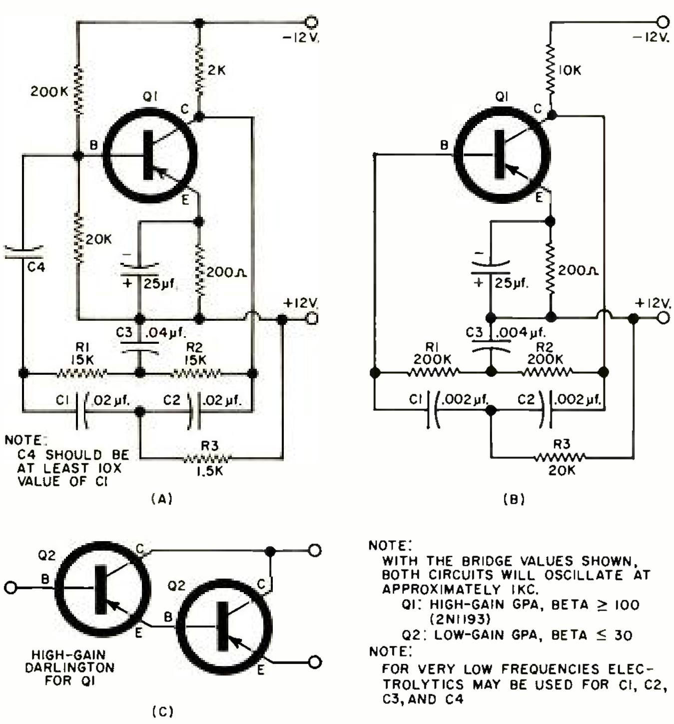
This article presents some empirical design data for simple transistorized forms of these oscillator circuits, including a convenient nomogram for the rapid set up of an oscillator circuit in any range of the audio frequencies, and describes some useful applications of this circuitry.

The Twin-T Circuit

The twin-T oscillator circuit is closely allied to the well-known twin-T notch filter circuit. Basically, it consists of a parallel network of two *RC* filter T's in opposed form. One of these, composed of two equal series resistors and a shunt capacitance from the midpoint, constitutes a low-pass *RC* filter. The other, with two series capacitors and a shunt resistor, is a high-pass filter.

The configuration is connected between the collector and base of a suitable grounded-emitter transistor amplifier and, over certain ranges of interrelated values of the *RC* components within the bridge, sustained oscillations are obtained.

Fig. 1. The twin-T oscillator circuits discussed in the text.



The development of this oscillation depends on the selection of suitable values at which a net phase shift of 180 degrees is presented at the oscillation frequency.

Frequency range can be adjusted from a very few cycles-per-second well up into the megacycle range by means of suitable transistors and components. The considerations in this article will be restricted, essentially, to the audio range from 10 to 10,000 cps. Other ranges either way from this may also be established quite readily from the data provided.

General-purpose, low-power audio transistors, such as the *Motorola* 2N1193, with a nominal *beta* equal to or greater than 100 are required for this circuit (Figs. 1A and 1B). The minimum gain that can be used is around 60, but a higher-gain transistor is certainly preferred in the interests of stability and frequency range. In some of the oscillators we have built we have used a Darlington compound connection of two low-gain units (Fig. 1C) with excellent results.

In Fig. 1A, the twin-T bridge is connected between the collector and base of an independent, biased high-gain amplifier, Q1. In Fig. 1B, the resistive leg of the bridge also provides the collector-to-base stabilizing bias feedback resistance. Both of these basic circuits are quite useful. The circuit of Fig. 1A is more stable, due to the lower impedances involved and the independence of the bridge components from the biasing network. On the other hand, the circuit of Fig. 1B is also quite stable and is considerably simpler as far as the number of components is concerned.

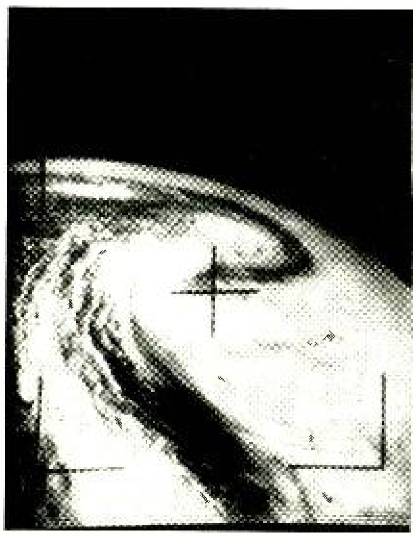
The circuit of Fig. 1B has an added advantage at very low frequencies. Since the bridge resistors must, of necessity, be on the order of 100,000 ohms or larger as required by feedback bias considerations, the capacitance values are consequently much smaller for a given frequency than in the case of the circuit of Fig. 1A. In this particular case, relatively low resistive impedances are used.

Oscillator-Bridge Requirements

Independently of the actual frequency range, the twin-T bridge must be set up in correct proportions of component values to obtain sustained oscillations. The best balanced conditions are obtained when, in Fig. 1, $R1 = R2$ and $C1 = C2$ (nominal tolerance values), $R3$ = 2% to 30% of the value of $R1$ and $C3 = 2C1$.

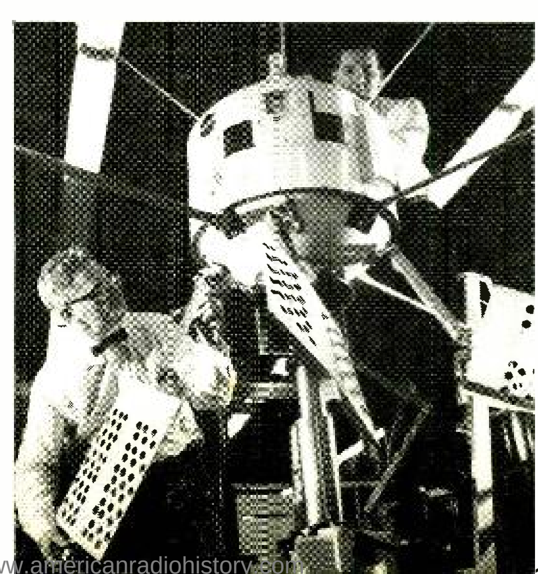
Theoretically, any combination of the proportional *C* and *R* values should be useful in this circuit. However, since there are loading effects from the input and output transistor impedances and bias consideration, the *R* values must be somewhat restricted in practical circuits and the *C* values may be widely varied, still keeping the balanced proportional values.

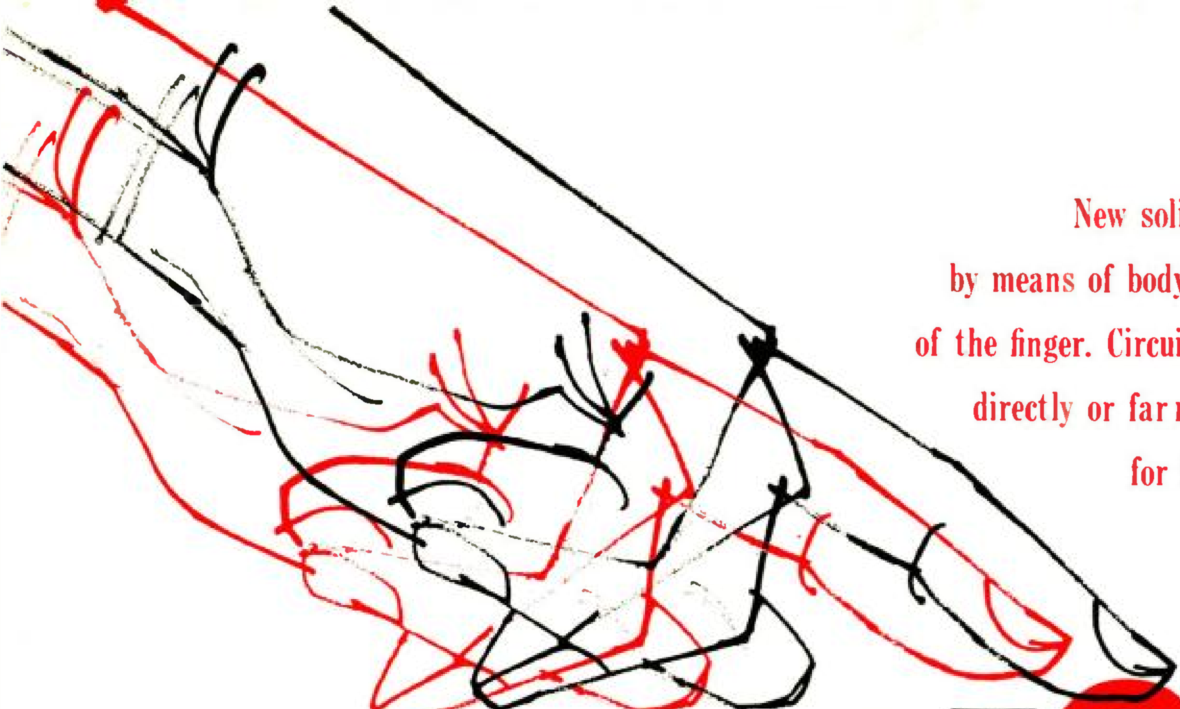
While the main factor establishing the frequency of free oscillation is determined by the parallel bridge constants, there are other factors which reflect back on this bridge, and which tend to alter the oscillation frequency somewhat. Some



Storms Via "Tiros" TV. (Left) Some recent storm photographs transmitted by the television system of "Tiros VI" are shown here. Pictures depict dangerous swirling masses of clouds forming the vortex of a storm in the south Indian Ocean. The cloud movement was actually stretched out over thousands of miles. Well over 200,000 TV pictures of the earth's cloud cover have been transmitted by the meteorological satellite system since "Tiros I" was launched in April, 1960. Since that time, six such satellites have been launched and orbited successfully in six tries. Their average lifetime was more than twice the 90-day designed and projected operational life of each satellite. Currently, both the fifth and sixth RCA-built satellites are still operating and providing world-wide weather information.

Communications Satellite Ship. (Right) The first communications satellite ship, the USNS "Kingsport," heads for sea trials before joining the Military Sea Transportation Service. The ship is being used as a mobile terminal for the support of NASA's "Syncom" communications satellite. Although the first launch failed, another satellite is slated to be boosted into a 22,300 mile high "stationary" orbit. The ship's big ball is a 53-foot air-inflated radome, housing a 30-foot antenna. A helicopter landing platform is astern. The shipboard communciations equipment was developed by Bendix for the Navy's Bureau of Ships. The ship will be used to test world-wide satellite communications capabilities and provide data for developing new design concepts. . . . **Radio-Noise Satellite.** (Below right) Westinghouse engineers examine solar paddles and antennas of an engineering test model of the S-52 satellite structure being built by the company's air arm division for the National Aeronautics and Space Administration. S-52, a joint U.S.-United Kingdom project, will be used to measure galactic noise, the r.f. signals generated by stars and galaxies; the distribution of ozone in the atmosphere; and the quantity and size of micrometeoroids in space. British scientists will provide the instrumentation for the satellite. Following this model, two prototypes and two flight models will be built before S-52 is actually launched into space. The project is managed and technically supervised by NASA's Goddard Space Flight Center at Greenbelt, Md.





New solid-state circuits switch by means of body capacity at the touch of the finger. Circuits handle 30-40 watts directly or far more power via a relay for industrial applications.

Latest advances in TOUCH CONTROL

By C. E. ATKINS / Tung-Sol Electric Inc.

NEW developments in touch-control circuits have spawned a host of novel and useful devices such as lamps, clocks, display systems, safety and alarm units as well as a number of other new consumer products. In addition, there are many commercial and industrial applications where it is desired to operate equipment merely by touching a handy surface. Touch or proximity control of apparatus is not new but recent advances in circuitry have added greatly to reliability, low cost, compactness, as well as small amounts of standby power required.

Early Methods

The control of lights and other electrical appliances by touch has been partially successful in the past. In general, these methods have been of two kinds: 1. An r.f. oscillator is detuned or stopped altogether by body capacity and associated body resistances shunting the oscillator tank, resulting in a change of current which operates a relay. 2. A thyratron is fired by an a.c. signal coupled to one electrode, by means of body capacity.

Both of these methods have serious drawbacks. With the oscillator it is difficult to eliminate radio interference while with the thyratron actuation by means of stray 60-cycle flux is not always dependable. At low frequencies the capacitive reactance of the body amounts to several megohms and, accordingly, similar high-impedance circuitry must be employed to complement it. This makes for instability—false firings occur occasionally. Also, apparatus of this type has been bulky and required a fair amount of standby power.

Fig. 1 illustrates the manner in which these two methods can be applied. Fig. 1A is the circuit developed by the author using a vacuum-tube oscillator.

In the design of this oscillator there is sufficient feedback and the grid capacitor–grid resistor combination ($C2$, $R2$) is so chosen that the tube functions as a blocking oscillator. Because of this the plate current which flows through the relay is only a few microamperes during oscillation.

If the touch point $T1$ is contacted by a person, the tank circuit of the oscillator becomes loaded partly by the individual's body capacitance, which may be approximately 50 pf. ($\mu\mu$f.) and by his shunt resistance. This loading stops the oscillator and the high grid bias developed during oscillation vanishes so that the vacuum tube can now draw several milliamperes of plate current, thus energizing the relay. Closure of the relay turns on the load and also opens the tickler coil.

The tickler, however, is not completely off ground since it is connected there through two series capacitors, $C3$ and $C4$, at the junction of which is provided a second touch point, the "antenna" $T2$. When this second antenna is touched, enough additional capacity is provided to capacitor $C4$ so that the low side of the tickler is brought close enough to ground potential to restore oscillation, whereupon the relay is de-energized, the tickler return is again grounded, and the system is then returned to its original state.

Fig. 1B shows a more or less typical thyratron circuit with a latching relay in series with the anode so that switching can be achieved by means of successive firings of the thyratron. The thyratron is normally biased off, but this bias may be disturbed when the control antenna $T1$ is touched. This then permits actuation of the stepping relay during a succession of positive pulses of the a.c. power line. $R1$ is one megohm or more so that the body can usually kick up enough voltage from stray flux to overcome the bias.

Both of the foregoing circuits have disadvantages. The thyratron circuit consumes too much standby power, is an objectionable heat generator, and is of limited reliability and life. The r.f. oscillator, while overcoming some of the objections of the thyratron circuit, still has drawbacks of its own. It does produce radio interference and tube life is a problem. The author was never able to achieve more than 7000 hours of service from the filamentary tubes he employed.

Semiconductor Circuits

Using semiconductor devices overcomes most of the objections associated with tube circuitry; one can obtain low standby power, freedom from r.f. interference, compactness, cool operation, and long life if semiconductors are used.

Because most of the inexpensive semiconductors are low-impedance devices, control methods analogous to that shown in Fig. 1B cannot be used. One could, of course, use an oscillatory circuit like that shown in Fig. 1A, but here again the low-impedance nature of the semiconductor complicates matters. In addition, the insidious problem of r.f. interference requires too many awkward compromises because the loading and feedback features of these oscillators are incompatible.

It is therefore better to provide a source of self-sustaining oscillations which can then be fed through a suitable touch-control network to a semiconductor device. This, then, serves only as a more or less passive switch. One can, of course, use semiconductors in the self-sustaining oscillator. The author has, in fact, used a free-running multivibrator with a pair of transistors in a more or less conventional circuit for this purpose. However, a more compact and less expensive system can be provided by using small neon lamps. While their life is, theoretically, not as long as that of semiconductors they can be counted on for several years of continuous operation and they require very little power.

Neon-Lamp Oscillators

Fig. 2 shows the basic circuits the author has developed for accomplishing this purpose. These circuits have an elegant simplicity and an amazing flexibility. The circuit of Fig. 2A is designed to supply negative-going pulses when energized from a positive power supply, while the circuit of Fig. 2B provides positive-going pulses.

Referring to Fig. 2A, capacitor *C1* is charged through resistor *R1* from the power supply which can be, say, 150 volts. When the potential across *C1* reaches the firing point of the neon lamp, this lamp breaks down and a portion of the charge in *C1* is dissipated through the lamp and resistor *R2* in series. Since the ungrounded side of the capacitor is positive, the direction of current flow through the neon will result in positive-going pips across resistor *R2* and a saw-tooth wave across the capacitor and neon-lamp combination. If the saw-tooth is fed through a small capacitor, the resulting differentiation yields the negative-going pips.

The positive-going and negative-going pulses from this circuit can be combined so that there is cancellation. By suitable adjustment of the value of *R2*, the output of the system can be balanced to zero or adjustment can be made to achieve a residual pulse in either direction. If additional capacity is now added in shunt with *C1* (as a result of a person touching *T* through an isolating capacitor), this balance will be altered. Now, more stored energy will be available to discharge through *R2*, resulting in larger positive pulses at this point. The negative-going pulses, however, will not be appreciably altered since the firing voltage of the neon lamp has not changed, nor has its extinction voltage. These two characteristics largely determine the amplitude of this particular pulse.

The circuit of Fig. 2B operates in a somewhat different manner. In this circuit the neon lamp fires almost immediately upon application of the source voltage and stays in the fired condition during the brief time that it takes *C1* to charge. Then when there is no longer enough potential across the lamp to keep it fired, the lamp is extinguished and the capacitor begins to discharge slowly through *R1*. Because of this different mode of behavior, the saw-tooth is inverted with respect to the one in Fig. 2A. This is because there is a rapid rise in the potential across *C1* when the series neon fires. The decline in this saw-tooth potential is determined by the time constant *R1-C1*, which can be varied over a wide range of values; the saw-tooth is differentiated to produce the positive pips shown. Since *R2* is much smaller than *R1*, *C2* charges rapidly and its energy is available to charge *C1* when the neon fires. The brief decline in the charge of *C2* is the cause of the negative-going pips at this point.

As in the circuit of Fig. 2A, the output pulses of Fig. 2B may also be added algebraically so that any desired degree of cancellation may be achieved. Furthermore, as the capacity of *C1* is increased (as a result of a person touching *T* through an isolating capacitor), the negative-going pulses will rise while the positive-going pulses remain substantially the same.

The average adult has a body capacity with respect to ground which usually varies between 50 and 100 pf. ($\mu\mu$f.) depending on his proximity to metal objects such as plumbing, electric wiring, or metal furniture. In a structural steel building body capacity will approach the 100-pf. value whereas in a frame dwelling with a minimum of metal objects nearby it will approximate the 50-pf. value. For a child the corresponding values are 25 to 50 pf., respectively.

The circuits of Fig. 2 are capable of feeding low-impedance loads, such as transistor circuits and give good sensitivity under these conditions. For example, a change of 30 pf. in the capacity of *C1* will effect a change of 1 volt across 10,000 ohms. This is enough to insure dependable control at the base of a transistor or the gate of a semiconductor switch. Furthermore, this magnitude of control is achieved even if *C1* is as much as 200 to 250 pf. This means that a wide variety of appliances can use this circuit even though the geometry of the structures entails considerable capacity. For instance, the touch point *T* could be at the end of a 100′ wire, provided *C1* is readjusted accordingly.

This characteristic makes it possible to separate the control point from the electronic circuitry. Examples where such installation would be desirable include explosion-proof rooms, where all sparking contacts are outside the room and control is effected by touching a spark-free high-impedance plate. This, in turn, connects to the circuit located in a safe area by means of a fine wire passing through the wall of the room. Household circuits can be remotely switched by contact with

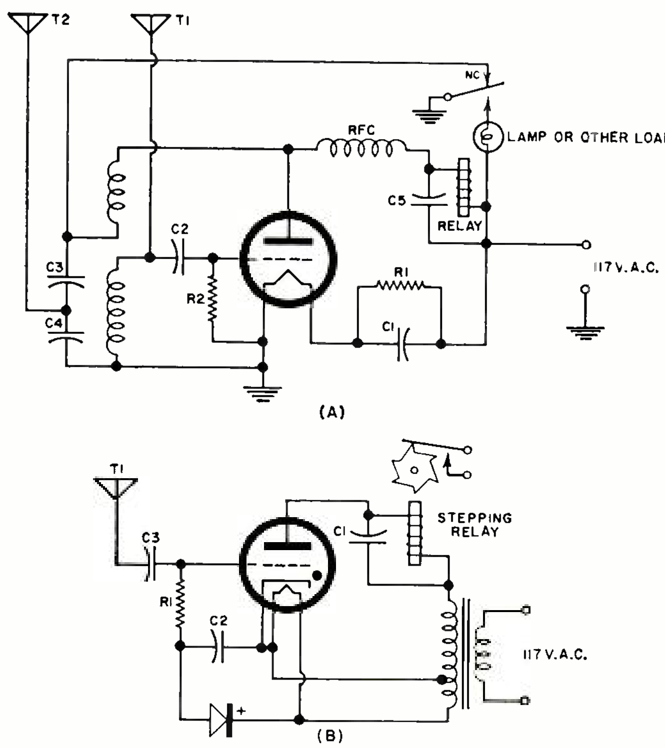
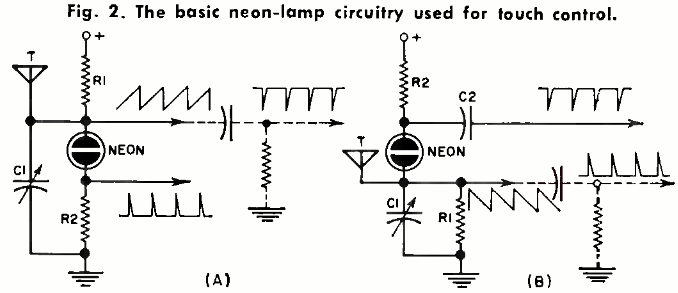
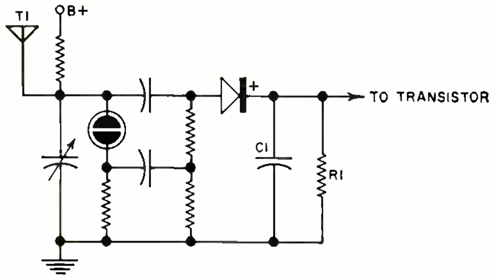


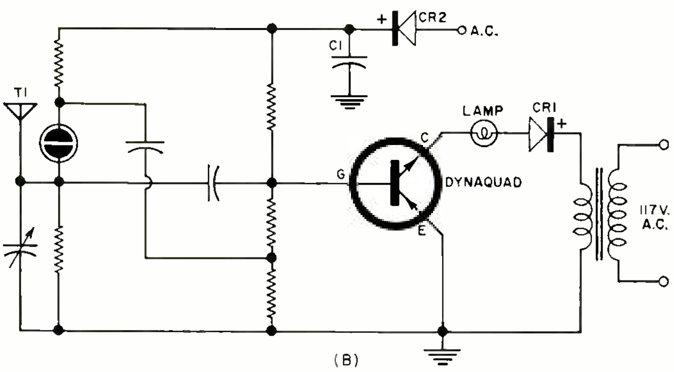
Fig. 1. Early vacuum-tube oscillator and thyratron circuits.

Fig. 2. The basic neon-lamp circuitry used for touch control.





(A)



(B)

Fig. 3. (A) The output from a neon oscillator can be rectified and applied to a transistor or (B) Dynaquad may be used.

touch-plates at convenient spots—these being connected by means of a *single* small wire requiring negligible insulation to a centrally located control box. The economies in power wiring and standard switches and switchboxes might pay for the modest cost of the electronic gear.

The fundamental control circuit can be used in many ways. For instance, the output of the neon oscillator can be fed to a diode and the rectified signal used to control a transistor which might directly actuate a lamp, meter, or other small load or, by means of a relay, control any suitable load regardless of size.

Fig. 3 illustrates how one might control a transistor by means of the rectified signal appearing across the filter network *R*1-*C*1. By reversing the polarity of the power supply and the rectifier diode, or by using the circuit of Fig. 2B, we can produce control voltage of either polarity. Hence devices that must be controlled can be turned off or on at will.

Switching with a "Dynaquad"

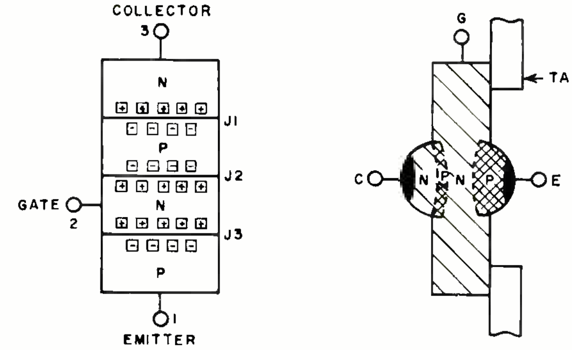
Fewer parts are needed if a four-layer *p-n-p-n* semiconductor switch, such as the *Tung-Sol* "Dynaquad" or its equivalent is used. The "Dynaquad" is made by alloying a die of *n*-type germanium to a pellet of indium and gallium in the conventional manner employed in the manufacture of alloy-junction transistors. This assembly constitutes the base (gate electrode) and emitter of the device. The collector is alloyed to the opposite side of the die using a sphere which contains a trace of antimony dissolved in the indium. When this is alloyed a differential segregation between the indium and antimony occurs, thereby forming two junctions instead of one. The finished junction assembly is usually mounted on a standard TO-5 transistor case having three leads for the electrodes.

Fig. 4A shows the junction arrangement where the junction *J*1 (in the collector pellet) is floating. If a negative potential is applied to collector electrode 3, junction *J*2 will be back-biased as in ordinary transistor action. At the same time, due to the peculiar arrangement of materials in the "Dynaquad," *J*1 is also back-biased. When the gate or base electrode 2 is made negative with respect to the emitter (1), current can readily flow across junction *J*3. When this current reaches a suitable value, the carrier concentrations about junctions *J*2 and *J*1 are successively upset so that these junctions no longer appear back-biased and a large amount of collector current can now flow. This current will then continue to flow even after the negative gate voltage is removed. In order to turn off the current, it is necessary either to apply a positive voltage to the gate or to interrupt the collector current.

These devices are in some respects solid-state equivalents of thyratrons and can be switched to the conducting state by the application of merely microwatts of energy to the base or gate. They react rapidly, usually in a few microseconds or less. When switched on, the device stays on but it can be turned off by means of a substantial signal to its gate or more simply by briefly opening its output or collector electrode.

The equivalent of disconnecting the output can be achieved by operating the "Dynaquad" on half-wave a.c. Then when the voltage drops to zero no current can flow and the switch begins the next half cycle in the "off" state. If a "firing" signal is present at the gate, current will again pass and a succession of half-wave pulses will be available to energize the load. Of course, if there is no negative signal, the "Dynaquad" will stay "off."

Fig. 3B shows how simple it is to apply the fundamental oscillator circuit to a "Dynaquad" for the direct control of a lamp. This system has been used by the author to light the face of an electric clock when the case of the clock is touched. Another interesting application of this circuit is a coin box



(A) (B)

Fig. 4. Symbolic and actual electrode arrangement of "Dynaquad."

or money receptacle used at a cashier's position in business places. By using this circuit it is possible to have the customer's hand effect the illumination of a good-will or advertising sign when his change is picked up.

The circuit of Fig. 3B uses the oscillator of Fig. 2B because *positive* bias is needed for the "Dynaquad" to keep it "off" in the *absence* of a signal. At this time the antenna is *not* being touched. When *T*1 is touched, the gate voltage goes negative and the "Dynaquad" turns on the lamp.

Diode *CR*2 and capacitor *C*1 provide the positive bias and, at the same time, power the neon oscillator. Diode *CR*1 limits the voltage on the "Dynaquad" collector to negative half-cycles only. The small transformer can be a winding or even a tap on the armature winding of the clock motor in the particular case of the clock application.

Complete Touch-Control Circuit

The circuit of Fig. 5 (which is considerably more elaborate) is the heart of a touch-control lamp recently introduced in kit form by *Tung-Sol Electric Inc.* This lamp has two major metal areas which are readily isolated from the rest of the structure and from each other. The larger and more accessible of these is the base of the lamp connected to *T*1. When touched, the circuit of Fig. 5 energizes the control relay turning on the lamp and latching it in the "on" position. Later the lamp is turned off by touching the center metal ring ornament on the lamp's upright portion. This is indicated in Fig. 5 as the second antenna or touch point *T*2.

The relay is energized from the 117-volt a.c. line through

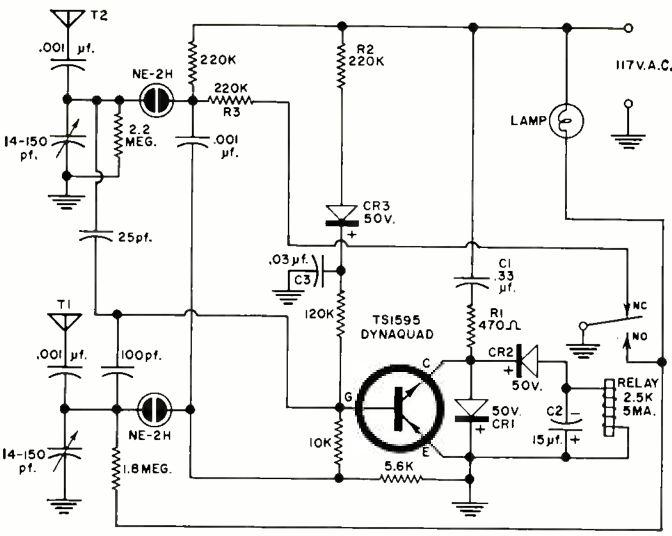


Fig. 5. Complete circuit diagram of the touch-control switch. Crystal diode CR3 was added in later production models of the switch in order to prevent reversal of bias on the "Dynaquad." This precludes any false triggering due to radio interference.

a .33-µf. capacitor *C*1. Two diodes, *CR*1 and *CR*2, serve to rectify this a.c. at the relay. *CR*1 serves to make the collector of the "Dynaquad" negative with respect to ground, while *CR*2 makes the relay negative and passes its energizing current. An electrolytic capacitor *C*2 filters the a.c. component and provides a bit of time delay to stabilize relay action. A 470-ohm resistor, *R*1, is also in series with the relay to provide filter action against power-line transients.

*C*1 could be replaced with a resistor, however using a capacitor has two important advantages: (1) By using reactance instead of resistance for voltage drop, no power is lost and hence no heat is generated. (2) The capacitor introduces a very useful phase shift which permits a.c. operation of the neon oscillators to be employed in the circuit. With a.c. on the neon lamps, there is a cluster of pips on each peak of the a.c. cycle as the line voltage equals or exceeds the firing potential of the neon lamps. Only the pips produced on the positive half-cycle are important in this particular circuit since at other times there is no voltage applied to the collector of the "Dynaquad" due to the shorting effect of diode *CR*1. Because of *C*1, the current in this branch leads the line voltage, and the voltage at the collector—about 20 v.—will also lead the line voltage. This means the pips from the neon oscillators occur at the right times for best action. The bias on the "Dynaquad" is also a.c. with its phase shifted by network *R*2-*C*3. This shift is in the opposite direction from that at the collector—giving best bias conditions at the proper time. These phase relationships are shown in Fig. 6.

Shunting the relay-diode combination is a "Dynaquad." type TS-1595 or equivalent. In operation, if the "Dynaquad" draws current the relay does not and *vice versa*. The "Dynaquad" is biased in the off direction (this requires a positive voltage on its gate with respect to ground) by means of a bias supply comprising an *RC* network to reduce the voltage and shift the phase as described.

During operation, arrangements are made to fire the "Dynaquad" with a burst of pips from the neon oscillator adjusted to give negative-going pulses which are in the turning-on direction for the "Dynaquad." When antenna *T*1 is touched, the body capacity added to the circuit reduces this firing signal at the gate below the bias level so that the "Dynaquad" cannot fire. On the next negative half-cycle of a.c., current flows through diode *CR*2 and into the relay instead of flowing to ground through the "Dynaquad." After a few such cycles, enough energy develops in the relay coil to attract its armature, thus lighting the lamp and also removing power from the sustaining oscillator.

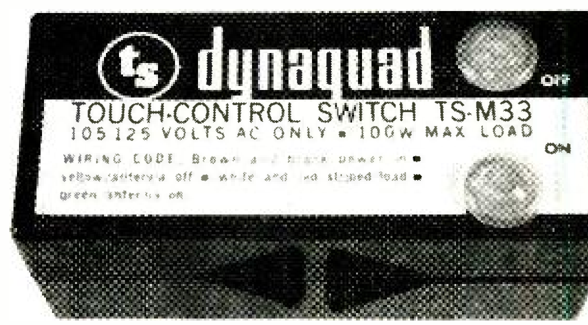
Since these basic signal sources are fairly inexpensive, it is possible to provide a second one for the purpose of turning off the lamp. When antenna *T*2 is touched, the added capacity upsets the signal balance in the output of the circuit thereby providing a negative signal to fire the "Dynaquad." When this happens, the relay will become de-energized and the first or sustaining oscillator will be repowered as the lamp is turned off. The continuing availability of pulses from this first oscillator will thus provide repeated firing of the "Dynaquad," maintaining the lamp in an "off" position until antenna *T*1 is again touched.

When the relay armature engages the upper contact, resistor *R*3 is grounded, lowering the voltage available to the upper neon lamp so this oscillator is de-activated. This is useful because heterodyning between the oscillators can be troublesome. Each oscillator is then operating only when its action might be required.

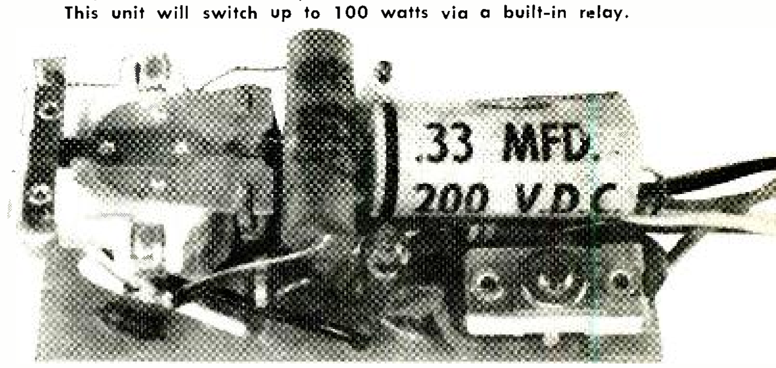
Single-Touch Circuit

In many cases, the provision for separate touch points to turn an appliance on and off is desirable. However, sometimes only a single touch point can be provided in which case

(*Continued on page* 86)

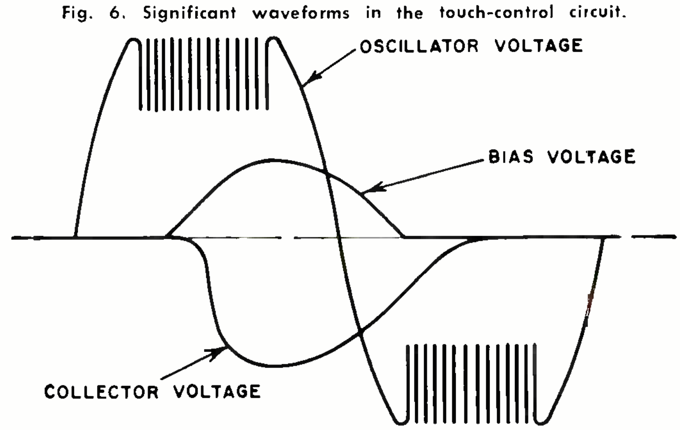


The complete touch-control circuit is contained within plastic box only 3" x 1¼" x 1¼". The two hole plugs at the right may be removed for readjustment of the trimmers if required. This unit will switch up to 100 watts via a built-in relay.



The touch-control circuit is built around a small printed board. The Dynaquad is hidden in this photo. It is located directly below electrolytic capacitor shunting the relay.

Fig. 6. Significant waveforms in the touch-control circuit.



Directory of IMPORTERS and MANUFACTURERS of JAPANESE TRANSISTOR RADIOS

Repairing an unknown-brand transistor radio can be a first-class headache if the schematic cannot be found in any of the standard manuals. Check the alphabetical listing of brand names below, then contact the importer or manufacturer for service information.

Brand Name	Importer and Address	Mfgr. and Address
Acme	Manhattan Novelty Co. 263 Canal Street New York, N.Y.	
Aiwa		Aiwa Co., Ltd. 4 Kanda Moto Sakumacho Chiyoda-ku, Tokyo, Japan
Alaron	B & B Import Co. 15755 Wyoming Ave. Detroit 28, Mich.	
Alpen		Haya Electric Co., Ltd. 440 Shimura Nakadai-machi Itabashi-ku, Tokyo, Japan
Alpha	Alfred Toepfer 1 Broadway New York, N.Y.	Nippon Alpha Electric Co., Ltd. 6 Asabu Fujimi-cho Minato-ku, Tokyo, Japan
Ambassador	Allied Purchasing Co. 401 Fifth Avenue New York, N.Y.	
Americana	Inter-Ocean Commerce Corp. 170 Broadway New York, N.Y.	
Amertone	Amerex Trading Co. 444 Fifth Avenue New York, N.Y.	
Angel	Arrow Trading Co. 1133 Broadway New York, N.Y.	
Arrow (See Angel)		
Audion	Audion Importers 18 West 27th Street New York, N.Y.	
Beniida	Marybeni lida 39 Broadway New York, N.Y.	
Best Tone	Charles Bestesh (Best Tone Electronics) 295 Fifth Avenue New York, N.Y.	
Brighton	A & A Trading Co. 64-14 Woodside Woodside, L.I., N.Y.	
Brenell	Fen-Tone Corp. 106 Fifth Avenue New York, N.Y.	
Browni	Charles Brown & Co. 1170 Broadway New York, N.Y.	
Candle	Toyama & Co. 855 Avenue of the Americas New York, N.Y.	
Canton-Son	Canton-Son. Inc. 12 West 27th Street New York, N.Y.	
Capri	Nason Trading Co. 303 Fifth Avenue New York, N.Y.	
Channel Master	Channel Master Corp. Ellenville, N.Y.	Sanyo Electric Co., Ltd. 18 Keihanhon-dori, 2-chome Morikuchi-city, Osaka, Japan
Commodore	Commodore Import Corp. 507 Flushing Avenue Brooklyn, N.Y.	

Brand Name	Importer and Address	Mfgr. and Address
Constant (See Canton-Son)		
Consul Deluxe	General Consolidated Ltd. 5 East 17th Street New York, N.Y.	
Continental	Continental Merch. Corp. 236 Fifth Avenue New York, N.Y.	
Coronet (See Angel)		
Craig	Craig Panorama 5290 Washington Blvd. Los Angeles, Calif.	
Crest (See Alpha)		
Crestline (See Canton-Son)		
Crown	Shriro Trading Corp. 276 Park Avenue S. New York, N.Y.	Asahi Radio Mfg. Co., Ltd. 38 Kanda Suehire-cho, Chiyoda-ku, Tokyo, Japan
Daltone	Dalamal & Sons 1185 Broadway New York, N.Y.	
Delmonico	Delmonico International 120-20 Roosevelt Avenue Corona, N.Y.	
Eagle		Nippon Columbia Co., Ltd. 125 Minato-cho Kawasaki City, Japan
Ebner (See Brenell)		
Eldorado	A. Cohen & Sons, Inc. 27 West 23rd Street New York, N.Y.	
Electra	Electra Industries Co. 1204 Broadway New York, N.Y.	
Empire	Trade Distrib. 260 Fifth Avenue New York, N.Y.	
Family (See Angel)		
Fen-Tone (See Brenell)		
Fleetwood (See Craig)		
Fountain	Harpers International 315 Fifth Avenue New York, N.Y.	
Four Star	Fortune Star Products 1207 Broadway New York, N.Y.	
Fuji	Eisenberg & Co. 52 Broadway New York, N.Y.	
Fujitone (See Angel)		
Fujiya	Fujiya Electric Co. 405 Lexington Avenue New York, N.Y.	Fujiya Electric Co., Ltd. 6 Ginza-Nishi 7-chome Cho-ku, Tokyo, Japan
General	Trans America Import & Export Co. 116 So. Michigan Blvd. Chicago 3, Illinois	Yaou Electric Co., Ltd. 3 Shiba Shinbashi 6-chome Minato-ku, Tokyo, Japan
Global	Masuyama Int'l Corp. 214 W. 14th Street New York, N.Y.	Global Mfg. Co., Ltd. 13 Shiba Sakaecho Minato-ku, Tokyo, Japan
Grand Prix	A & S Trading Co. 124 W. 30th Street New York, N.Y.	

Brand Name	Importer and Address	Mfgr. and Address
Hadson	Caroline Mfg. Co. 315 Fifth Avenue New York, N.Y.	
Halco	Halen Associates 125 Fifth Avenue New York, N.Y.	
Harlie	Harlie Transistor Prod. 393 Sagamore Avenue Mineola, Long Island New York	
Harpers (See Fountain)		
Hi-Delity	Petely Enterprises 300 Park Avenue New York, N.Y.	
Hitachi	International Importers 2242 S. Western Avenue Chicago, Illinois J. H. Thal & Assoc. 220 W. Merrick Road Valley Stream, N.Y.	Hitachi, Ltd. 4 Marunouchi 1-chome Chiyoda-ku, Tokyo, Japan
Hikari		Mitsuoka Electric Mfg. Co., Ltd. 8 Kanaya-machi 1-chome Kita-ku, Osaka, Japan
Imperial (See Fountain)		
Intermark	Inter-Mark Corp. 80-00 Cooper Avenue Brooklyn, N.Y.	
International (See Amertone)		
Invictor	Toyomenka, Inc. 2 Broadway New York, N.Y.	
Ken	Ken Electronics 500 Fifth Avenue New York, N.Y.	
Kent	Kent Overseas, Inc. 14 West 23rd Street New York, N.Y.	
Kobe Kogyo (See Halco)		
Kowa (See Fuji)		
Koyo		Koyo Denki Co., Ltd. 6 Ginz Migashi 7-chome Chuo-ku, Tokyo, Japan
Lafayette	Lafayette Radio Co. 165-08 Liberty Avenue Jamaica 33, N.Y.	
Lic	Lucky International 1155 Broadway New York, N.Y.	
Linmark	Linmark International Corp. 276 Park Avenue S. New York, N.Y.	
Little Pal (See Acme)		
Lloyd's	Lloyd Trading Co. 1147 S. Hope Street Los Angeles, California	
Mantone (See Acme)		
Mark (See Alpha)		
Matsushita	41 E. 42nd St. New York, N.Y.	Matsushita Electric Co., Ltd. 1006 Oaza Kadoma, Kadoma-cho, Kitakawachi-gun, Osaka, Japan
Marvel (See Acme)		
Mayfair	Artic Import Co. 1024 West Randolph St. Chicago 7, Illinois	
Mel Rose	Federal Aides Corp. 875 Broadway Brooklyn, N.Y.	
Mitsubishi	Lissner Trading Co. 1111 N. Cherry Street Chicago 2, Illinois	Mitsubishi Electric Co., Ltd. 3 Marunouchi 2-chome Chiyoda-Ku, Tokyo, Japan
Monarch	Spera Electronics 3710 33rd Street Long Island City, N.Y.	
Nanaola		Nanao Radio Co., Ltd. 1060 Shimomeguro 4-chome Meguro-ku, Tokyo, Japan

Brand Name	Importer and Address	Mfgr. and Address
Nec	Kanematsu New York 1 Whitehall Street New York 4, New York	Nippon Electric Co., Ltd. 2 Shiba Mita Shikoku-machi Minato-ku, Tokyo, Japan
Nipco		Nipco Mfg. Co., Ltd. 36 Okachimachi 1-chome Taito-ku, Tokyo
Nippon Columbia (See Fuji)		
Nobility	New York Merchandise Co. 32 West 23rd Street New York, N.Y.	
NVC		Victor Co. of Japan, Ltd. 1 Nihonbashi Moncho 4-chome Chuo-ku, Tokyo, Japan
Olympic	Nichimen Co. 60 Broad Street New York, N.Y.	
Omscolite	Omscolite Corp. Stokley & Roberts Ave. Philadelphia, Penna.	
Onkyo	Sanyo Trading Co. 149 Broadway New York, N.Y.	Osako Onkyo Co., Ltd. 32 Ohmiya Nishino-cho 5-chome, Asahi-ku, Osaka, Japan
Pacific	Pacific Import Co. 149 Fifth Avenue New York, N.Y.	
Panasonic	Matsushita Electric Co. 41 East 42nd St. New York, N.Y.	
Petite	Sterling Hi-Fi Co. 20-20 40 Avenue Long Island City, N.Y.	
Realistic (See Brighton)		
Realtone	Realtone Electronics 71 Fifth Avenue New York, N.Y.	
Renown (See Nobility)		
Rincan		Kyowa Denki Kagaku Co., Ltd. 390 Nishi Ohsaki 1-chome Shinagawa-ku, Tokyo, Japan
Ross	Ross Electronics 216 W. Jackson Blvd. Chicago 6, Illinois	
Royal		Mikusai, Ltd. 4 Marunouchi 1-chome Ohta-ku, Tokyo, Japan
Royce	Elise Mercantile of N.Y. 1140 Broadway New York, N.Y.	
Sampson (See Hitachi)		
Sansei (See Fuji)		
Sharp (See Invictor)		
Sheraton	Brothers International 36-50 38th Street Long Island City, N.Y.	
Skymaster (See Nobility)		
Sony	Sony Corporation 504 Broadway New York, N.Y.	Sony Corp. 351 Kitashinagawa-6 Shinagawa-ku, Tokyo, Japan
Sovereign (See Sheraton)		
Starlite	Starlite Electronics 37 West 23rd Street New York, N.Y.	
Standard		Standard Radio Corp. 53 Mukoyama-machi Shibuya-ku, Tokyo, Japan
Tempest	Azad International 1133 Broadway New York, N.Y.	
Ten	Sanyo Trading Co. 149 Broadway New York, N.Y.	Nobe Nogyo Co. 7 Yaesu 3-chome Chuo-ku, Tokyo, Japan
3-Star (See Capri)		
Toptone	Alfred Toepfer 1 Broadway New York, N.Y.	Tokyo Optical & Radio Mfg. Co., Ltd. 407 Nukui-cho Nerima-ku, Tokyo, Japan

(Continued on page 79)

TWIN-T OSCILLATORS

design & application

By FRED MAYNARD / Motorola Semiconductor Products Inc.

Practical data on simple transistorized RC oscillators having many applications in the audio-frequency range.

THE twin-T oscillator is one form of pure *RC* oscillator which presents some interesting advantages over other types. Some of these advantages include simplicity, stability, variety of waveform, and ease of frequency adjustment.

There are many uses for stable oscillators in industrial and commercial applications in such areas as time-base generators, signalling, counting, clocking, tone generators, and remote-control devices.

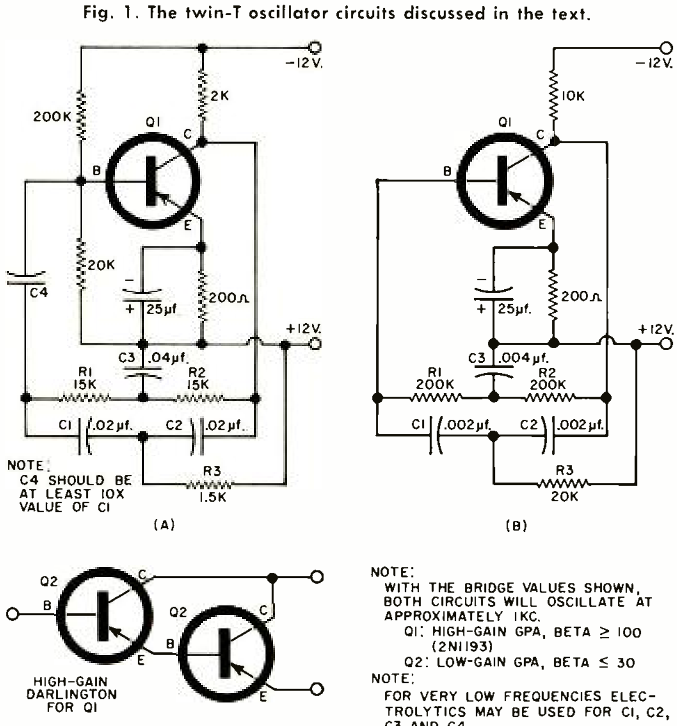
This article presents some empirical design data for simple transistorized forms of these oscillator circuits, including a convenient nomogram for the rapid set up of an oscillator circuit in any range of the audio frequencies, and describes some useful applications of this circuitry.

The Twin-T Circuit

The twin-T oscillator circuit is closely allied to the well-known twin-T notch filter circuit. Basically, it consists of a parallel network of two *RC* filter T's in opposed form. One of these, composed of two equal series resistors and a shunt capacitance from the midpoint, constitutes a low-pass *RC* filter. The other, with two series capacitors and a shunt resistor, is a high-pass filter.

The configuration is connected between the collector and base of a suitable grounded-emitter transistor amplifier and, over certain ranges of interrelated values of the *RC* components within the bridge, sustained oscillations are obtained.

Fig. 1. The twin-T oscillator circuits discussed in the text.



The development of this oscillation depends on the selection of suitable values at which a net phase shift of 180 degrees is presented at the oscillation frequency.

Frequency range can be adjusted from a very few cycles-per-second well up into the megacycle range by means of suitable transistors and components. The considerations in this article will be restricted, essentially, to the audio range from 10 to 10,000 cps. Other ranges either way from this may also be established quite readily from the data provided.

General-purpose, low-power audio transistors, such as the *Motorola* 2N1193, with a nominal *beta* equal to or greater than 100 are required for this circuit (Figs. 1A and 1B). The minimum gain that can be used is around 60, but a higher-gain transistor is certainly preferred in the interests of stability and frequency range. In some of the oscillators we have built we have used a Darlington compound connection of two low-gain units (Fig. 1C) with excellent results.

In Fig. 1A, the twin-T bridge is connected between the collector and base of an independent, biased high-gain amplifier, Q1. In Fig. 1B, the resistive leg of the bridge also provides the collector-to-base stabilizing bias feedback resistance. Both of these basic circuits are quite useful. The circuit of Fig. 1A is more stable, due to the lower impedances involved and the independence of the bridge components from the biasing network. On the other hand, the circuit of Fig. 1B is also quite stable and is considerably simpler as far as the number of components is concerned.

The circuit of Fig. 1B has an added advantage at very low frequencies. Since the bridge resistors must, of necessity, be on the order of 100,000 ohms or larger as required by feedback bias considerations, the capacitance values are consequently much smaller for a given frequency than in the case of the circuit of Fig. 1A. In this particular case, relatively low resistive impedances are used.

Oscillator-Bridge Requirements

Independently of the actual frequency range, the twin-T bridge must be set up in correct proportions of component values to obtain sustained oscillations. The best balanced conditions are obtained when, in Fig. 1, $R1 = R2$ and $C1 = C2$ (nominal tolerance values), $R3 = 2\%$ to 30% of the value of $R1$ and $C3 = 2C1$.

Theoretically, any combination of the proportional *C* and *R* values should be useful in this circuit. However, since there are loading effects from the input and output transistor impedances and bias consideration, the *R* values must be somewhat restricted in practical circuits and the *C* values may be widely varied, still keeping the balanced proportional values.

While the main factor establishing the frequency of free oscillation is determined by the parallel bridge constants, there are other factors which reflect back on this bridge, and which tend to alter the oscillation frequency somewhat. Some

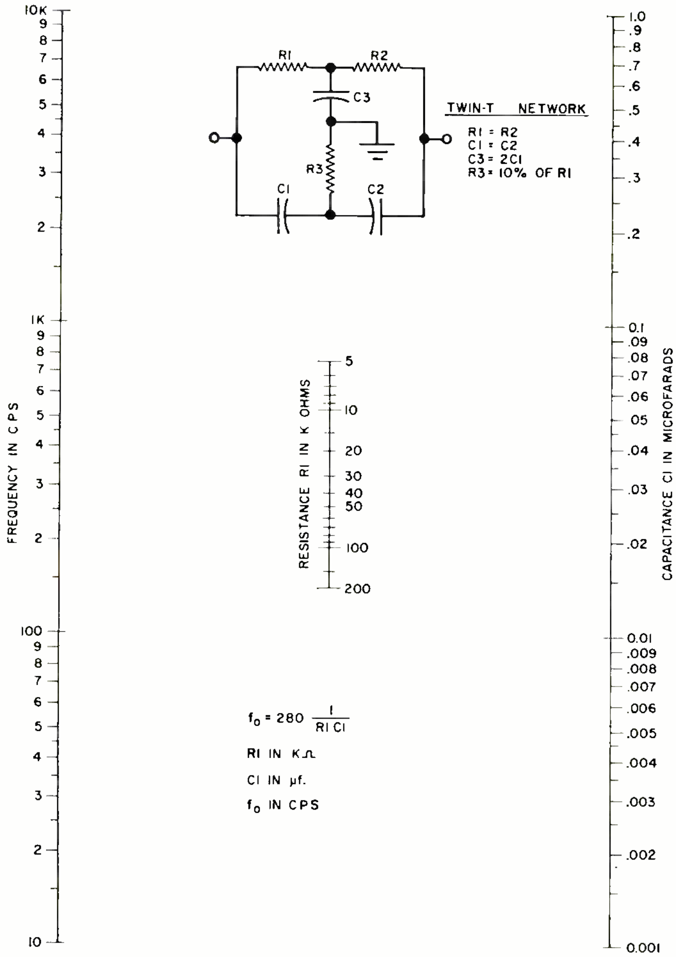


Fig. 2. Nomogram of RC values for various audio frequencies.

of these factors are: parallel resistive and capacitive loading due to finite input and output impedances, collector cut-off current, temperature, applied voltage, and external circuit loading.

Most of these effects are relatively minor so that a simple expression can be used to solve for the approximate frequency of oscillation. This solution is empirically restricted to the bridge conditions already given and where *R*3 is 10% of the value of *R*1. $f_o = 280/R1C1$ with f_o in cps, *R* in kohms, and *C* in µf.

The empirical factor, 280, holds fairly well for bridge resistor *R*1 values of 5000 to 25,000 ohms (Fig. 1A) or 100,000 to 200,000 ohms (Fig. 1B).

This relation is easily solved using the nomogram in Fig. 2. A straightedge is used to connect the frequency, in cps, on the left scale, the *R*1 bridge-resistor value on the center scale, and the *C*1 capacitance value on the right scale. The resistance ranges of approximately 4:1 in *R*1 values are those at which the empirical solution holds fairly well. At other values of *R*1, especially in the Fig. 1A configuration, oscillation may be obtained but the empirical relation falls off. The range of the nomogram may be extended by applying a suitable multiplication factor to the scales. For example, an oscillator for frequencies under 10 cps may be set up by multiplying the capacitive scale by 10, using the resistance scale unaltered, and dividing the frequency scale by a factor of 10.

The nomogram of Fig. 2 approximately relates the frequency bridge resistor values and bridge-capacitor values for the condition where *R*3 is 10% of the value of the *R*1 resistors. A very convenient and simple variable-frequency oscillator is obtained by varying *R*3 in either configuration. A continuous variation of better than 1⅓ octaves at any frequency range may be obtained.

The curve of Fig. 3 has been compiled to aid in predicting the frequency *versus* *R*3 resistor tuning range. The curve indicates that the frequency may be continuously adjusted to both higher and lower values than the median and that the frequency range is approximately 70% to 170% of this value. The ratios appear to hold at any median frequency.

Oscillator Loading and Waveforms

Undue added loading on any part of the oscillator circuit tends to change the frequency. When driving into a high-impedance device, it is enough to couple through a sufficiently large resistor, such as 100,000 ohms or more. When a low-impedance drive is required, an emitter-follower impedance-matching stage is used.

One of the interesting points of the twin-T oscillator is the variety of waveforms that may be obtained from different points in the circuit. This variety and the resultant tone color make these oscillators especially attractive in musical instruments and tone-signalling applications.

Fig. 4 shows a typical 12-volt, 400- to 800-cps tone generator. Waveform outputs, all different, may be obtained from points A, B, C, and D. The collector output, A, is the largest signal and is nominally close to a sine wave of approximately 10 volts p-p amplitude. This signal contains around 10% harmonic distortion.

From point B a much smaller, approximately ⅕ amplitude, signal is obtained. This is very pure and very closely sinusoidal in character. This is the low-pass filter signal in which practically all of the higher harmonics are excluded.

(Continued on page 70)

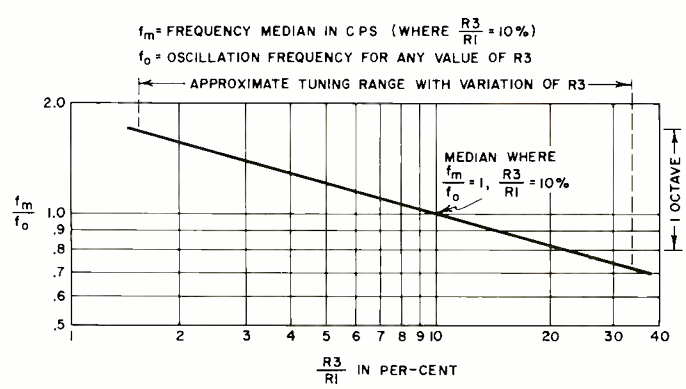
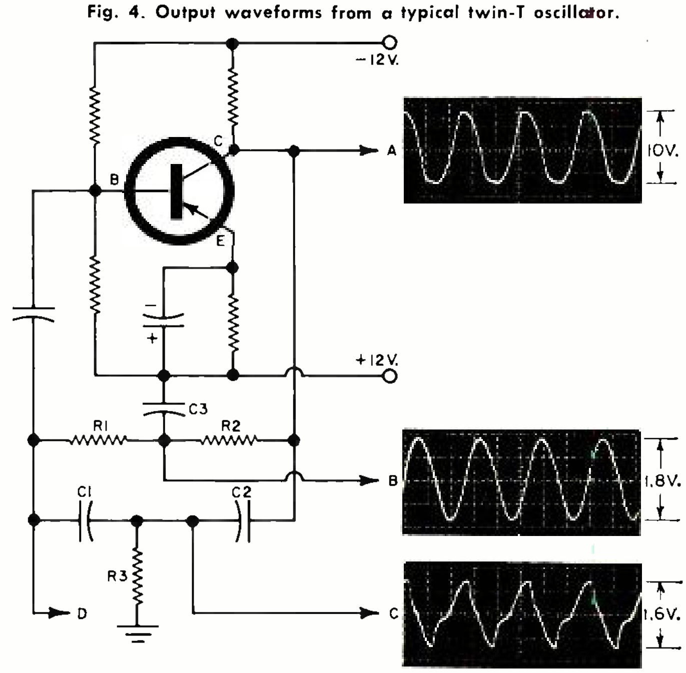
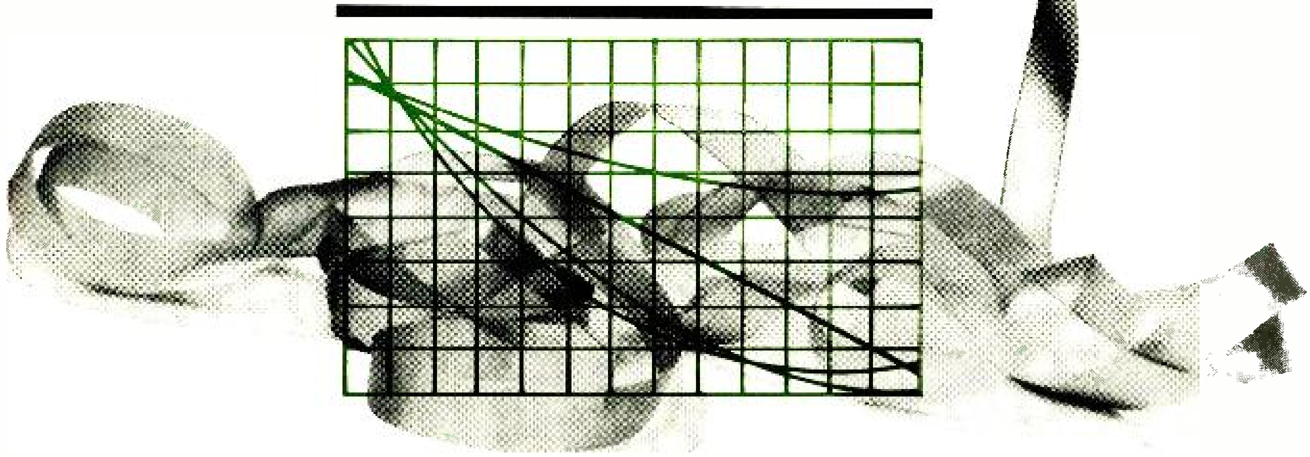


Fig. 3. Variation in frequency with changes in resistor R3.

Fig. 4. Output waveforms from a typical twin-T oscillator.



MODERN CAPACITORS



Spurred by the sophisticated needs of electronics today, developers have endowed an old, familiar component with variety and capabilities not anticipated years ago.

By JOHN R. COLLINS

ALTHOUGH capacitor development reached a highly advanced stage many years ago, the exploitation of all possible combinations of materials and configurations did not end. As electronic applications grow, the demands made of conventional components also expand. Manufacturers then reach into their accumulated store of know-how for the answers to new problems. After a few years of such stimulation, an "old" product can take on quite a new look, even without revolutionary design changes.

Current requirements for military and space programs and for complex industrial equipment are placing heavy demands on capacitor producers. High-temperature operation has become increasingly important, for example, and the effects of radiation must be reckoned with. Such factors have led to the production of capacitors that are quite special, although they may end by finding widespread application. The units in Fig. 1, to cite a case, are practically indestructible under the severest environmental conditions. Size and weight are of prime importance for airborne and space use, so special emphasis is placed on types with maximum capacitance per unit volume (Fig. 2).

Many materials now used are not very different from those employed in the past. Each, however, is now being perfected to the limits of its capabilities, so that even traditional paper and foil capacitors now meet specifications unknown years ago—and modern glass capacitors bear little resemblance to the ancestral Leyden jars!

On the other hand, there are many developments that are still in the laboratory stage. These include high-temperature dielectrics for use up to 750° C (almost 1400° F), thin-film dielectrics desposited on silicon slices (an outgrowth of recent semiconductor technology), printed tantalum/tantalum-oxide types, and microscopic *RC* combinations to serve as integrated networks and circuits.

Basic Factors

Although a capacitor can be defined simply as a device for storing an electric charge, it may be used to perform one of many functions in electronics. These include passing a.c. while blocking d.c., bypassing r.f. to ground, filtering ripple from rectified voltages, correcting phase angle, and being part of a resonant circuit. Each application makes different demands, and the variety of types has grown out of these needs. To clarify them, a preliminary review of fundamentals is helpful.

A capacitor is formed whenever two conductors are separated by an insulator. The amount of capacitance depends on the areas of the two conductors, the distance between them, and the material used for the insulator. For maximum capacitance, the conductor plates are made as large as possible and the separation as small as possible. Practical limits are set on the size of the conductors by space requirements; yet, if the separation is very small, the danger of arcing is increased.

The merit of the insulator, called the dielectric, is measured with respect to air. Air has a dielectric constant (designated by K) of 1. Other substances with higher dielectric constants permit greater capacitance to be obtained for plate areas of the same size and spacing. Certain mica, for example, has a K of 9, and therefore two plates separated

Fig. 1. These monolithic, glass dielectric types produced by Corning can withstand severe environmental conditions.

by it would exhibit 9 times the capacitance they would have when separated by an equal thickness of air.

Capacitance normally undergoes a change with a variation in temperature. The temperature coefficient is expressed conveniently as so many parts per million per degree centigrade (ppm/°C). It may be either positive or negative, depending on whether the capacitance increases or decreases with temperature.

A perfect type would introduce only capacitive reactance into a circuit, but every capacitor is bound to have some resistance in which power is dissipated. The merit of a capacitor, expressed in terms of the ratio of its resistance to its total impedance, is called its power factor. Merit is also stated at times in terms of the capacitor "Q," which represents the ratio of the capacitive reactance to the equivalent series resistance. For all practical purposes, "Q" is considered to be the reciprocal of the power factor.

Paper and Film Capacitors

Perhaps the most familiar type is the paper capacitor, which is made by rolling two strips of aluminum foil, separated by paper, and attaching leads to the foil strips. The unit is then encapsulated in any one of a number of ways to make it moisture resistant.

Kraft paper in extremely thin sheets, made from wood pulp, provides a superior dielectric now almost universally used. When impregnated with mineral oil, it gives good temperature stability and a low power factor. Since very thin sheets usually have pinhole defects, it is customary to use at least two sheets for the dielectric. The chance of two defects occurring at exactly the same place is relatively slight. Additional sheets may be inserted to increase the voltage rating of the capacitor.

In recent years, various plastic films have been used instead of paper for dielectrics (Fig. 3). They can be made extremely thin without danger of pinhole defects, and some have special properties that are otherwise desirable. Polystyrene, for example, has a remarkably small power factor and a very low temperature coefficient, while Teflon can be used at temperatures as high as 250° C. Mylar film as thin as 0.00015 inch, now in use, permits substantial reduction in capacitor size as well as an extended temperature range. Work is also progressing on combining two films with complementary temperature characteristics (*e.g.*, Mylar and polystyrene) in the dielectric to obtain a virtually flat temperature—capacitance curve.

Miniaturization has been greatly advanced by the process of vacuum-depositing metal in a thin layer on the surface of paper or film, thus eliminating the heavier aluminum foil normally used as plates. Metalized-paper and film capacitors also give a higher degree of reliability than conventional foil types.

This is so because a common cause of failure in paper and film capacitors is the breakdown of dielectric due to high-voltage puncture. When this happens, the two foil strips are brought into contact with each other and the capacitor is shorted. When arcing occurs in a metalized capacitor, however, the metal burns away with the paper or film at the puncture, so no short occurs: The capacitor is as good as ever, except for an almost imperceptible reduction in its capacity. Such types are called "self-healing."

Glass Dielectric

First developed as substitutes for mica types, glass-dielectric capacitors have reached so high a level of reliability that they have won an important place in missile and space programs. They have been boiled in salt water, immersed in saturated steam, subjected to many hours of salt spray and many days of moisture tests without failure or measurable degradation of their characteristics.

A special lead-potash glass with a *K* of about 6, used for the dielectric, is rolled into a ribbon approximately 1 mil

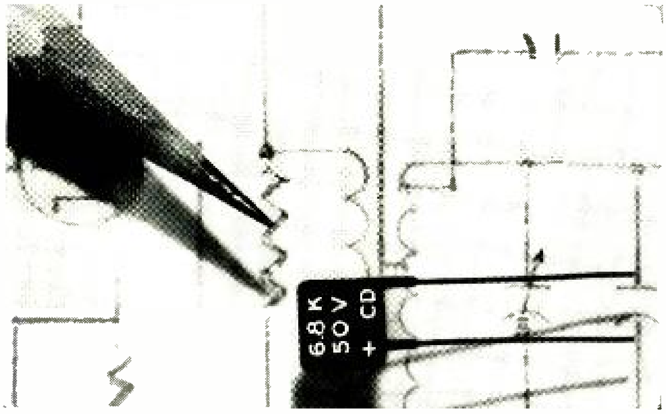
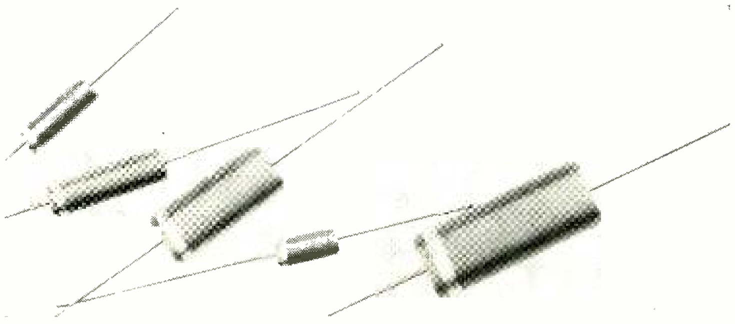


Fig. 2. This rectangular, solid-tantalum capacitor, made by Cornell-Dubilier, concentrates 6.8 μf. at 50 volts into a package so tiny as to be dwarfed by the average fingernail.

Fig. 3. They look like ordinary molded tubulars, but the dielectric is made of a thin film of Mylar. This type (these made by Erie Resistor) is being used in numerous applications.



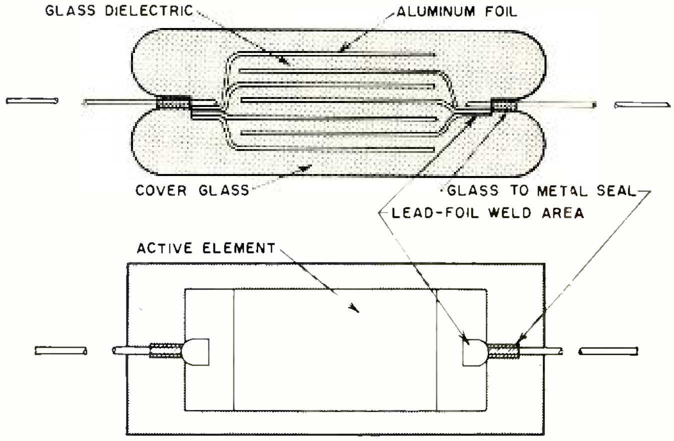
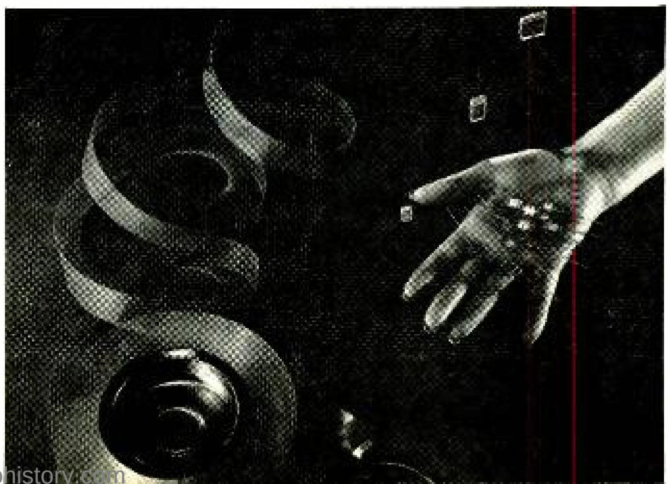
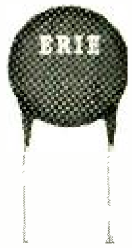


Fig. 4. Construction details of a glass-dielectric type, in side and top views. Compare with actual sample in Fig. 1.

Fig. 5. Thin ribbons of glass (left) are used to form the dielectric of capacitors like those in the hand at right.





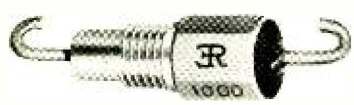


Fig. 7. A feedthrough ceramic for bypassing r.f. to ground.

Fig. 6. Disc ceramic types offer high capacitance relative to size. Values are affected by thermal and voltage changes.

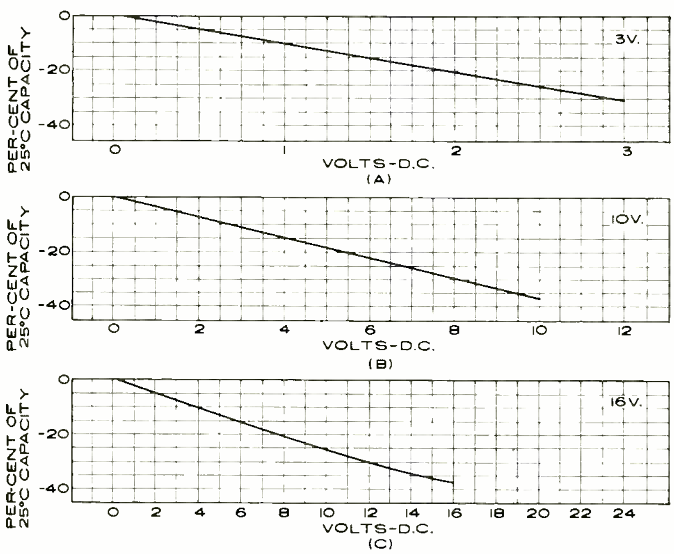


Fig. 8. Extent of variation from nominal capacity produced by voltage change in ceramics of 3 different voltage ratings.

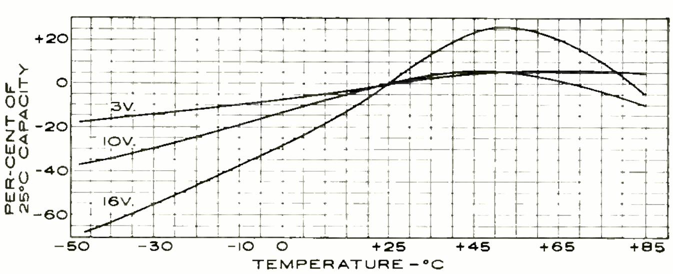


Fig. 9. Curves show capacitance change produced by temperature variation in ceramics of three different voltage ratings.

thick (Fig. 5). The basic construction involves interleaving layers of glass ribbon and aluminum foil to provide the active area, as shown in Fig. 4. Dumet leads welded to the aluminum foil provide glass-to-metal seals. The case is made of the same glass as the dielectric, and the entire assembly is then fused with pressure and heat to form a single block containing the capacitive element.

Glass capacitors are ordinarily made in a range of values from 0.5 to 10,000 pf. ($\mu\mu$f.). They are generally rated for 300 to 500 d.c. working volts, and for a temperature range of $-55°$ C to $125°$ C.

Since the cost of glass capacitors is higher than of mica varieties, they have little application in the entertainment field. They are used most frequently for military and certain critical industrial equipment.

Ceramic Capacitors

A number of ceramic dielectric materials have been developed with *K*'s ranging from 10 to 10,000. These include titania, barium titanate, stannate, and zirconate. They provide a high capacity-to-volume ratio plus other interesting features.

Normally, a ceramic capacitor is made with a small sheet of ceramic material that has been silvered on both sides. Wire or ribbon leads are applied to this sheet, and the unit is enclosed in an insulated case. Where more capacitance is desired in the same area, units are made with 2, 3, and 5 ceramic sheets. The most common kind of ceramic capacitor is shown in Fig. 6. However, they are designed in a number of configurations for special applications. Fig. 7 shows a feedthrough capacitor intended for mounting on a chassis, where it serves as a stand-off insulator for attaching other components and also for bypassing r.f. to ground.

Depending on the mixture of elements, ceramic capacitors exhibit large changes in capacitance with both voltage and temperature. Typical capacitance-voltage and capacitance-temperature curves are shown in Figs. 8 and 9. Both characteristics have been utilized for electronic circuits. Voltage-sensitive capacitors with barium titanate dielectrics are used for one kind of parametric amplifier and for special circuits where a voltage change varies the resonant frequency of a tank circuit.

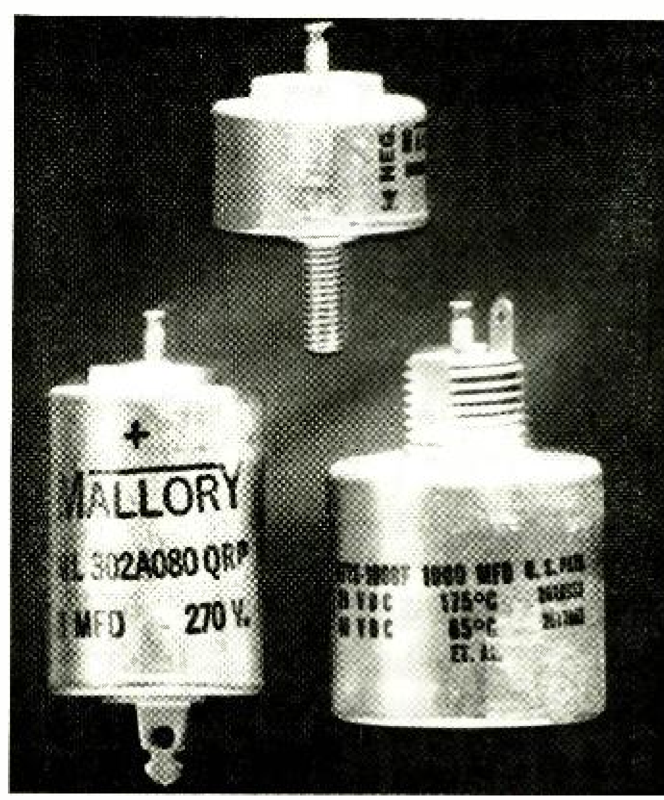
Ceramic capacitors which are capacitance-sensitive to temperature in varying, predetermined degrees have found wide application in tuning and resonant circuits. They are sometimes used in FM receivers, for instance, to maintain resonant circuits at a constant frequency and thus prevent drift during warm-up, by compensating for temperature-induced changes in coils and other circuit elements.

Electrolytic Capacitors

The greatest capacity per unit volume is provided by electrolytic capacitors. Although they have very large power factors and considerable leakage conductance, these factors are not important for many applications. Certain metals, especially aluminum and tantalum, are readily coated with a film dielectric by an electrochemical forming process. Aluminum electrolytic capacitors are made by placing gauze saturated with a highly viscous or fudge-like solution of aluminum borate between two strips of aluminum. The strips are then wound into a roll and placed in a suitable container. When d.c. is passed through this assembly, a thin film of aluminum oxide forms on the anode strip. This film serves as an insulated dielectric and current drops rapidly. The

(*Continued on page* 84)

Fig. 10. Liquid-electrolyte, sintered-anode, tantalum capacitors by Mallory. Unit at lower right is rated at 1000 μf.



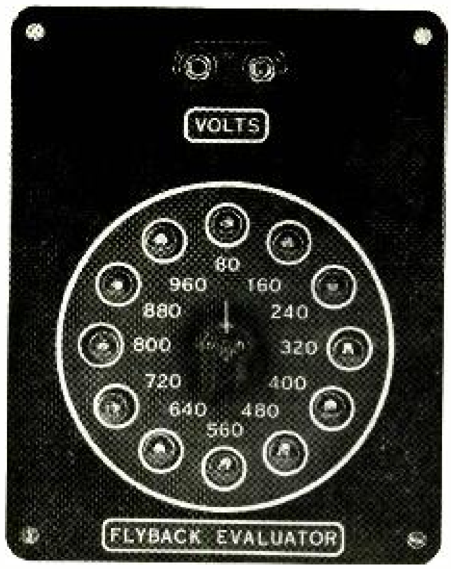


Fig. 1. A compact, insulated case combines convenience, safety, and durability.

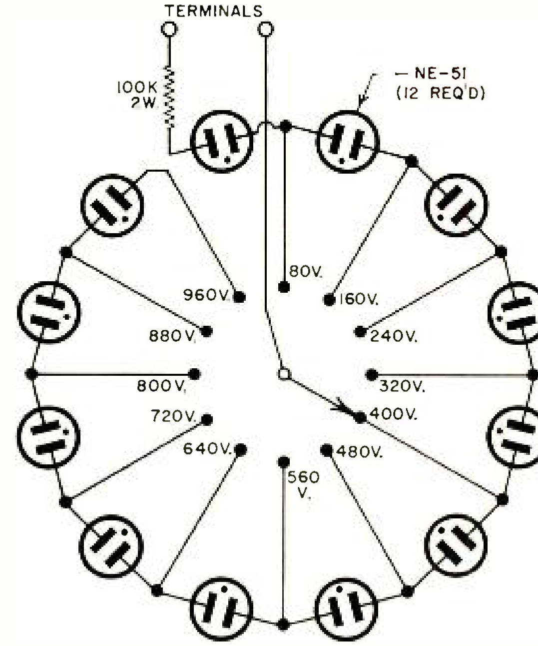


Fig. 2. A string of neon lamps to match highest voltage expected and a switch are the basic parts.

A TRANSIENT EVALUATOR

By RONALD L. IVES

Finding the amplitude of flyback surges, a first step to adequate suppression, is made quick and easy with this positive indicator.

THE SYSTEMIC transients inevitably developed in industrial control equipment have long been a source of great annoyance both to the users of the equipment and others. Destructive sparking at contacts and radiated interference to broadcast services are the two most obvious effects. Eliminating these problems is largely a matter of absorbing and suppressing the flybacks developed in inductive elements, such as relay coils and solenoids.

Various types of suitable devices are available. These include *RC* networks, "contact protectors," reversed diodes, and zener diodes. The effective configurations in which they can be used are well known, but the constants must usually be determined by experimentation. The hardest factor to determine, in most cases, is amplitude of the voltage to be suppressed. It may run from twice to more than twenty times the applied voltage, and there is no convenient way of calculating it. It is determined by direct measurement.

An instantaneous-peak voltmeter can do the job well, but this is a rather complex laboratory instrument, not well suited for on-the-job work. An oscilloscope, usually equipped with an added input attenuator, also measures peak surges reliably, but is not too handy for such service either. Its bulk is not convenient for the cramped quarters in most field locations encountered.

Inevitably electronics technicians began to discover that a string of neon lamps could be used as a rough but adequate peak voltmeter. If an unknown voltage would light four but not five lamps in a series string, then the voltage peak was at least four but less than five times the striking voltage for the type of lamp used. With NE-2 lamps, for instance, the peak would be between 320 and 400 volts.

Drawbacks that may occur at first thought are not serious; the principle is thoroughly workable and practical for evaluating flybacks. The lack of high precision and resolution in reading voltage is insignificant; if a suppressor is designed for 400 volts or slightly above in the case just cited, nothing is lost. Although a flyback pulse may last for only a few microseconds, the illumination it produces in a neon lamp endures for a considerably greater period due to residual ionization. This effect is augmented somewhat by persistence of vision. Other objections are that a string of neon lamps, as such, is neither a safe nor a convenient tool and will not last indefinitely, but each of these is a minor problem that can be taken care of easily.

We can socket-mount a dozen neon lamps, use a switch to change the length of the series string, and install this assembly in a suitable case with binding posts. The result is compact, convenient, and safe. One such device, using NE-51 lamps, is shown in Fig. 1.

In use, the terminals are connected across the source of transients to be suppressed, the switch is first set to the highest voltage value than can be checked (960 volts, in this case), and the source equipment is energized and de-energized. If the bulbs do not light, the switch is set down to the next lower voltage value and the flyback source is operated again. This is repeated until the bulbs light. Voltage is then read opposite the switch pointer, and the rating for the suppression device need not be more than 80 volts greater (plus any additional safety margin the user elects).

The simple circuit of the evaluator appears in Fig. 2. Usefulness of the device obviously extends beyond evaluation of the raw transient; it can also determine the degree of success attained in suppression. The evaluator will no longer be useful when the flyback has been reduced to about the same value as the supply voltage. If refinement greater than this is indeed considered necessary, a more sensitive instrument, such as an oscilloscope, would then be used.

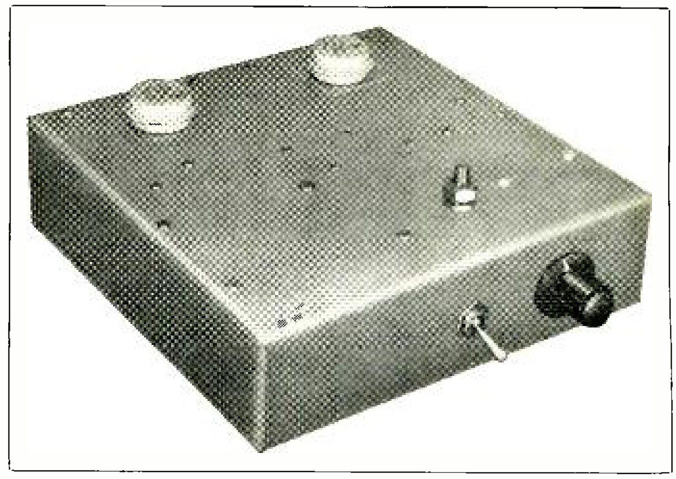
Construction

For adequate insulation, the illustrated version of the evaluator was housed in a Bakelite instrument case (*Smith* No. 2257, with No. 2260 cover). Terminals and switch were mounted on the cover, which serves as the instrument panel. The switch is a single-circuit, 12-point, continuous-rotation unit. The one shown was made from a *Centralab* type 2503

(*Continued on page* 76)

14-WATT TRANSISTOR HI-FI AMPLIFIER

By D. F. REHBERGER



Top-chassis view. Both output transistors are insulated from the chassis. The screwdriver-adjustable potentiometer is R3.

Construction of a compact, low-cost output-transformerless amplifier that delivers medium power at low distortion.

THIS amplifier was designed specifically to perform as well as conventional amplifiers using vacuum tubes. Transistors have some inherent advantages over vacuum tubes; namely, a reduction in size and weight of the amplifier, an improved signal-to-noise ratio, and an increase in operational efficiency. The cost of all the semiconductors in this circuit comes to a little less than $12.00.

Design Considerations

The circuit of this amplifier and the components chosen were designed such that the minimum performance characteristics are as follows: (1) a minimum of 12 watts output, (2) total harmonic distortion less than 0.5%, (3) noise better than 85 db down from 10 watts, and (4) frequency response within ±0.5 db from 20 to 20,000 cps.

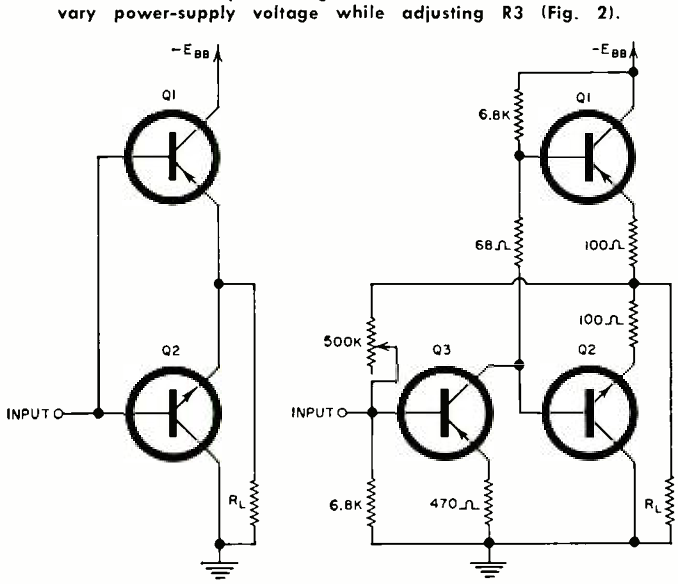
By eliminating the output transformer size and weight have been reduced resulting in a light, compact amplifier. The frequency response is increased and the distortion without feedback is decreased. With the increased stability of the amplifier, more feedback can be applied to further reduce distortion, with complete absence of parasitic oscillations so prevalent in some vacuum-tube amplifiers. There is a sizable reduction in cost with the elimination of the relatively expensive output and power transformers.

We used a circuit that would not require expensive or hard-to-find components. It would be inefficient to attempt operation of the output stage in the class A mode, also there is a hazard in operating the output stage at such a high zero-signal current. This would also cause a heat dissipation problem and increase the probability of thermal runaway.

Class B operation was chosen in order to keep heat to a minimum and increase efficiency. A conventional push-pull class B amplifier suffers from several types of distortion, the hardest to correct is caused by the difference in *beta* between the two output transistors and can only be corrected by careful matching. Since matched transistors would be expensive, the conventional push-pull configuration was set aside in favor of the complementary-symmetry connection.

Class B operation is usually thought to lead to considerable distortion as with vacuum-tube amplifiers. This crossover distortion is caused by imperfect coupling between the two halves of the primary of the output transformer. The small value of crossover distortion present with the complementary-symmetry configuration may be kept low by adding suitable negative feedback. The most straightforward method of coupling to the loudspeaker is with a capacitor, as transformers are to be avoided. The bridge output stage eliminates the coupling capacitor by direct connection to the speaker, but this requires both a positive and negative power supply.

Fig. 1. (A) Basic complementary-symmetry connection. (B) The addition of an amplifier stage is shown. (C) Method used to vary power-supply voltage while adjusting R3 (Fig. 2).



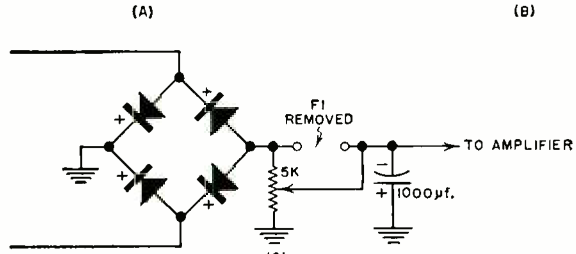
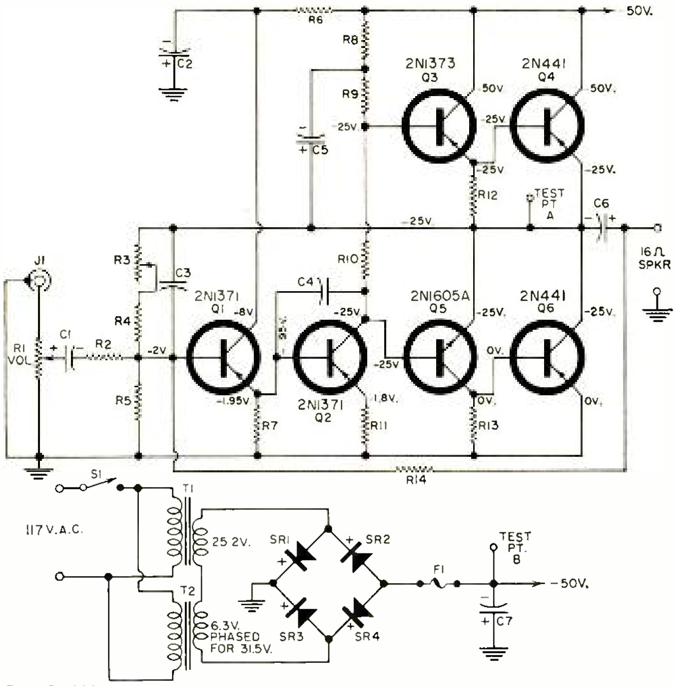


Fig. 1A shows the basic complementary-symmetry connection requiring both a *p-n-p* and *n-p-n* transistor. Q1 is a *p-n-p* type and acts as an emitter-follower for negative half cycles of the input. Q2, which is an *n-p-n* type, acts as an emitter-follower for the positive half cycles. Fig. 1B shows the complementary-symmetry connection with amplifier stage.

Circuit Operation

The complete amplifier is diagrammed in Fig. 2. The emitter-follower input stage Q1 provides the low-impedance drive required by the class A driver Q2. Both a.c. and d.c. feedback paths are returned to the base of Q1. Q3 is the *p-n-p* type and Q5 is the *n-p-n* type in the class B complementary-symmetry, common-collector stage and provides both an in-



R1—50,000 ohm audio taper pot
R2—2700 ohm, ½ w. res.
R3—250,000 ohm linear taper pot
R4—47,000 ohm, ½ w. res.
R5—33,000 ohm, ½ w. res.
R6,R14—27,000 ohm, ½ w. res.
R7,R8,R12,R13—1000 ohm, ½ w. res.
R9—6800 ohm, ½ w. res.
R10—68 ohm, ½ w. res.
R11—470 ohm, ½ w. res.
C1—25 µf., 25 v. elec. capacitor
C2,C5—25 µf., 50 v. elec. capacitor
C3—220 pf. (µµf.), 50 v. ceramic capacitor
C4—1000 pf. (µµf.), 50 v. ceramic capacitor
C6,C7—1000 µf., 50 v. elec. capacitor (two 500 µf. in parallel)
S1—S.p.s.t. toggle switch
F1—½-amp fuse (see text)
T1—Fil. trans. 25.2 v. @ 1 amp (Allied 61-G-421 or equiv.)
T2—Fil. trans. 6.3 v. @ 1 amp (Allied 62-G-030 or equiv.)
SR1,SR2,SR3,SR4—750 ma., 200 p.i.v. silicon diode
J1—Phono jack
Q1,Q2—40 v. "p-n-p" transistor (2N1371, 2N1373, 2N464, 2N381, 2N383, 2N1749 or 2N1924)
Q3—"p-n-p" transistor (2N1373 or any of above equiv.)
Q4,Q6—"p-n-p" transistor (2N441)
Q5—"n-p-n" transistor (2N1605A or 2N388A)
2—Transistor mounting kits for TO-36 case
1—2" x 7" x 7" aluminum chassis

Fig. 2. Complete circuit diagram of the transistor amplifier.

crease in current gain and phase inversion to drive the class B output transistors Q4 and Q6. The operating point of Q3 and Q5 is stabilized by the 100% feedback inherent in the common-collector configuration. They are biased slightly forward by the 68-ohm resistor *R*10 to further reduce crossover distortion. A germanium diode, type 1N91, would be used in place of *R*10 to temperature-stabilize the amplifier if operation above 45°C is required. The cathode of the diode goes to the base of Q3. Q4 and Q6 are also slightly forward biased to reduce crossover distortion to a minimum. The bias is set by the voltage drop across the 1000-ohm resistors, *R*12 and *R*13.

The 27,000-ohm feedback resistor *R*14 provides about 15 db of feedback around the amplifier. In parallel with *R*14 is a 220 pf. (µµf.) capacitor *C*3 to further stabilize the amplifier at high frequencies. *C*4 stabilizes Q2 by reducing the high-frequency gain and phase shift. The 250,000-ohm pot *R*3 is to adjust the bias of Q1 and to divide the supply voltage evenly between Q4 and Q6.

Heat sinks are not necessary for Q4 and Q6 when the amplifier is employed in general home use with conventional loudspeakers as the average current is quite low (between 12 and 60 ma.) The power supply has a conventional full-wave bridge rectifier providing −50 volts. In order to provide −50 volts as inexpensively as possible, two low-cost filament transformers are phased together to give about 32 volts r.m.s. Since the maximum power output depends on the regulation of the supply, the better the regulation the more sine-wave power is possible up to 14 watts. The transformers specified in the parts list give adequate regulation for 11.5 watts output. The ½-amp fuse protects both the output transistors and the silicon diodes from possible damage. A "Slo-Blo" fuse may be necessary if the initial surge current, when the amplifier is turned on, blows a conventional fuse.

Construction Details

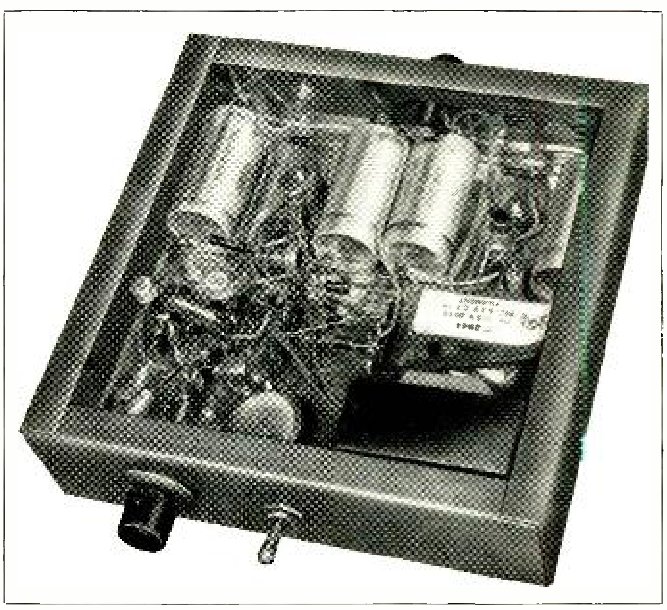
No special precautions are required with respect to component layout. Be particularly careful with the transistors so as not to damage them when soldering. Observe polarity with both the diodes and electrolytic capacitors. The power transistors should be mounted with silicone compound to provide good heat transfer away from the cases. A transistor mounting kit for the TO-36 case should be used for both output transistors. The resistance between the transistor case and the chassis should be very high. All burrs should be removed from the chassis, or heat sink, to prevent shorts to the transistor case.

The components used in the initial design are not critical. Q1 and Q2 may be any *p-n-p* transistor able to operate at −40 volts and dissipate 120 mw. Q3 and Q4 become somewhat more critical as a mismatch in *beta* of more than 4 to 1 causes an increase in distortion, specifically crossover distortion. Q1, Q2, Q3, and Q4 were chosen not only for their electrical characteristics but for their ready availability.

Adjustment & Performance

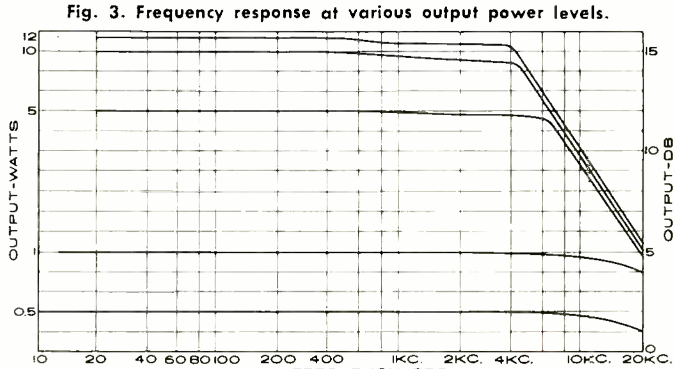
After a thorough check of the completed circuit, temporarily remove the fuse and connect a 5000-to 10,000-ohm pot as shown in Fig. 1C. With the output voltage at zero connect a lead to the amplifier with a voltmeter at test point A. This voltage should be half that of the supply voltage. Adjust *R*3 for the proper voltage at test point A. Continue to increase

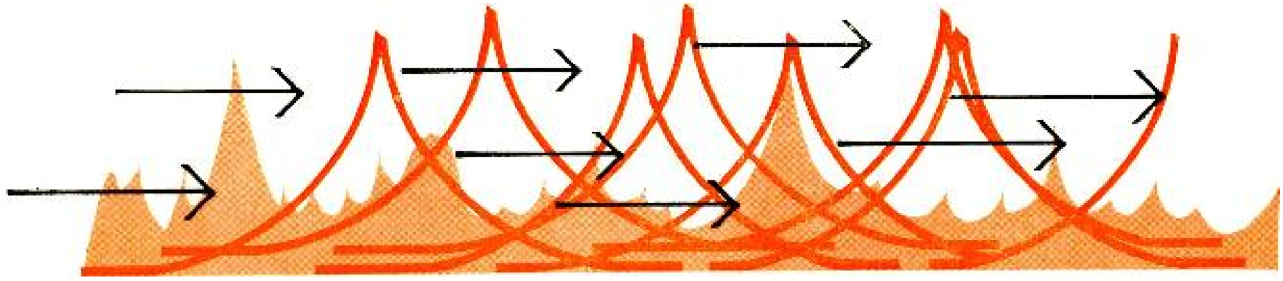
(*Continued on page* 71)



Under-chassis view of one of the units built by the author.

Fig. 3. Frequency response at various output power levels.





Tunable Phase-Shift Audio Filter

Construction of an accessory for communications receiver that boosts audio selectivity. Unit is inexpensive, simple to build, convenient to use.

By RONALD L. IVES

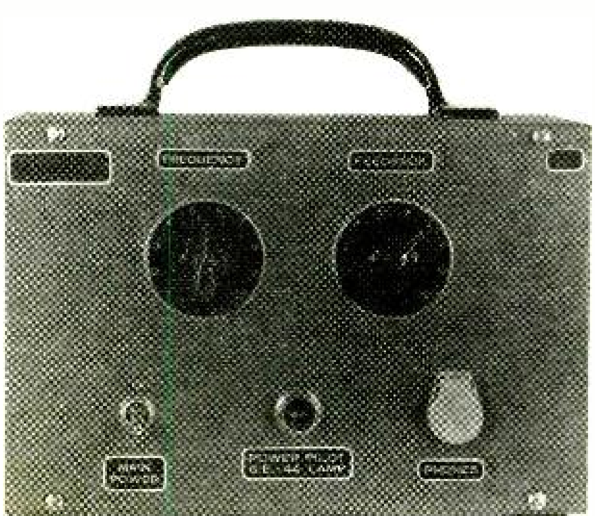
NO matter how good or how costly your receiver, increasing crowding of the bands, whether commercial or amateur, raises the need for greater and greater selectivity. This problem is not new and radio handbooks, from at least 1922 on, suggest a number of ways for increasing receiver selectivity. Surviving methods include crystal filters, multiple conversions, "Q" multipliers, and audio filters. Many receivers now use different combinations of these methods, with varying success.

Audio filters, particularly those involved in *LC* circuits, have been a problem of long standing because the electrically large inductors and capacitors required are also mechanically large, very costly, and most difficult to tune or adjust. Additionally, *LC* circuits of the requisite "Q" tend to ring like a carillon and thus when the selectivity is adequate to isolate a given signal, the dots and dashes run together and the signals cannot be copied too accurately.

RC Filter Circuit

To avoid the difficulties inherent in *LC* circuits, various *RC* filters, most of them of the phase-shift variety, have been proposed and constructed in recent years[1]. Some of these work quite well, but are either fixed-tuned or have most awkward or costly tuning mechanisms. A restudy of the problem, in the light of currently available components, has disclosed a method of making a tunable phase-shift audio filter that is not only inexpensive and easy to build, but also most convenient to use. A panel view of the completed filter, with built-in power supply, is shown in the photograph below.

Front-panel view of unit. The case measures 5"x 6"x 9".



Interestingly, all of the principles involved in this filter are more than 40 years old; the first phase-shift vacuum-tube circuit, an oscillator, having been patented by H. W. Nichols in 1921[2]. The basic circuit of this oscillator, with salient operational data, is shown in Fig. 1. Here, at the frequency which produces a 180° phase shift in the *RC* network, oscillation will occur whenever the feedback equals or exceeds in amplitude the initial signal at the grid. Otherwise stated, if the tube amplification exceeds the network loss, the circuit will oscillate.

When the network loss is greater than the tube amplification, the circuit cannot oscillate, but will amplify a signal fed into it. If we can approach the condition of oscillation

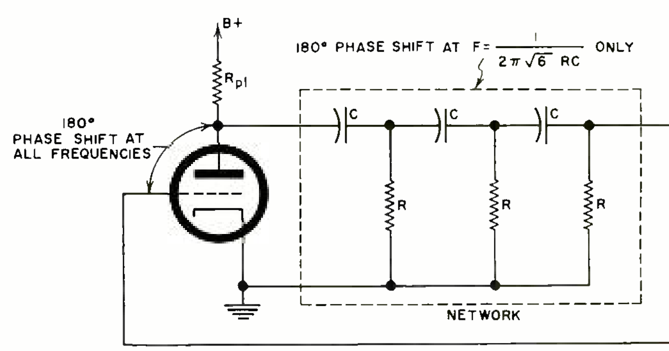


Fig. 1. The basic phase-shift feedback circuit arrangement.

closely, while maintaining circuit stability, we can obtain enormous amplification at one frequency only. If, in addition, we can make the phase-shift network tunable, while maintaining the requisite stability, we have a most useful receiver adjunct.

In a definitive study of phase-shift circuits, Ginzton and Hollingsworth[3] determined most of the basic constants which we need. They found that the network, when producing a 180° phase shift, had a transfer constant of 1/29. This shows that the tube used must have an attainable gain of at least 29. Their computations also indicated that the plate-load resistor (R_{pl} of Fig. 1) must be very much smaller than *R*, or it will influence operation of the network.

Their study also showed that the frequency of oscillation or of maximum amplification of a circuit like Fig. 1 could be found from $F = 1/(2\pi\sqrt{6}\,RC)$, where F is in cycles per second, R is in ohms, and C is in farads.

Using this data, the circuit of Fig. 2 was developed, tested extensively, and found very satisfactory. In this circuit, the first triode *V1A*, couples the signal input, *via* the common cathode resistor, to the phase-shift selective amplifier tube, *V1B*. Output of this tube is fed to a cathode-follower, *V2*, which isolates both the output and the phase-shift network from the plate circuit of *V1B*, so that neither ordinary changes in external load nor tuning of the filter will change the stability of the circuit. With this arrangement, the "Frequency" and the "Feedback" controls are entirely independent.

Most of the components are standard and any good part coming within about 10 per-cent of the listed value will perform satisfactorily. The only difficult part to obtain on the open market is the triple 0.1-megohm variable resistor, *R6*, used to tune the phase-shift network. Thanks to mass-production, this is not a real problem since the needed resistor can be assembled in a few minutes from two *Ohmite* CCU-1041 dual potentiometers.

To make this change, set both pots to full counterclockwise shaft rotation. On the first, carefully raise the four case-holding ears on the shaft end and work out the front section. Put this aside for future use. On the second, carefully raise the four case-holding ears on the rear section and remove the rear cover. Put this aside for future use. Now push the rear portion of the first assembly onto the front portion of the second, making sure that the driving lug of the front portion goes into the driving slot of the rear portion. Check for good mechanical operation then bend down the case-holding ears to complete the assembly. This composite unit becomes *R6* of Fig. 2.

Now, arrange an arm stop in the leftover case section. A 4-40 roundhead screw is suitable here. Assemble this case onto the front section removed from the first pot. Check for mechanical operation and bend down the case-holding ears. Saw off the shaft to a length of about ⅜" and carefully slot it. This is now *R4* of Fig. 2.

The power supply for this filter is made integral, as the accessory sockets on most receivers are already overloaded. This is a simple full-wave voltage-doubler arrangement, the circuit of which is shown in Fig. 3. Any other power supply with the same outputs will perform about as well. Note that the filament center-tap is biased positive with respect to ground, a procedure which minimizes hum and which is most desirable in equipment employing cathode-follower circuits, such as this particular unit.

Construction Details

A standard 5" x 6" x 9" utility cabinet (*Bud* CU-1099) with a 4" x 2" x 8" chassis is adequate to house the filter and its power supply, without crowding and allowing adequate isolation of heat-producing components from those controlling frequency. The arrangement shown in the above-chassis photo is not mandatory and may be modified to suit the builder's preferences.

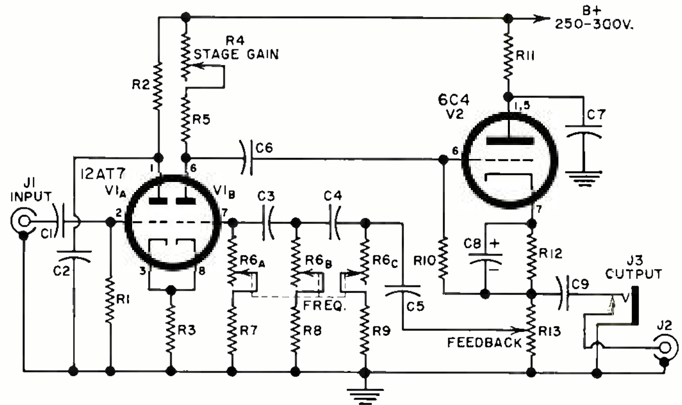
Although physical placement of the various components is not at all critical, firm mounting and tight connections are. To insure mechanical stability which, in turn, determines electrical stability, free use was made of high-quality tie points, so that components would "stay put."

Signal and power connections are made at the rear of the chassis, to keep the operating space as free as possible of connecting wires. The rear cover of the case is cut out to pass these connectors so that the panel and chassis can be removed as a unit without removing the back plate.

For safety and operating convenience, the case is fitted with heavy rubber feet and a strong carrying handle (a *Stanley* 482-J-3). Control functions and constants of removable components are indicated by use of Metalphoto labels.

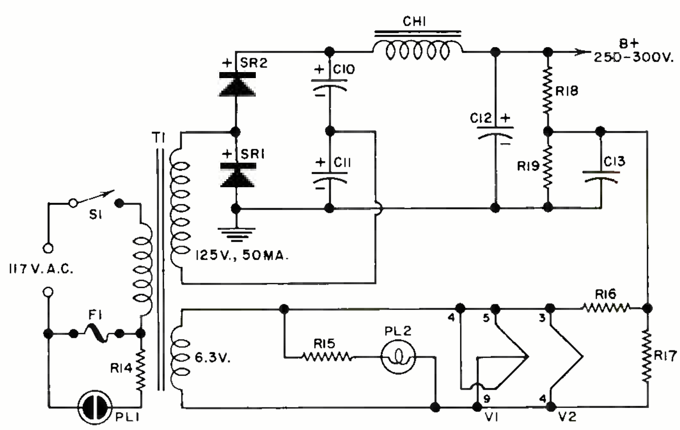
When all construction work is completed and checked, and before the filter is installed in the case, insert tubes, fuse, and pilot lights and connect the device to an a.c. supply. Plug a headset into the "Phones" jack *J3*, set the "Feedback" control to maximum, and the "Frequency" control to minimum. Now adjust *R4* ("Stage Gain") until the filter oscillates strongly. Back the control off from this position until the oscillation just stops. When a position of the "Stage Gain" control is found at which no oscillation occurs at any setting of the "Frequency" control, the filter is adjusted for optimum sensitivity. Install it in the case, and it is ready to use.

This filter is best installed between the volume control of the receiver and the first a.f. stage. Because the filter provides considerable amplification, particularly at maximum selectiv-



R1—1 megohm, 1 w. carbon res.
R2,R11—4700 ohm, 2 w. carbon res.
R3—470 ohm, 2 w. carbon res.
R4—.1 megohm linear pot (see text)
R5—10,000 ohm, 1 w. carbon res.
R6—triple 0.1 megohm linear pot
R7,R8,R9—5600 ohm, 1 w. carbon res.
R10—.1 megohm, 1 w. carbon res.
R12—330 ohm, 1 w. carbon res.
R13—25,000 ohm pot (Ohmite CU)
C1—.1 µf., 600 v. paper capacitor
C2,C6,C7,C9—.1 µf., 600 v. ceramic capacitor
C3,C4,C5—.0033 µf., 600 v. paper capacitor
C8—25 µf., 25 v. elec. capacitor
J1,J2—SO-239 coax fitting
J3—Phone jack
V1—12AT7 tube
V2—6C4 tube

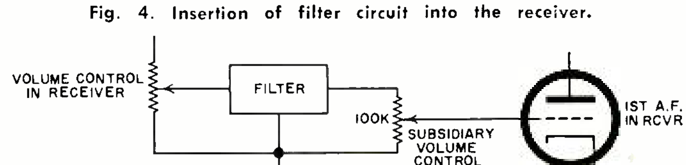
Fig. 2. Circuit diagram and parts list of the filter unit.



R14—100,000 ohm, ½ w. carbon res.
R15—10 ohm, 2 w. carbon res.
R16,R17—100 ohm, 1 w. carbon res.
R18,R19—10,000 ohm, 1 w. carbon res.
C10,C11—50 µf., 250 v. elec. capacitor
C12—80 µf., 450 v. elec. capacitor (Mallory FP 149)
C13—0.1 µf., 600 v. ceramic capacitor
S1—S.p.s.t. bat handle toggle switch
CH1—12 hy., 30 ma. choke (Stancor C-2813)
PL1—NE-51 lamp
PL2—No. 44 lamp
SR1,SR2—Silicon rectifier in dual holder (Sarkes Tarzian M-500)
F1—1-amp fuse
T1—Power trans. 125 v. @ 50 ma.; 6.3 v. @ 2 amps (Stancor PA-8421)

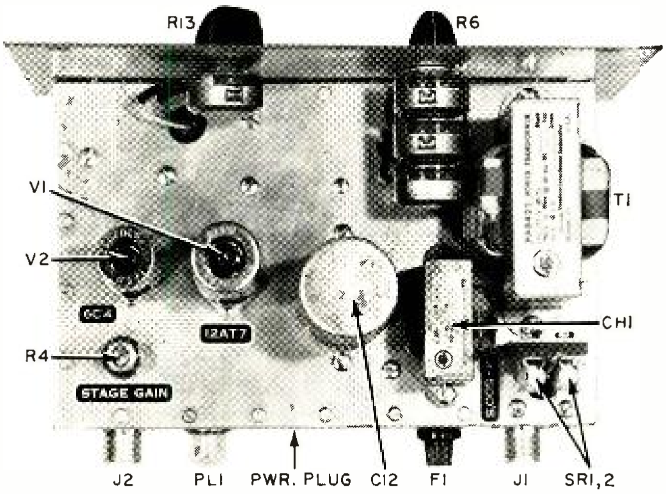
Fig. 3. Integral power supply circuit and parts listing.

Fig. 4. Insertion of filter circuit into the receiver.



ity (maximum feedback), a subsidiary volume control, between the filter and the first a.f. grid, is usually found desirable. This can be set once for the desired volume and then left alone. This volume control also furnishes a grid return for the a.f. stage. If this is omitted, the audio quality may be most unsatisfactory. The circuit found suitable for filter connections is shown in Fig. 4.

To use the filter, tune into any c.w. "bedlam," with the "Feedback" control at minimum, then slowly advance the



Top-chassis view of author's unit with the cover removed.

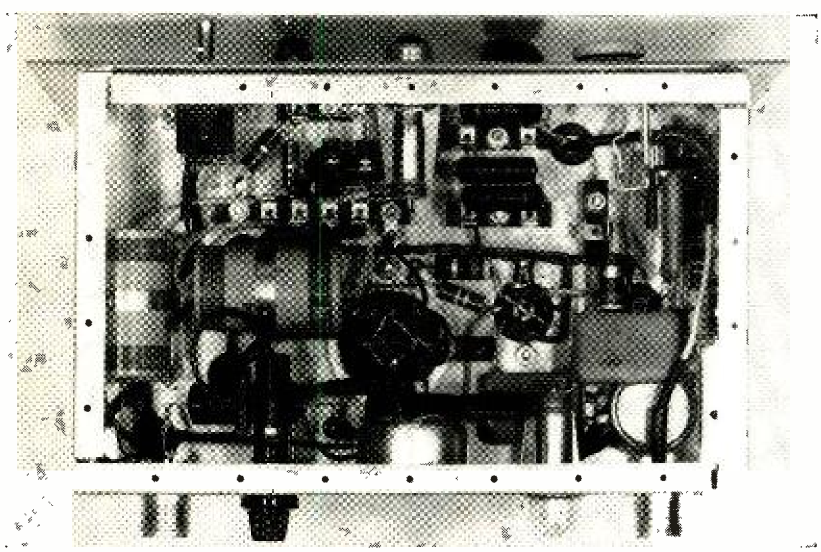
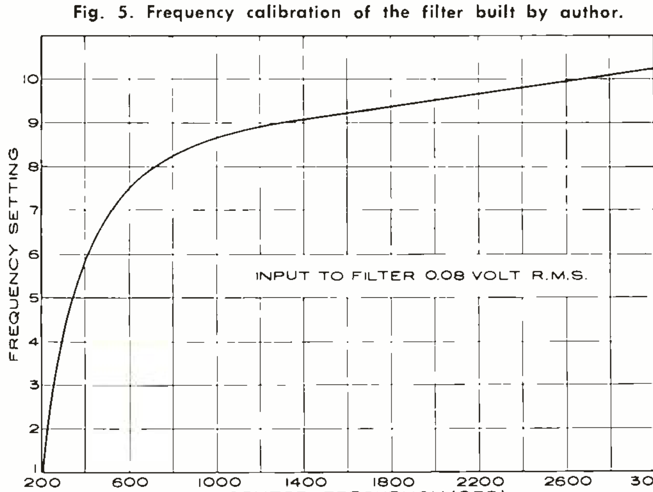

Under-chassis view. Note liberal use of circuit tie points.

Fig. 5. Frequency calibration of the filter built by author.



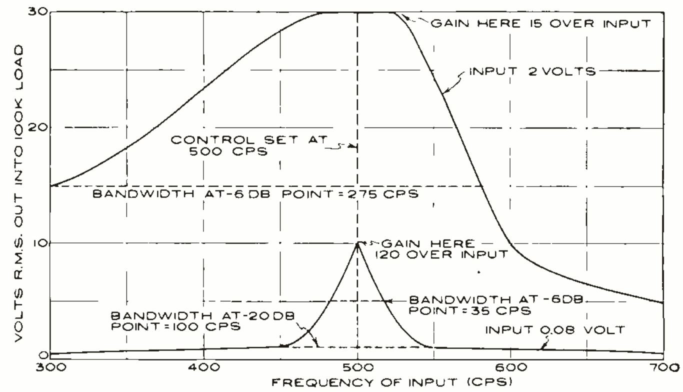


Fig. 6. Bandwidths at various levels of input signal voltage.

"Feedback," and note how the number of signals declines. Any given signal can be favored and elevated out of the background by turning the "Frequency" control to its frequency. The amount of elevation of a chosen signal above the background is determined by the "Feedback" setting. Frequency calibration of the illustrated filter is shown in Fig. 5. Any filter built with the same constants will have *about* the same characteristic, but it should not be used as a frequency meter without careful calibration. The frequency control pot here was polarized so that resistance was at a maximum at the low-frequency (1) end and at a minimum at the high-frequency (10) end.

This filter gives excellent, stable performance throughout its tuning range when the input is from 1 to 120 millivolts. At these input values, its gain at center frequency is 120; its bandwidth at 6-db down (at 500 cycles) is 35 cps; and its bandwidth at 20-db down is 100 cps. The characteristic is slightly asymmetrical, giving a little higher attenuation at the higher frequencies, as was correctly pointed out in Ref. 1. Normal bandwidth is shown in the lower curve of Fig. 6. Slightly greater gain is possible by careful adjustment of the "Stage Gain" control, but the infinite amplification suggested by the formulas is attainable only on paper.

As the input voltage is increased to the point where output voltage exceeds approximately 15, the tube circuits overload, the filter characteristic "flat tops," and the bandwidth increases, while amplification decreases. The characteristic curve also becomes much more asymmetrical, as is shown by the upper curve in Fig. 6.

Thus, for optimum performance, the filter input must be kept low, preferably below 0.1 volt r.m.s.

In common with most other feedback filters, this phase-shift audio filter tends to ring as maximum sharpness is approached. This limits the code speed receivable through it to about 20 words-per-minute, with the settings used. At higher speeds, the dots and dashes all run together. When ringing is a problem, it can be reduced either by raising the center frequency of the filter or by reducing the feedback and raising the input.

Although the filter will automatically clip strong noise pulses, so that the output can never exceed approximately 30 volts r.m.s., it works best if preceded by a noise limiter.

Use of an audio filter will not cure all interference problems, but it will, when properly adjusted and not overdriven, pick one clear, readable signal out of the pandemonium of five or six. If built with proper care, this filter will need no more maintenance than a good receiver, and will outlast most of your station equipment. ▲

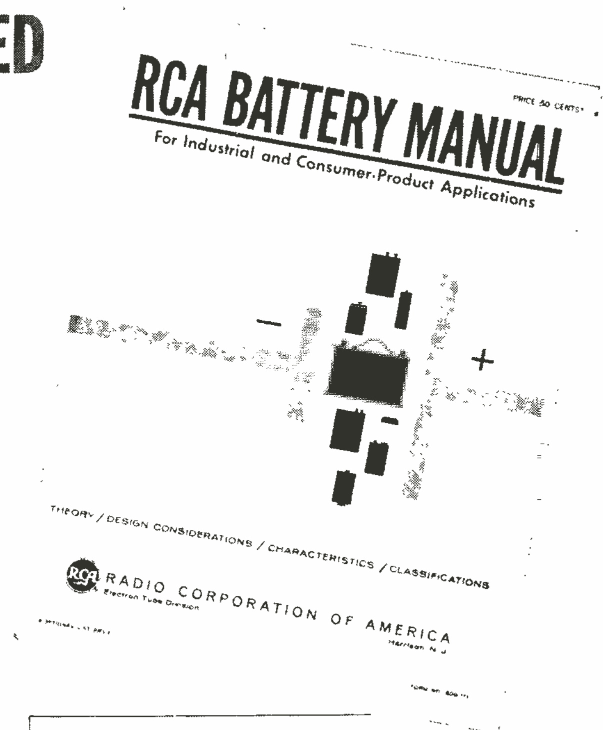
REFERENCES

1. Kyle, Jim: "Phasing for Audio Selectivity," 73, November 1961.
2. Nichols, H.W.: U.S. Patent 1,442,781, issued Jan. 16, 1923; filed Jan. 7, 1921.
3. Ginzton, E.L. & Hollingsworth, L.M.: "Phase-Shift Oscillators," Proc. of the I.R.E., February 1941.
4. Kohler, G.M.: "Photography Makes Custom Labels," Electronics, Jan. 1, 1960.

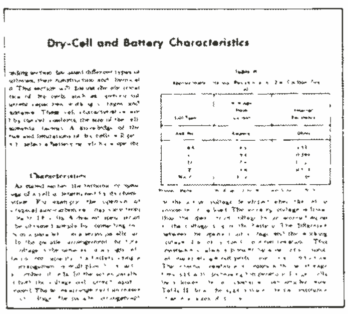
If you design or work with battery-operated equipment...

THIS IS THE BOOK YOU NEED

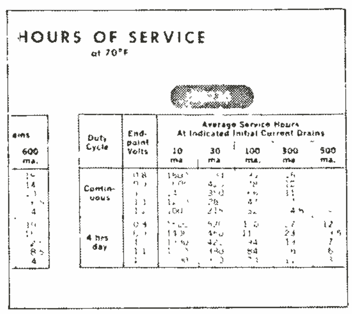
RCA's comprehensive new 64-page battery manual is an invaluable reference source for anyone designing or working with battery-operated circuits, whether for industrial, consumer or hobby applications.



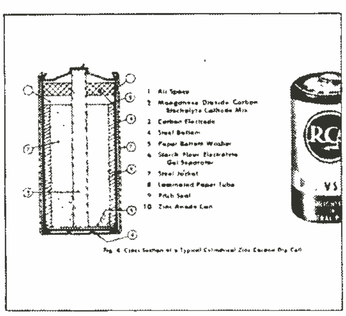
WHAT IT GIVES YOU:



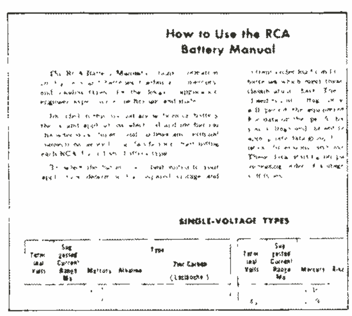
Battery principles and characteristics . . . Page 12



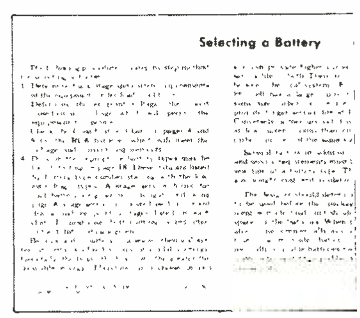
Average service hours (in tabular form) . . . Page 25



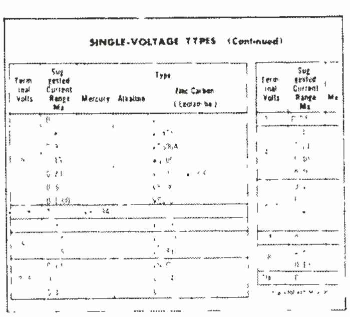
Battery construction . . . Page 10



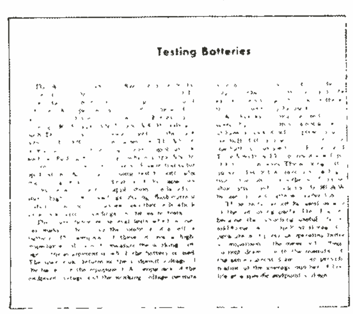
Comprehensive classification chart . . . Page 4



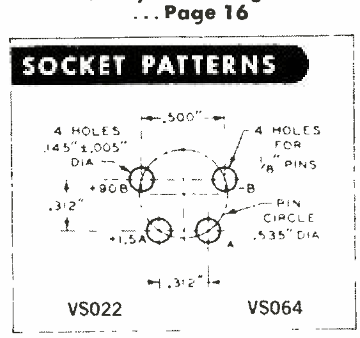
Battery selection guide . . . Page 16



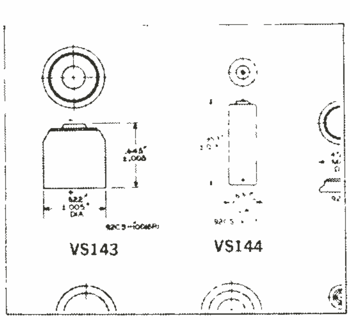
Recommended current ranges . . . Page 5



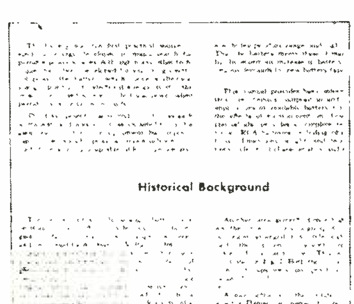
Test procedures for different types . . . Page 15



Terminal and socket connections . . . Page 56



Dimensional outlines, sizes, weights . . . Page 18



Battery development . . . Page 6

Available through your Authorized RCA Battery Distributor. Get a copy the next time you're there. $.50 Optional List Price.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

The Most Trusted Name in Electronics

JOHN FRYE

Mac has lunch with Colonel Schatzel, Director of Engineering of the Midwest Program on Airborne Television Instruction.

MPATI—Its Problems & Solutions

BARNEY, the youthful technician at Mac's Electronics Service Shop, was not hurrying back to work after lunch. The feel of the warm sun beating down on his shoulders, the summer-scented breeze wafting past his nostrils, the sight of girls tripping along in their pretty spring dresses, and the gay "churlikking" of robins sound-searching the greening lawns for hapless worms—all these things dragged at his feet and slowed his steps to a saunter.

But Mac, Barney's employer, was obviously in a good mood; for when the spring-fevered youth ambled into the service department, the older man didn't even glance disapprovingly at the clock.

"Ah, there you are," he said. "I just had a most interesting lunch with Colonel Schatzel, Director of Engineering of the Midwest Program on Airborne Television Instruction, and I'm busting to recite some of the things I've learned to sort of fix them in my mind."

"Be my guest," Barney invited, smothering a yawn. "You've got the best listener in seven states standing—or rather sitting—in front of you," his voice trailed off as he slumped down on a stool.

"Those MPATI boys have been doing some real pioneering," Mac said enthusiastically. "When you load two complete v.h.f. transmitters and their accompanying video tape recorders into an airplane, translate their outputs to u.h.f. channels 72 and 76, amplify these outputs with klystron amplifiers, feed both of these u.h.f. signals into a single slotted antenna jutting down from the belly of the plane, and finally radiate an effective 50 kw. apiece from the transmitters carrying entirely different programs while the plane is flying at 23,000 feet in a skinny figure-8 pattern inside a ten-mile-radius circle centered over a point on the earth's surface, you're doing something no one else has ever done before."

"And I'll bet you're going to run into some dandy new headachy problems," Barney offered.

"True, but actually the problems were not as many nor as bad as you might imagine. One trouble in the early days was with the hydraulic system of the plane. As you probably know, the antenna is hydraulically and automatically stabilized so that it never varies more than one degree from the vertical while the plane is flying a normal course. The hydraulic system for doing this was married to the plane's hydraulic system. Now ordinarily the only time the plane's hydraulic system is required to do much work is when the plane is landing or taking off. Then it controls the flaps, raises and lowers the wheels, does the braking, etc. Once the plane is in the air, the system is placed in a 'bypass' condition and has little to do. This is not true, however, when the antenna stabilizer is connected to the hydraulic system. The system is kept working almost constantly, and severe problems were encountered with heat that broke seals, destroyed pumps, and impaired valves.

"To solve the problem, elaborate instrumentation was installed that continuously monitored the heat and pressure at almost every point in the system. Once the trouble points were spotted, the solution was simply a matter of rearranging the plumbing so that pressures were reduced, cavitation of the pumps was prevented, valve leakage was stopped, and so forth."

"When the plane first started transmitting, I noticed dark bands shifting back and forth across the picture," Barney said. "I was told this was caused by vibration and that it was cured by better shock-mounting of the tubes and by going to transistors wherever possible. Is that true?"

"Only partially. Vibration *was* a problem. The CAA insists all equipment be solidly and rigidly mounted, and this doesn't help much when you're trying to keep vibration from reaching sensitive electronic components, such as amplifier tubes in the tape recorders. But a great deal of this 'banding' was caused by the 400-cycle voltage from the power supply getting into the video circuits. Careful filtering and shielding was necessary to reduce this, and it is contemplated shifting the power supply frequency to 420 cycles so that it will be an integral multiple of the 60-cycle frequency to which the vertical and horizontal oscillators of the TV receiver are geared. This would stop the movement of any banding that cannot be entirely eliminated and so render it less noticeable."

"Wouldn't it be a heck of a lot simpler just to use 60-cycle a.c. in the first place?" Barney asked. "I know the transmitter power is produced by an alternator driven by a gasoline engine back in the tail of the plane; so why not use a 60-cycle alternator instead of a 400-cycle job?"

"I'm comforted to see you're as dumb about aviation problems as I was," Mac answered with a grin. "I asked the same question. What we both forgot is that every pound of unnecessary weight must be eliminated from equipment you intend to fly. Right now the transmitting equipment in a single plane weighs about 10,000 pounds. If 60-cycle instead of 400-cycle current were used, the extra iron necessary in the alternator, transformers, and similar equipment would add hundreds and hundreds of pounds."

"Makes sense," Barney admitted grudgingly. "Say, I understand an antenna was wrecked. What hoppened? Did the pilot try to land with the antenna still pointing straight down?"

"MPATI people are pretty weary of that joke," Mac said. "It's true, though, one antenna was ruined. It was burned out. There is a directional coupler in each feedline, and when the s.w.r. indication from one of these goes too high that transmitter is automatically cut off. In the beginning, though, the power was automatically restored almost immediately; and since the trouble was not cleared, the resulting arc-overs ruined the antenna. This has been changed to an arrangement in which the power has to be restored manually after a high s.w.r. has caused it to be disconnected.

"You have to keep in mind that MPATI is a *complete system* involving both transmission and reception of the educational programs, and the reception of u.h.f. TV signals from

Take your choice of Winegard's 2-nuvistor Colortron or single-transistor Red Head antenna amplifiers — both great — both trouble-free! Both work with any TV or FM antenna. Here's the story!

COLORTRON ANTENNA AMPLIFIER . . . ONLY $39.95 • EXCELLENT FOR COLOR • WON'T OVERLOAD • TAKES UP TO 400,000 MICROVOLTS OF SIGNAL

FINEST ANTENNA AMPLIFIER MADE . . . Because the COLORTRON amplifier takes up to 400,000 microvolts of signal input, strong local signals won't overload and cause interference on distant fringe stations. It takes 20 times more signal input than any transistor antenna amplifier and without compromising its ultra low noise ability to pull weak signals out of the snow.

A special "lifesaver" circuit gives the 2 nuvistors an expected life of 5 to 8 years. It's the only amplifier that's completely weather-proof —nothing exposed, even terminals are protected. Install it and forget it! Fits any TV or FM antenna.

Colortron Amplifiers are Available in 2 Models for TV

FOR TV—Model AP-200N—twin nuvistor, takes up to 400,000 microvolts, input 300 ohm, output 300 ohm, $39.95 list.

FOR TV—Model AP-275, twin nuvistor, takes up to 400,000 microvolts, input 300 ohm, output 75 ohm, $44.95 list.

RED HEAD TRANSISTOR MODEL . . . ONLY $29.95 • FOR COLOR AND BLACK & WHITE • MOST RELIABLE TRANSISTOR ANTENNA AMPLIFIER EVER MADE.

With the Red Head, you won't have transistor "pop-out" because of its special advanced circuit that protects against lightning flashes, precipitation static and power line surges. Has high pass interference filter, 2-set coupler, fully AC—no polarity problems. Tremendously effective in remote areas where all signals are less than 20,000 microvolts. Uses latest low noise MADT transistor. Bright red amplifier housing gives lasting product identification. The Red Head supersedes Winegard's famous MA-300 amplifier.

For TV or FM—Model No. RD-300, single transistor, takes up to 20,000 microvolts, 300 ohm input and output, $29.95 list.

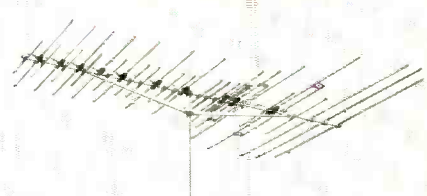
Stereotron Amplifiers are Available in 2 Models for FM

FOR FM—Model AP-320, twin nuvistor, takes up to 200,000 microvolts, input 300 ohm, output 300 ohm, $39.95 list.

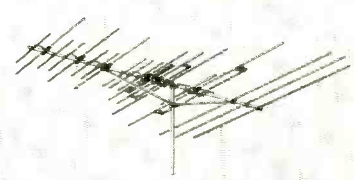
FOR FM—Model AP-375, twin nuvistor, takes up to 200,000 microvolts, input 300 ohm, output 75 ohm, $44.95 list.

Write for technical data or ask your Winegard distributor.

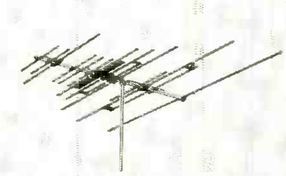
There's a Winegard Quality Antenna for Every Reception Need



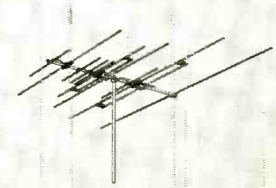
COLORTRON ANTENNA
Model C-44 • Gold Anodized • $64.95



COLORTRON ANTENNA
Model C-43 • Gold Anodized • $51.90



COLORTRON ANTENNA
Model C-42 • Gold Anodized • $34.95



COLORTRON ANTENNA
Model C-41 • Gold Anodized • $24.95

YOU GET AN EXTRA BONUS OF QUALITY AND VALUE FROM WINEGARD

Winegard ANTENNA SYSTEMS

WINEGARD COMPANY • 3003-5 KIRKWOOD BLVD. • BURLINGTON, IOWA

CIRCLE NO. 147 ON READER SERVICE PAGE

a constantly moving airplane at distances up to and beyond 200 miles presents some unique problems, too. MPATI people start with the reasonable premise that dependable u.h.f. reception has to be line-of-sight. Since the signal is attenuated only 6 db each time the distance from the transmitter is doubled, and since a good TV antenna can contribute 15 db of gain, this line-of-sight signal is adequate for good reception out to better than 200 miles—without complications.

"Unfortunately fading introduces a complication, fading that is caused by the ground-reflected signal combining with the direct signal. The reflected signal necessarily travels a longer path than the direct signal; so it arrives at the antenna a fraction of a microsecond later than the direct wave. Depending on *how much later* it arrives, its cycles will either reinforce the cycles of the direct wave or oppose them. If the cycles are completely out of step, or phase, and if the reflected signal is exactly as strong as the direct signal, complete cancellation can result. On the other hand, if both signals are precisely in phase, the combined reception strength can be twice that from the direct signal alone.

"Prevention of fading, then, has two possible solutions: either we can try to prevent the reflected wave from reaching the antenna at all, or we can attempt to arrange matters so that the reflected wave always helps instead of hinders our direct-wave reception. Close to the plane the use of a reflected-wave screen placed in front of and below the antenna can be quite effective, because the direct wave comes in at a fairly steep angle above the horizon and the reflected wave comes in to the antenna at about the same angle below the horizon; but when you get out to 100 miles where the elevation of the plane above the horizon is less than 2 . any barrier high enough to block the reflected wave is likely to interfere with reception of the direct wave.

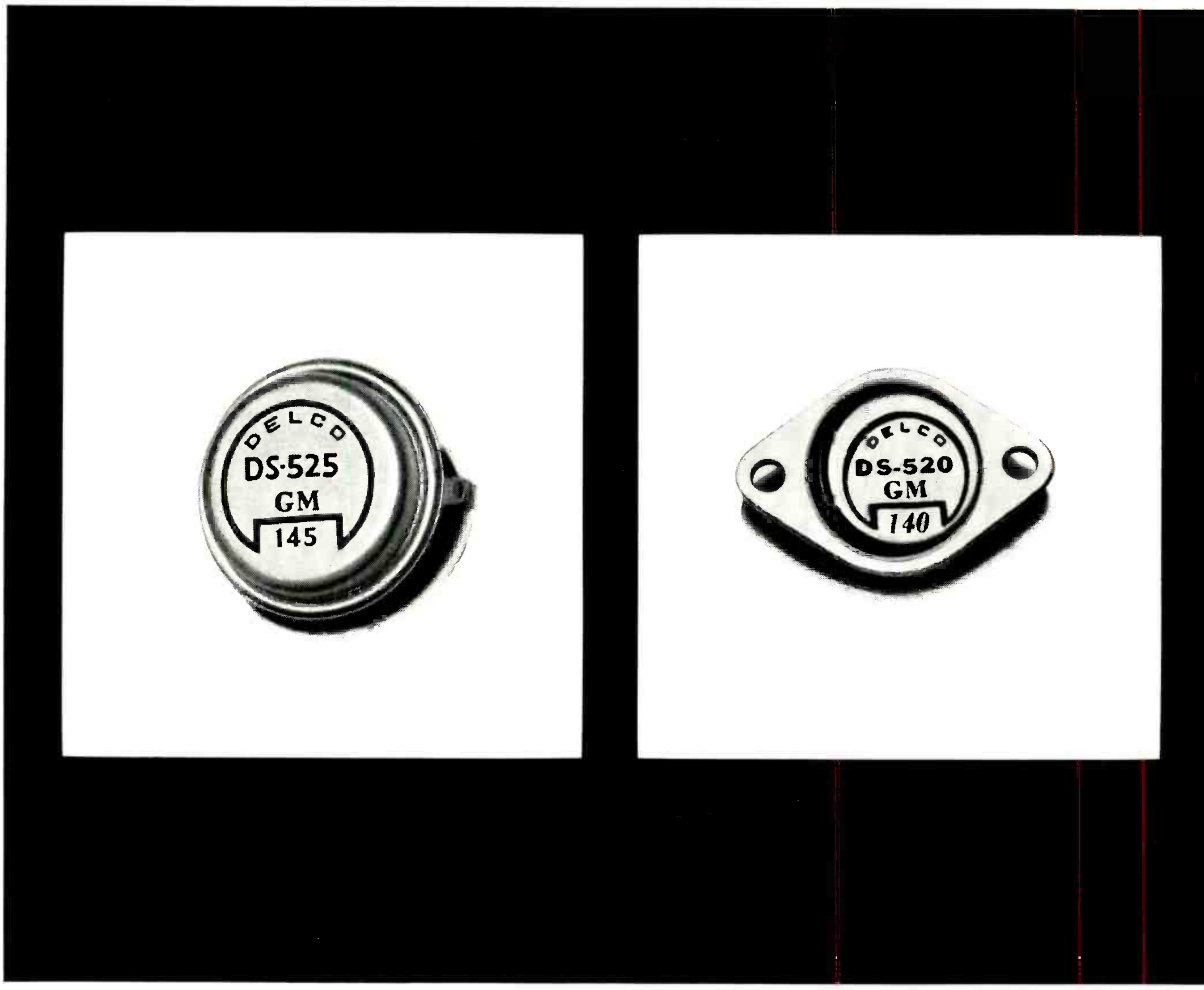
"When we start trying to make the reflected wave work for us, several things must be kept in mind. At ground level the direct and reflected waves are 180 out of phase and cancel completely. As the antenna is raised, signal strength increases until it reaches a maximum at a certain height above ground. This height is inversely related to both the frequency of the signal and the angle the line-of-sight path makes with the horizontal. MPATI telecast frequencies are fixed at 800 megacycles plus, but the size of the angle is a function of the distance from the high-flying plane.

"You can draw a little diagram and use high school trig to convince yourself the farther the receiving antenna is from the plane, the higher it must be raised to maintain this optimum relationship between direct and reflected path distances. Directly beneath the plane at Montpelier, Indiana, the height is less than 4 inches; at 60 miles it is 4.6 feet; at 100 miles it is 9 feet. As the antenna is raised beyond this critical point, signals arriving along the two paths combine to produce alternate nulls and peaks of strength. Peaks are found at odd multiples of the first height, and nulls are midway between the peaks. At 100 miles, for example, peaks will be found at 9′, 27′, 45′, 63′, etc. Nulls will appear at 18′, 36′, 54′, etc. For reasons having to do with the vertical lobing characteristics of the receiving antenna, less fading will be encountered if the antenna is placed at the lowest of these maximum signal points."

"But the plane doesn't hold still. It flies that figure-8 pattern so that turns are always made into the wind; so its pattern-axis is as variable as the wind. On some days the plane will be twenty miles closer to a particular receiving location than it will be ten or twelve minutes later."

"Right you are, and that's what causes trouble at locations fairly near Montpelier where this distance variation makes a substantial change in the line-of-sight angle and consequently in the optimum antenna height. A fixed antenna location may be bringing in maximum signal at one time and be in a near-null a few minutes later. Colonel Schatzel proved this to himself by erecting two antennas separated vertically by the peak-null separation distance at his location at Purdue University. He could select either antenna with a relay, and he found that when snow began to appear in the picture he could always get a much stronger picture by switching to the other antenna. A few minutes later he would have to switch back to maintain a snow-free picture.

"Being an engineer, he started thinking about doing the switching automatically, and he came up with an interesting little dual-diversity arrangement. He showed me the diagram, and the gadget works essentially like this: a gas-tube relaxation oscillator fires every four or five seconds. Each time it fires it operates an impulse relay that changes the receiver from one antenna to the other. I should say this oscillator fires unless something happens. That 'something' is the development of another a.g.c. voltage by the receiver to bias the oscillator and prevent its firing. Only when the strength of the received signal falls below a predetermined level will the lowered a.g.c. voltage permit the oscillator to fire and change antennas. Then that antenna will stay in use until the signal strength again goes down, whereupon the oscillator fires once more and returns the receiver to the original antenna. Colonel Schatzel has worked out an all-electronic version in which the firing



HOW TO CUT THE COST OF POWER TRANSISTORS—WITHOUT CUTTING CORNERS:

simply say Delco

Now you can offer your customers inexpensive replacements for their Delco audio output transistor needs. The DS 520 and our new DS 525 can be used in place of the Delco DS 503 and DS 501 where low cost is a factor. Each of these low-priced transistors can produce 4 watts of output with top Delco reliability. They're ideal for the servicing of older car radios or for the experimenter or ham operator. The DS 520 and the new DS 525 will be a profitable addition to your basic line of Delco transistors: the DS 501 and DS 503 —to restore full power audio output in all Delco Radios; the DS 25 and DS 26 to cover small signal needs in Delco and just about every other auto radio or small portable on the market. How's that for a complete line of transistors? Oh, you need application and cross reference charts too? Look in the package. They come with all Delco transistors. All are available now through your United Delco electronics parts distributor.

Delco Radio automotive radio service parts and electro-mechanical devices are distributed nationally through **United Delco.**

DELCO RADIO, Division of General Motors, Kokomo, Indiana

United Delco

CIRCLE NO. 110 ON READER SERVICE PAGE

of the oscillator causes a bi-stable multivibrator to flip. The "B+" of the multivibrator is at ground with a negative voltage on the cathodes. A negative voltage is thus available at either conducting plate that can be used to cut off the appropriate one of two mast-mounted amplifiers and permit the antenna in the favored position to feed a signal through its amplifier to the receiver."

"Is such an elaborate installation usually necessary to receive MPATI programs?" Barney asked.

"By no means. The receiver's a.g.c. system is usually more than adequate to maintain a steady picture with fading ordinarily encountered, especially if the antenna installer has taken the precaution to mount the antenna at a location that produces the *best average signal* as observed over a considerable length of time. An installer used to working with reception from a fixed transmitter is prone to move the antenna around until he gets the best signal strength reading at that particular moment and mount it there."

"You know," Barney mused, "what these MPATI people have learned can be applied to other fields. For example, I'd like to try this diversity reception bit on some of our u.h.f. ham bands where signals arrive by more than one path, too. Also, when we start receiving programs from satellites, the problems involved will be similar in many ways to the ones you have just been discussing."

"Knowledge is usually a kind of monkey wrench that will fit a wide variety of nuts," Mac offered as he stood up and stretched. "And now that I've delivered my wise observation for today, let's get to work." ▲

MONTGOMERY HAMFAIR

MONTGOMERY Amateur Radio Club will hold its annual Hamfair on Sunday, April 21st at the State Coliseum in Montgomery, Alabama.

A banquet will be held Saturday evening at the Holiday Inn Motel with tickets going for $4.00 each.

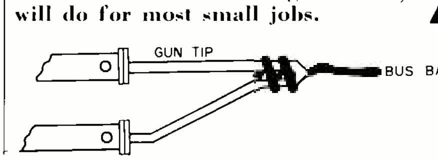
For banquet reservations and additional information, contact Montgomery Amateur Radio Club, P.O. Box 6187, Montgomery 6, Ala. ▲

SOLDER PENCIL SUBSTITUTE

By THOMAS R. HASKETT

IF YOU don't have a soldering pencil, you are apt to run into difficulty getting the tip of your soldering gun into tight spaces. One way to overcome this is by wrapping a short length of bus bar around the tip as an extension, as shown in the illustration.

The bus bar, or heavy solid-conductor wire, should be pre-tinned and wrapped tightly around the tip several times. It won't conduct all of the gun's heat, but will do for most small jobs. ▲



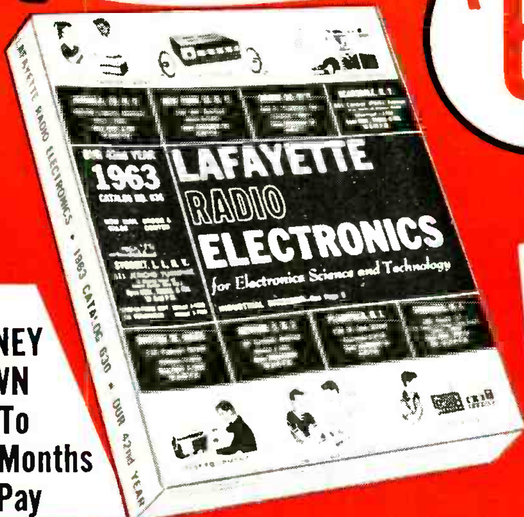
FREE! FOR '63

LAFAYETTE RADIO ELECTRONICS

1963 CATALOG NO. 630

388 GIANT-SIZE PAGES —

The Largest Catalog in Our 42-Year History



NO MONEY DOWN Up To 24 Months To Pay

from the "WORLD'S HI-FI & ELECTRONICS SHOPPING CENTER"

WHEN YOU BUY AT LAFAYETTE, YOU GET THESE EXCLUSIVE BENEFITS

- OUTSTANDING LAFAYETTE KITS
- LOWEST PRICES
- 24-HOUR SERVICE

- **SATISFACTION GUARANTEED OR MONEY REFUNDED.** Use Lafayette's 30-Day FREE Home Trial.
- **LARGEST STOCK SELECTION.** If it's in Hi-Fi or Electronics, it's in the Lafayette Catalog.
- **NO MONEY DOWN.** Buy or time with Lafayette's Easy Pay Credit Plan, up to 24 months to pay.

TRUE, CUSTOM MATCHED STEREO COSTS LESS AT LAFAYETTE

Only at Lafayette could you find an outstanding, custom-matched stereo system at such an amazing low price. System includes: a powerful Lafayette LA-224 24-watt stereo amplifier with complete stereo controls; a 4-speed Garrard Autoslim automatic/manual record changer with a Pickering U/38AT cartridge and 2 Lafayette SK-124 2-way speaker systems for gigantic full size performance. Compare components, compare price — you'll choose Lafayette.

LS-225WXM specify: Pickering cartridge; wood base finish (walnut, Mhg. or Blonde); Speaker system finish (walnut or Mhg.). Shpg. wt., 64 lbs. .... Net **129.50**

COMPLETE SYSTEM ONLY **129.50** NO MONEY DOWN

NEW LAFAYETTE DELUXE PROFESSIONAL QUALITY 4-TRACK STEREO TAPE DECK

Records Sound-on-Sound
Built-in Transistorized
Stereo Record/Play Preamps

Shown with optional case

99.50 NO MONEY DOWN

A truly outstanding tape recorder/reproducer. Superb electronics, smooth, dependable tape transport. Plugs into your hi-fi system. ■ Plays: 4-track & 2 track stereo; 4-track, 2-track and full track mono; ■ Records: 4-track stereo or mono; ■ Sound-on-Sound; ■ Freq. response 40-18,000 cps @ 7½ ips; ■ **Complete with cables and empty reel.**

RK-143WX as above but with carrying case .... Net 114.50

MAIL THIS COUPON TODAY for YOUR FREE LAFAYETTE 630 CATALOG

Get One for a Friend Too

LAFAYETTE RADIO ELECTRONICS
Dept. RF-3, P.O. Box 10, Syosset, L.I., N.Y.

☐ Rush my FREE 388-page giant-size Lafayette Catalog
☐ Send me # ...., Shipping charges collect.
I am enclosing ....

Name ....
Address ....
City .... Zone .... State ....

Friend's Name ....
Address ....
City .... Zone .... State ....

LAFAYETTE'S MAIL ORDER and SALES CENTER

SYOSSET, L. I., NEW YORK
111 Jericho Turnpike

OTHER LOCATIONS

NEW YORK, NEW YORK 100 6th Avenue	SCARSDALE, NEW YORK 691 Central (Park) Ave.	PARAMUS, NEW JERSEY 182 Route 17
JAMAICA, NEW YORK 165-08 Liberty Avenue	PLAINFIELD, NEW JERSEY 139 W. 2nd Street	BOSTON, MASS. 110 Federal Street
BRONX, NEW YORK 542 E. Fordham Rd,	NEWARK, NEW JERSEY 24 Central Avenue	NATICK, MASS. 1400 Worcester Street

ARE YOU A POTENTIAL ELECTRONICS TECHNICAL WRITER?

By CYRUS GLICKSTEIN / Author, "Basic Ultrasonics"

WANTED—Technical Writers in Electronics. This listing appears regularly in newspaper ads throughout the country. The electronics industry wants and needs more technical writers and, in many cases, firms are willing to pay rather well for those who qualify.

If you are an electronics technician with appropriate education and experience, you may be able to qualify for a job as a technical writer. As a matter of fact, there are several possible paths to jobs in this comparatively new field.

This article will attempt to answer questions such as: "Exactly what do electronics technical writers do and why is there such a need for them?" "Would I be happy doing this kind of work?" "What are typical pay scales?" "How can interested persons enter the field?"

Electronics technical writing became recognized as a field requiring specialized skills during World War II because many engineers had trouble making themselves understood by technicians. Originally, the same electronics engineers who developed equipment also wrote the instruction manuals telling operating personnel how to operate and technicians how to repair the gear. In many cases, competent engineers proved to be less than competent writers and the instructions were more complex than the equipment. Too often, costly apparatus could not be repaired efficiently, especially where hastily trained technicians had to rely heavily on instruction manuals. A new breed of writer was evidently required—one who could work closely with design engineers, understand technical principles and terminology, and then translate engineering lingo into clear directions that the technician could follow readily.

In the past 15 years, the field of technical writing in electronics has broadened considerably. Today, there are three main branches—military, commercial, and general. Electronics writers now include a growing number of engineers who find they prefer writing to designing equipment, technicians who have traded a soldering iron for a pencil (or typewriter), and writers who have rounded out their technical background sufficiently to qualify for technical writing assignments—either as an employee or free-lancer.

Military Technical Writing

Military technical writing includes various types of instruction manuals for equipment being delivered to the armed forces. Every piece of electronic gear delivered to these services—from a walkie-talkie to the most complex missile systems—requires at least one instruction manual. Large systems usually require a whole set of manuals. It is axiomatic in the services that the equipment will not be accepted from the manufacturer unless complete and accurate instruction manuals are available to permit proper operation, maintenance, preventive maintenance, troubleshooting, repair, and, where required, overhaul. Service manuals also include a fairly detailed description of pertinent circuit theory to assist technicians in understanding and maintaining the equipment.

The armed forces have drawn up very detailed specifications for the content of technical manuals and these specifications must be followed carefully by military technical writers. While most military technical writing is concerned with handbooks, some writers may be assigned to other phases of military writing such as:

1. *Engineering reports.* Manufacturers may be required to provide various kinds of reports, especially when a new type of equipment is being developed. These reports cover progress being made in the delivery schedule, analysis of new circuits, engineering analysis of the equipment design, analysis of the reliability program, etc. The facts are usually turned over by engineers to technical writers for editing, rewriting, and putting into proper format for submission to the contracting agency.

2. *Proposals.* Technical writers may be assigned to work with engineers in writing proposals for submission to government agencies or other manufacturers. In response to a request to bid on a given type of equipment, invited companies return a proposal—a detailed outline of what they plan to deliver and how they would design the proposed equipment in the event they obtained the contract. In many cases, unsolicited proposals are submitted by companies when they feel they have a worthwhile idea which would be of interest to a given agency.

3. *Training manuals.* Training manuals may cover general electronic subjects such as "Basic Electronics," "Microwaves," "Transistors," not directly related to specific equipment or may cover more specialized subjects such as "Theory and Use of Electronic Test Equipment," "Guided Missile Fundamentals." Many of these training manuals are available to the public through the U.S. Government Printing Office. However, a good deal of military technical literature is classified, that is, rated Confidential, Secret, or given an even higher classification. Only those who have a need to know and have the proper security clearance are permitted access to classified publications.

Military technical writers may be employed by equipment manufacturers, by technical writing firms, or directly by the government. There are many civilian positions for technical writers in the armed forces and in government agencies.

Commercial Technical Writing

Commercial technical writing is concerned directly or indirectly with products intended primarily for use by civilian rather than military personnel. Commercial equipment may be sold to private consumers (radio, TV sets), other manufacturers (test equipment), or to civilian (or even military) government agencies contracting for commercial off-the-shelf items. Many manufacturers are relying more and more on their technical writing groups to put out commercial literature requiring some technical content. As a result, commercial technical writing in electronics is growing in importance. Commercial literature includes:

1. *Instruction manuals.* Booklets describe how to operate and, where necessary, how to maintain the equipment. Commercial manuals differ from military manuals in that they usually are not as detailed and do not follow a set format specified by a government agency.

2. *Brochures.* Brochures cover various phases of the manufacturer's activities. Separate booklets may be issued describ-

There are several possible paths to positions in this comparatively new field whose importance is growing steadily in the electronics industry. The various types of technical writing are described, along with duties, requirements, and pay scales.

ing plant facilities, types of equipment produced. In many cases, brochures and most of the following categories of commercial literature require a dash of advertising flavor mixed with the skills of the technical writer.

3. *Application bulletins.* Usually 1- to 4-page leaflets outlining important and/or novel uses for a given piece of equipment.

4. *Specification sheets.* Outline physical and electrical specifications for a specific model of equipment.

5. *Newsletters and newspapers.* Many companies regularly publish newsletters, newspapers, semi-technical or technical bulletins, and magazines (internal and external house organs), describing new and interesting developments in their field. This literature is distributed to interested parties including past, present, and potential customers.

General Technical Writing

General technical writing covers miscellaneous writing activities which can't be pigeon-holed in the other two categories and includes technical writing not associated primarily with either a military contract or commercial products. This category includes technical books, general articles for technical and semi-technical magazines, and programming for teaching machines. In the very new field of programming for teaching machines, the writer often works with teachers and psychologists in preparing material for the machines.

A good deal of general technical writing is done on a free-lance, spare-time basis. The spare-time free-lancer may be employed as a full-time writer, or he may be an engineer, technician, or even work outside the electronics industry and write electronics articles occasionally as a hobby. However, there are comparatively few free-lance technical writers. Most technical writers in electronics today are in the commercial and military writing fields, with the latter category being considerably larger.

Advantages and Disadvantages

Each of the two major branches of electronics technical writing—military and commercial—has its advantages and disadvantages. In military technical writing, writers become familiar with varied types of electronic equipment and circuits and in many cases with the most advanced equipment currently being produced in a given field. They maintain contact with engineers and keep abreast of new developments that are incorporated in the equipment they write about. In many cases, senior writers must describe circuit theory and maintenance procedures using schematic diagrams as the only available reference material and with a minimum of consultation with the design engineers. Far from being a hardship, most writers find this one of the most interesting and stimulating aspects of their work. The general pay level is highest in this category.

The disadvantages of military technical writing include: very little direct contact with equipment, except as an onlooker (to a technician used to handling equipment, this may be somewhat discouraging at first), and standardized format for presenting material.

The advantages of commercial technical writing include: 1. varied assignments, not bound by rigid specifications; 2. may be more challenging than military manual writing in terms of methods of presentation and description; 3. generally provides more scope for initiative and imagination. Disadvantages of commercial writing are: 1. not very technical in many cases and, when this is the case, there is less opportunity for technical growth and development; 2. poorer pay as a rule.

Salary ranges in technical writing vary according to job level, experience, skill and, as in other fields of electronics, geographical location of the job opening and the relationship between supply and demand for the given type of technical personnel in the area. Job categories are more clear-cut in the military technical writing field.

Military Writer Grades

Typical grades of military technical writers, type of work performed, and average salary range in each grade are:

1. *Trainees and junior writers.* Compile tables; check art (schematics, blueprints, etc.); write simple sections or parts of sections under the guidance of experienced writers, such as operating procedures and physical description of the equipment; help prepare rough art for the art department. Salaries, as a general rule, will range from $90 to approximately $140 per week.

2. *Intermediate writers.* Write most types of manuals, prepare rough art for the art department; may direct one or more junior writers who work on various phases of a manual; in many cases, will work under the direction of a senior writer. Salaries range from $90 to $140 per week.

3. *Senior writers.* Have complete writing responsibility for a technical manual, possibly supervising one or more intermediate or junior writers; responsible for keeping on schedule and alerting management when problems arise that may delay production or increase the cost of the manual. Have a thorough knowledge of government writing specifications and of the various types of manuals required by different agencies. In many cases, senior writers help estimate the cost of manuals on which their firm is submitting a bid. Salaries range from $6000 to approximately $13,000 a year.

4. *Executive personnel.* Must understand all phases of technical writing, technical art, publication and printing procedures, estimating costs of jobs, and budget control. Ability to coordinate work of writing, art, and clerical departments; able to hire, train, and direct personnel; produce finished handbooks within budget estimates; note progress of jobs, anticipate and resolve difficulties. Salaries vary depending on responsibilities and the size of the organization and range from $10,000 to $15,000 or more.

Where Are the Jobs?

Where are most of the technical writing jobs? They are to be found in (1) publication departments of manufacturing plants and engineering organizations (military and commercial writing); (2) technical manual firms (military writing mainly); and (3) contract job shops (military writing mainly). The job-shop writer works on the premises of and for a manufacturer but is actually an employee of the job shop which has contracted to provide the manufacturer with personnel.

In general, the pay rates for equivalent experience tend to vary exactly in the order listed above. For a given background of experience, the manufacturer will generally (but not always) pay less than a technical manual firm and this type firm less than a job shop.

As with most choices in life, there are advantages and disadvantages in each type of employment and the individual must make his choice depending on the factors he considers most significant.

Advantages of working for a manufacturer generally include: closeness (and usually easier access) to the equipment being described; less susceptibility to periodic fluctuations in employment resulting from downturns in business; more fringe benefits; and more opportunity for promotion. Disadvantages include: less variety in equipment over a period of time and a somewhat lower pay scale as a general rule.

Advantages of working for a technical manual firm usually include: greater variety in equipment written about and in the types of manuals put out; and higher wage scale. Disadvantages include: writers are further removed from equipment, are more susceptible to employment fluctuations, have fewer fringe benefits, and have more limited promotional opportunities.

Advantages of contract job shop employment include: highest pay scale, closeness to equipment, varied equipment and writing assignments. Disadvantages include: no openings for trainees; greatest job fluctuation since contract personnel are hired by the manufacturer only to help solve a peak overload problem (jobs are for limited periods—usually from 6 months to a year but may be longer or shorter) with few fringe benefits; usually requires periodic change of employment locale as well as change of employer (both job shop as well as on-location employer), although some persons consider periodic change of locale an advantage. There is practically no possibility of working up to an executive position. The higher pay is offered in order to compensate for absence of job security.

Finding a Position

Openings for technical writers of various grades may be available in both manufacturing and technical manual firms. Contract job-shop openings are usually available only for experienced personnel with a specific background which enables them to start work immediately with either a brief or no training period. Leads for job openings can be found in newspaper help wanted ads (usually under "Technical Writers," "Electronics," and "Engineers"). Further checks can be made with firms listed in the classified telephone directory under "Electronics Manufacturers" or "Technical Manual Firms." Firms which advertise out-of-town locations with *per diem* pay are offering on-location contract job shop employment.

Background for Technical Writing

Electronics technical writers come into the profession through four main doors. New writers include (1) electronics technicians (or people with some basic background in electronics or science) who feel they want to write; (2) people with some experience in writing (newspapermen, English majors, etc.) who feel they can pick up the necessary technical background through on-the-job training or school courses; (3) people who have taken the recently developed technical writing curricula in schools and colleges and who have received some background in both writing and science. Other more highly skilled beginners in this group are college graduates who were English majors and have a technical background as a technician in the armed services or technical school graduates who have a good academic background; and (4) electronics engineers who decide to specialize in writing rather than design engineering.

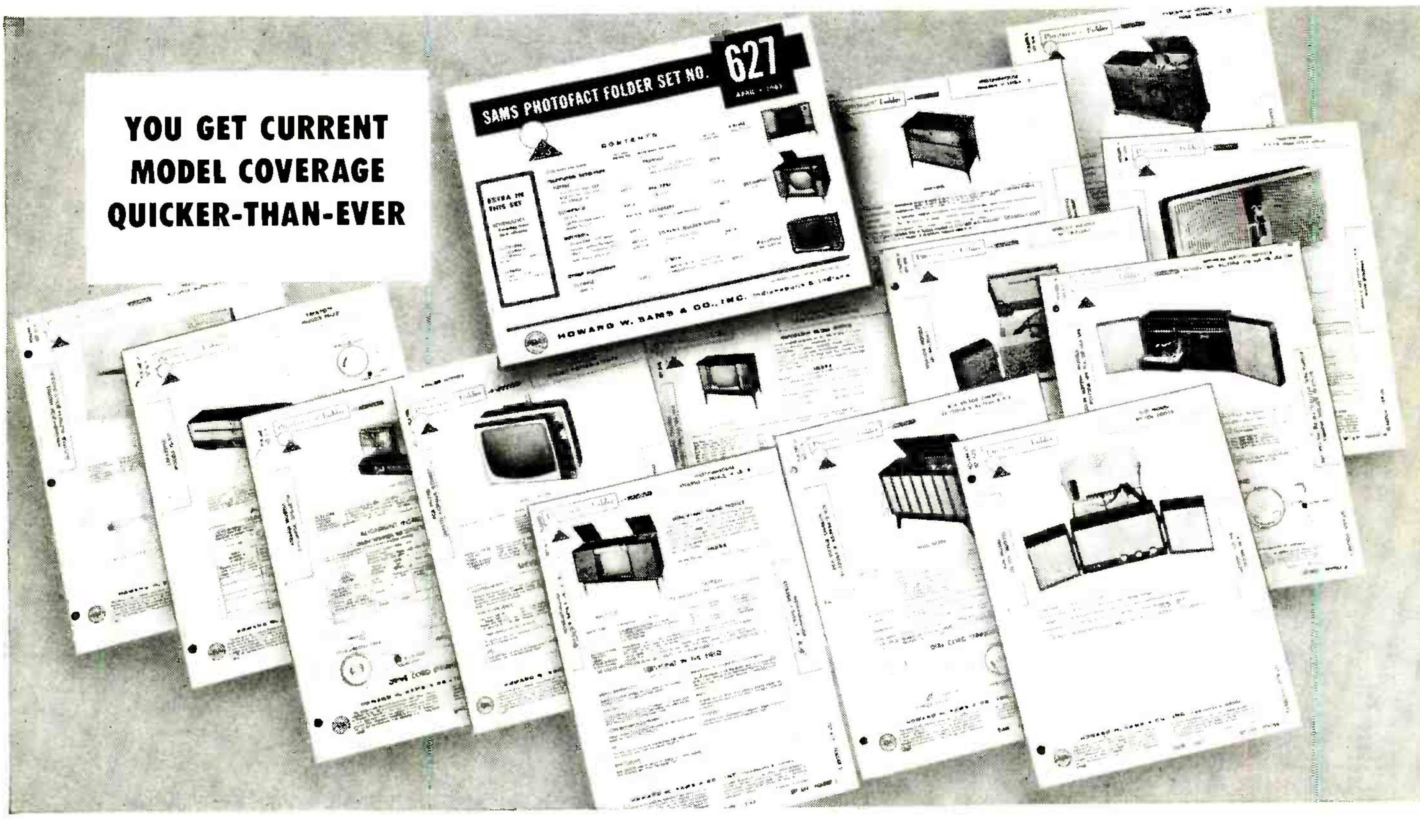
A newcomer may start as a trainee, a junior writer, or an intermediate writer, depending on his background. Interestingly enough, it is usually easier and faster to make a good military technical writer from a technician with no writing experience but with a desire to write (plus a basic education such as a high school or community college diploma) than from a good general writer (newspaper or advertising experience) with no technical training. On the other hand, the reverse seems to be more often true for commercial technical writing.

Some manufacturers and many technical manual firms will hire trainees who have no technical writing experience but have education and/or experience as a technician and show some evidence of basic writing ability.

For those interested in learning how to be a technical writer, or who have insufficient electronics background to enter as trainees, there are several possible paths. Many colleges now provide one or more courses on various phases of technical writing. Trade and technical schools offer courses which enable the student to round out his technical background. Courses in grammar and English composition (organization of written material) are helpful in learning writing techniques.

In planning a course of study, it should be remembered a competent technical writer must be both a skillful writer and a person with a good technical background. Because of the extremely fast growth of the profession in recent years,

NOW! PHOTOFACT®—BETTER THAN EVER—



Now! More TV Coverage in Every PHOTOFACT Set

More coverage of the type of equipment you service most!

- MORE **TV** COVERAGE
- MORE **AC-DC** COVERAGE
- MORE **AM-FM** COVERAGE
- MORE **HI-FI** COMBINATIONS
- MORE **RECORD CHANGER** COVERAGE
- MORE **PHONOGRAPH** COVERAGE

UP-TO-THE-MINUTE COVERAGE KEEPS YOU AHEAD

Here it is—beginning with April releases—quicker service data coverage for more of the kind of equipment you most frequently repair. And it's the same famous PHOTOFACT time-saving, troubleshooting help—*everything* you need to earn more daily. You get: Exclusive Standard Notation Schematics packed with all the service details you need; full photo coverage of all chassis views; complete replacement parts lists, tube placement diagrams; actual waveform photos; CircuiTrace® for printed boards; alternate tuner data; terminal identification and connections; disassembly instructions; field servicing notes; dial cord stringing diagrams—plus dozens of other great features. Take the *right* step to time-saving, profit-building servicing—see your Sams Distributor for details on an Easy-Buy PHOTOFACT Library and Standing Order Subscription—or send coupon today!

SEND COUPON

HOWARD W. SAMS & CO., INC.

Howard W. Sams & Co., Inc., Dept. 5-E-3
4300 W. 62nd St., Indianapolis 6, Indiana

☐ Enter my Photofact Standing Order Subscription
☐ Send full information on money-saving Easy-Buy Plan

My Distributor is: ____________________

Shop Name ____________________

Attn. ____________________

Address ____________________

City ____________ Zone ____ State ________

SAVE 30¢ PER SET!

SIGN UP TODAY FOR A MONEY-SAVING PHOTOFACT STANDING ORDER SUBSCRIPTION!

With a Standing Order Subscription to receive PHOTOFACT regularly each month as issued, you pay only $1.95 per Set instead of the regular $2.25 price. You save 30¢ per Set—and you keep right up with the rapidly-increasing current model output! You enjoy the same 30¢ per Set savings when you purchase an Easy-Buy PHOTOFACT Library. Take advantage of substantial savings—sign up for a Standing Order Subscription or Easy-Buy Library with your Sams Distributor, or send coupon now for full details.

SAVE WITH A STANDING ORDER SUBSCRIPTION!

there are some technical writers now in the field who may be weak in either or both of these qualifications. Those who will remain in the field will be those who are most qualified. In all technical areas, there seems to be trend toward requiring higher levels of competence as the equipment to be written about grows more complex.

What is the present status of technical writing as a profession? Technical writing started as an appendage of engineering and for some time engineers and plant managements had a tendency to look down their noses at technical writers as glorified clerical workers. The situation has changed drastically in the last five years. Technical writing is becoming recognized as a profession.

Most engineers now look on technical writers as indispensable fellow workers. In many cases, engineers find they need the efforts of technical writers not only to make their own contributions more effective but even to understand much of the output of their fellow engineers.

There are professional organizations of technical writers. The largest is the STWP, Society of Technical Writers and Publishers. Also, the Institute of Electrical and Electronics Engineers has a special professional group on Engineering Writing and Speech. These organizations, which have shown impressive membership gains in recent years, have contributed substantially to professional growth and recognition. Conventions, seminars, educational meetings, in-service training programs, and formulation of college training programs for technical writers, have helped raise the status of the professional and the skill of the practitioners. In the best sense of the word, a competent technical writer is becoming recognized as a professional writer. ▲

MAKE EMERGENCY FUSES

By THOMAS R. HASKETT

DOES THIS situation have a familiar ring? Saturday evening, you are working on a hi-fi amplifier, ham final, or other piece of equipment. When you finish, you turn on the power and bang —there goes the fuse in the equipment! You do not have a replacement of the right value and the parts houses are closed until Monday. What do you do?

You make your own fuse from the wire in an old r.f. or i.f. transformer or coil in your junkbox. Unwind the wire carefully, cut off a short length, and scrape its ends clean. Then connect this strip between the terminals on the fuse post. If a single strand won't hold the load, use two or more.

If possible, disable the part of the circuit you were working on until you experimentally determine the number of strands necessary to carry the load. Then reconnect the questionable circuit. If the "fuse" blows this time, you know you are on the right track.

If necessary, you can use a resistive substitute for the normal load to determine how many strands are required to make up the emergency fuse for normal use. If the voltage and current (or power) ratings of the equipment are known, the value of the substitute resistor can be calculated. ▲

RAPID-TUNING-KNOB ADAPTER

By ROBERT K. RE

MANY times during the operation or servicing of receivers and transmitters, it is necessary to rapidly tune from one end of the dial to the other. Equipment with vernier dials of large gear ratios require many turns to accomplish this range of tuning. If you are looking for an easy and speedy way to turn that tuning knob, why not try this adapter for your equipment?

Fig. 1A shows the layout of the device before bending and shaping. Length L should be about ¾ of the knob circumference, while width W can be about ¼ to ½ inch. Soft steel, iron, copper, brass, or aluminum about 1/16 inch can be used; the final choice should be made on the basis that the metal should bend easily, but retain its final shape after bending.

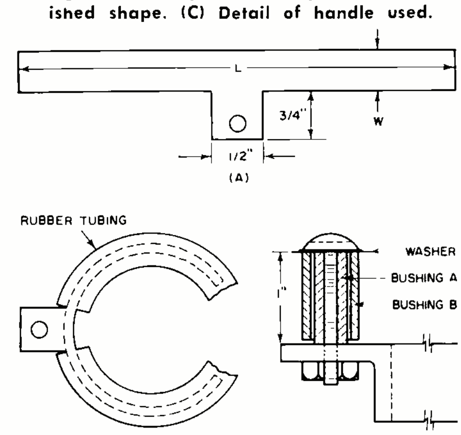
After drilling a small hole in the tab, round and smooth all edges of the metal. A rod of wood or steel, of appropriate diameter, placed in a vise, will provide a convenient form to shape the two arms into a circle, as shown in Fig. 1B. Soft rubber tubing, slipped over the two curved arms, provides a "friction fit" over the knob to be turned.

Fig. 1C shows the assembly of the small handle for the adapter. A close fitting bushing A is slipped over the screw. Next a loose fitting and slightly shorter bushing B is placed over A. A bit of oil or grease between the parts will provide easy and smooth turning of the handle.

The screw, with its washer and two bushings, is placed in the hole and tightened down. The outer bushing should spin freely after the screw has been tightened. Almost any material can be used for the two bushings; metal on the inside and Bakelite on the outside work very well.

The finished adapter should fit snugly over the tuning knob. If not, enlarge the adapter's diameter slightly (the rubber tubing has decreased its diameter). Once on, the tuning-knob adapter will provide a means of rapid tuning for those vernier dials. ▲

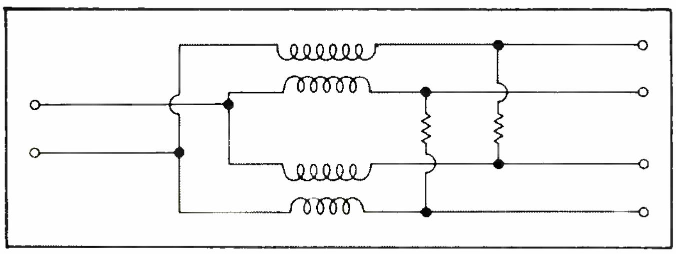
Fig. 1. (A) Layout of adapter. (B) Finished shape. (C) Detail of handle used.



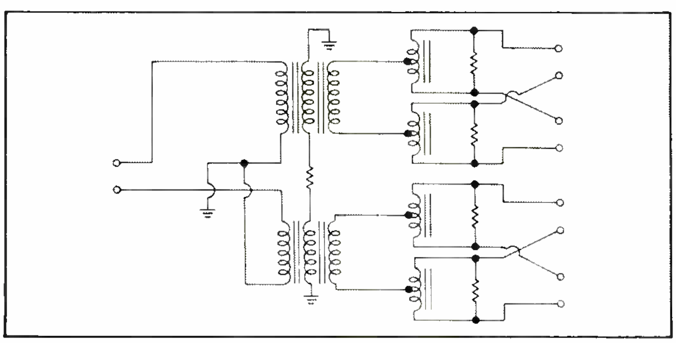
THE SECRET'S IN THE CIRCUIT

BLONDER-TONGUE TV/FM COUPLERS

You can't tell a coupler by its case. However, a view of what's inside can tell you why a coupler will deliver clean, interference-free signals to a multi-set installation. Examine the circuitry of Blonder-Tongue couplers. Compare them with ordinary units. It's easy to see why they are the best selling quality couplers on the market.



THE TIME TESTED BLONDER-TONGUE A-102
This is the champion performer among all 2-set couplers judged on the basis of its popularity with technicians and TV viewers. The A-102 offers 12 db isolation *with only 3 db insertion loss*—half the insertion loss of the average 2-set coupler! Designed for both TV and FM, it is especially effective in weak signal areas. For FM stereo, this low loss hybrid type unit is the answer. A look at its circuitry will tell you why. • patented bifilar transformers • backmatched for precise impedance match • heavy conductors end burnouts. List $3.20



NEW COLOR-ENGINEERED COLOR-4
Where a color TV set is one of the sets receiving signals from a single antenna, the Color-4 is the only answer. This super deluxe 4-set coupler offers maximum interset isolation (16 to 24 db), excellent impedance match and only a 6.5 db insertion loss. The Color-4 uses ferrite broadband transformers in balanced bridge design and it has a voltage standing wave ratio of less than 1.5. Result: Lower inherent insertion loss, less smear and ghosts, sharper pictures than any other 4-set coupler.

- Ferrite broadband transformers in balanced bridge design
- VSWR of outputs and inputs no greater than 1.5.
- Backmatched List $9.95

BLONDER-TONGUE TV & ANTENNA COUPLERS

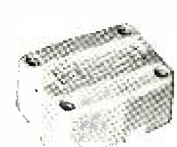
NEW BLONDER-TONGUE ALL CHANNEL SET-2. The SET-2 is one of the few couplers available today that can deliver full power signals to two UHF, or a VHF and UHF receivers operating from the same antenna. Effective straightforward resistive circuit provides 12 db interset isolation with 6 db loss. While it's effective on VHF and FM, the low loss A-102 is a better choice for FM stereo. List $3.20

BLONDER-TONGUE A-104 FOUR SET COUPLER. Inductive — resistive coupler for VHF and FM. Feeds 4 VHF receivers from one antenna, or mixes 4 antennas into one line. Isolation: 12-20 db. Loss: 7.5 db. List $4.50

BLONDER-TONGUE A-105-HI-LO COUPLER. Combines low and high band VHF antennas and provides separate low and high outputs from a common line or antenna. Less than 0.5 db loss. List $4.10

BLONDER-TONGUE A-107 UHF-VHF ANTENNA COUPLER. The choice in UHF areas throughout the country. It combines VHF and UHF antennas, or provides separate VHF and UHF outputs from a common line or antenna. Less than 1.0 db loss. List $4.75

INDOORS OR OUTDOOR. Blonder-Tongue couplers are the easiest to install. Patented stripless connectors assure rapid, positive installation—no stripping, no splicing twinlead. Weatherproof, *non-breakable* case permits installation indoor or outdoors.

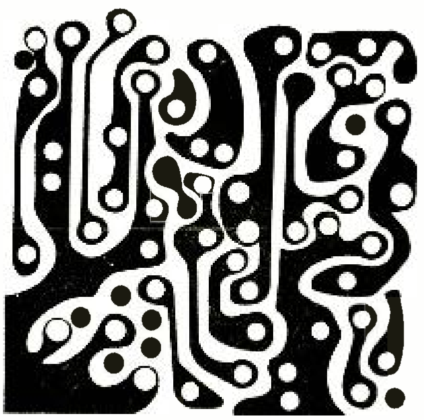


For the right coupler at the right price, contact your Blonder-Tongue parts distributor or write Dept. EW-5

engineered and manufactured by

BLONDER TONGUE
9 Alling St., Newark, 2 N. J.

Canadian Div: Benco Television Assoc., Ltd., Tor., Ont.
home TV accessories • closed circuit TV systems UHF converters • master TV systems



HOME-MADE PRINTED CIRCUITS

By THOMAS J. BARMORE

Printed boards may be made from start to finish by employing ordinary, readily available materials.

MOST experimenters and designers have thought of using custom-made printed-circuit boards instead of hand-wired circuitry, but have balked at the idea merely because of the high cost of the copper-clad glass epoxy board used in such construction.

Materials Needed

Printed-circuit boards, from start to finish, may be made using only ordinary materials. Here is a list of materials you will need and their sources. (1) 1/16" or ⅛" glass-epoxy (fiberglass) board (lumber supply, boat supply, or hardware stores). (2) .005" copper foil (art supply and stationery stores). (3) epoxy glue kit (hardware, lumber supply, or department stores). (4) butyrate plastic airplane dope (model shops, hardware stores, five-and-ten-cent stores). (5) one pound of lump-type ferric chloride (drugstores, scientific suppliers).

Procedure

After the materials are obtained, the first step in making the copper-clad board consists of bonding the copper foil to the glass board. Begin by sanding the board on one side with finish sandpaper (do not use emery paper), and then wash it with warm water. When this is done, mix the resin and epoxy together in equal parts or according to the directions supplied with the glue kit. Apply the epoxy cement evenly with a roller and place the copper foil on the glue-coated surface. Clean the roller and use it to remove the air bubbles between the fiberglass board and the copper foil.

On the copper side of the board, place two pieces of ¾" plywood on top of each other and, using one more piece of plywood as a backing, clamp the whole assembly together using about ten large and five small "C" clamps per square foot of board.

Warm an oven to about 125 degrees F and place the clamped circuit board in it for two hours to cure the glue. At the end of this time, remove the assembly, let it cool to room temperature, and remove the plywood and the clamps. The board is now ready for the actual etched circuit layout and etching.

First of all, draw the circuitry on the board on the copper side using a soft lead pencil and a guide so that the desired line width is maintained. Use a circle template for the terminal points, and avoid sharp bends on corners and joints. Using a small brush, and the butyrate airplane dope, carefully paint those portions of the circuitry which have been outlined in pencil.

Etching & Soldering

The actual etching process uses an etchant of one part warm (120 degrees F) water and one part lump ferric chloride. This solution will mix quite easily and one pint should be used for every 80 square inches of .005" copper. Keep the etchant warm and etch the board just long enough to allow the exposed copper to disappear. Remove the board and wash it with hot water, using a terry-cloth rag to remove the airplane dope.

The board may be solder-coated in a solder bath although actual soldering should be done quickly and with a low-temperature iron. If too hot an iron is used, the bond between the epoxy, the copper, and the fiberglass board may be weakened.

The total cost per square foot of circuit board is about $3.00 as compared with a cost of about $14.00 per square foot for a commercial board of comparable quality. ▲

TRY THIS STEREO TEST RECORD!!

Special to our readers for only ...$3.98

Featuring Tests Never Before Available To The Music Listener

Why We Make the Model 211 Available Now

Although there are many stereo test records on the market today, most critical checks on existing test records have to be made with expensive test equipment.

Realizing this, HiFi/STEREO REVIEW decided to produce a record that allows you to check your stereo rig, accurately and completely, **just by listening!** A record that would be precise enough for technicians to use in the laboratory—and versatile enough for you to use in your home.

The result: the HiFi/STEREO REVIEW Model 211 Stereo Test Record!

Stereo Checks That Can Be Made With the Model 211

- ✓ Frequency response—a direct check of eighteen sections of the frequency spectrum, from 20 to 20,000 cps.
- ✓ Pickup tracking – the most sensitive tests ever available on disc for checking cartridge, stylus, and tone arm.
- ✓ Hum and rumble—foolproof tests that help you evaluate the actual audible levels of rumble and hum in your system.
- ✓ Flutter—a test to check whether your turntable's flutter is low, moderate, or high.
- ✓ Channel balance – two white-noise signals that allow you to match your system's stereo channels for level and tonal characteristics.
- ✓ Separation—an ingenious means of checking the stereo separation at seven different parts of the musical spectrum—from mid-bass to high treble.

ALSO: ✓ Stereo Spread
Speaker Phasing
Channel Identification

PLUS SUPER FIDELITY MUSIC!

The non-test side of this record consists of music recorded directly on the master disc, without going through the usual tape process. It's a superb demonstration of flawless recording technique. A demonstration that will amaze and entertain you and your friends.

UNIQUE FEATURES OF HiFi/STEREO REVIEW'S MODEL 211 STEREO TEST RECORD

- Warble tones to minimize the distorting effects of room acoustics when making frequency-response checks.

Warble tones used are recorded to the same level within ± 1 db from 40 to 20,000 cps, and within ± 3 db to 20 cps. For the first time you can measure the frequency response of a system without an anechoic chamber. The frequency limits of each warble are within 5% accuracy.

- White-noise signals to allow the stereo channels to be matched in level and in tonal characteristics.
- Four specially designed tests to check distortion in stereo cartridges.
- Open-air recording of moving snare drums to minimize reverberation when checking stereo spread.

All Tests Can Be Made By Ear

HiFi/STEREO REVIEW's Model 211 Stereo Test Record will give you immediate answers to all of the questions you have about your stereo system. It's the **most complete test record** of its kind—contains the widest range of check-points ever included on **one** test disc! And you need no expensive test equipment. **All checks can be made by ear!**

Note to professionals: The Model 211 can be used as a highly efficient design and measurement tool. Recorded levels, frequencies, etc. have been controlled to very close tolerances—affording accurate numerical evaluation when used with test instruments.

DON'T MISS OUT—ORDER NOW AND SAVE $1

The Model 211 Stereo Test Record is a full 12" disc, made from the finest virgin vinyl. For a limited time only, it is being sold by ELECTRONICS WORLD for $3.98. Starting July 1, 1963, we will sell this record for $4.98. Order now and save $1. Make sure you don't miss out on this special offer. Fill in and mail the coupon, together with your check ($3.98 per record) today!

FILL IN AND MAIL TODAY!

Stereo Test Record N
Electronics World—Dept. SD
One Park Ave., New York 16, N.Y.

Please send me ________ test records at $3.98 each. My check (or money order) for $________ is enclosed. I understand that you will pay the postage and that each record is fully guaranteed.

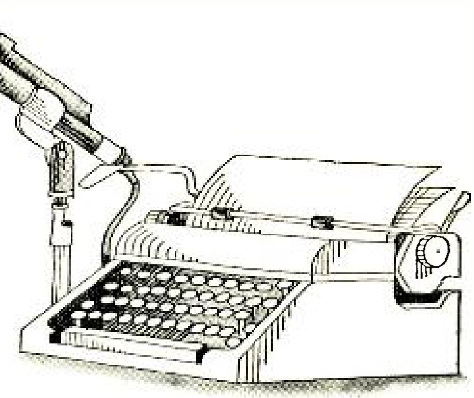
Name ______________________________
(Please Print)

Address ______________________________

City ______________ Zone ________ State ______________

SORRY—No charges or C.O.D. orders!
(Special price offer of $3.98 expires on June 30, 1963) EW 563

RADIO & TV NEWS



OUR CONFIDENCE that color TV will yet fulfill its great potential remains unshaken. Yet we cannot help but marvel at the number of snags it has run into (and weathered) since the present system began its less-than-meteoric ascent almost a decade ago. Yes, it's been that long.

A year or so ago, various pundits came up with the "real" solution to the bottleneck. Price was no problem. The viewing public not only wanted color but was willing to pay for it. The difficulty was a psychological one. With slim, trim sets available in monochrome, prospective purchasers were bucking the necessity to return to the enormous box that dominated the living room and threw it out of proportion if they wanted color. So the gargantuan picture tube had to be reduced enough in depth to make a reasonably flat set. To this end, *RCA* announced that a 90-degree CRT would soon be available to replace the 70-degree type.

Set depth was not the only factor, other authoritative voices proclaimed. The rectangular shape of the viewing screen, spake *Motorola*, was one the public had learned to expect as normal. Years of seeing motion pictures in theaters and watching black-and-white receivers had established this configuration. The shape provided by the round tube did not seem right. So *Motorola* proclaimed the miracle of the 23-inch rectangular tube.

But *RCA*, alas, has encountered "technical difficulties during pilot production." The tube, which was supposed to have been in use right now, may still be a year away. And *Motorola*, which had also originally expected that receivers with its rectangular, 90-degree version would be bringing color into American homes before now, announced a delay earlier. As of now, the latter manufacturer is simply saying nothing whatever about its breakthrough.

What effect has this had on the acceptance of color TV? Fortunately the pundits seem to have missed the mark. The viewing public, eager for tinted pictures and evidently convinced that, with no revolutionary breakthroughs after all these years, there will be none in the immediate future, has abandoned the waiting game. Color sets, in all major brands, accounted for a quarter of a billion dollars in retail sales last year and continue to move as fast as they can be made. With the rate of sales still climbing, that dollar figure will be dwarfed this year.

Strange that, no matter how we strive to plan and deal with them logically, important developments persist in choosing their own timing and making their own opportunities. Triumphs of caprice over intelligent control are ever the bane of the orderly mind.

Other Straws in the Wind

For those dwellers in backwater areas who have not yet seen direct evidence of the color boom, let us belabor the point a little further. *Admiral* has expanded its color line with the addition of a few more models. This follows a pattern laid down by other manufacturers.

RCA's banner year for color sales, 1962, was marked by a phenomenal percentage increase over the year before. Can the giddy pace be maintained this year? Figures for the early part of 1963, compared to the same period last year, show a 45 per-cent increase in dollar volume. The boom is still picking up momentum!

Another sidelight revives a familiar theme: Will Japan be a factor in color with low-priced imports? Despite much talk over the last couple of years, only one such set, handled here by *Delmonico*, has established itself.

Toshiba has put out a feeler with a set slated for display at the IEEE show in New York. Noteworthy features include the fact that the picture tube is a 16-incher instead of 21—and it is also rectangular. Absence of a color-saturation control (a hue control is the only viewer-operated color adjustment) suggests circuit innovation. This is supported by mention of a direct demodulation system, which eliminates conventional matrixing networks.

Nevertheless, the set uses 27 tubes. The cabinet is fairly compact, but depth (24 inches) suggests no increase in deflection angle. Most important, no price had been announced at this writing. ▲

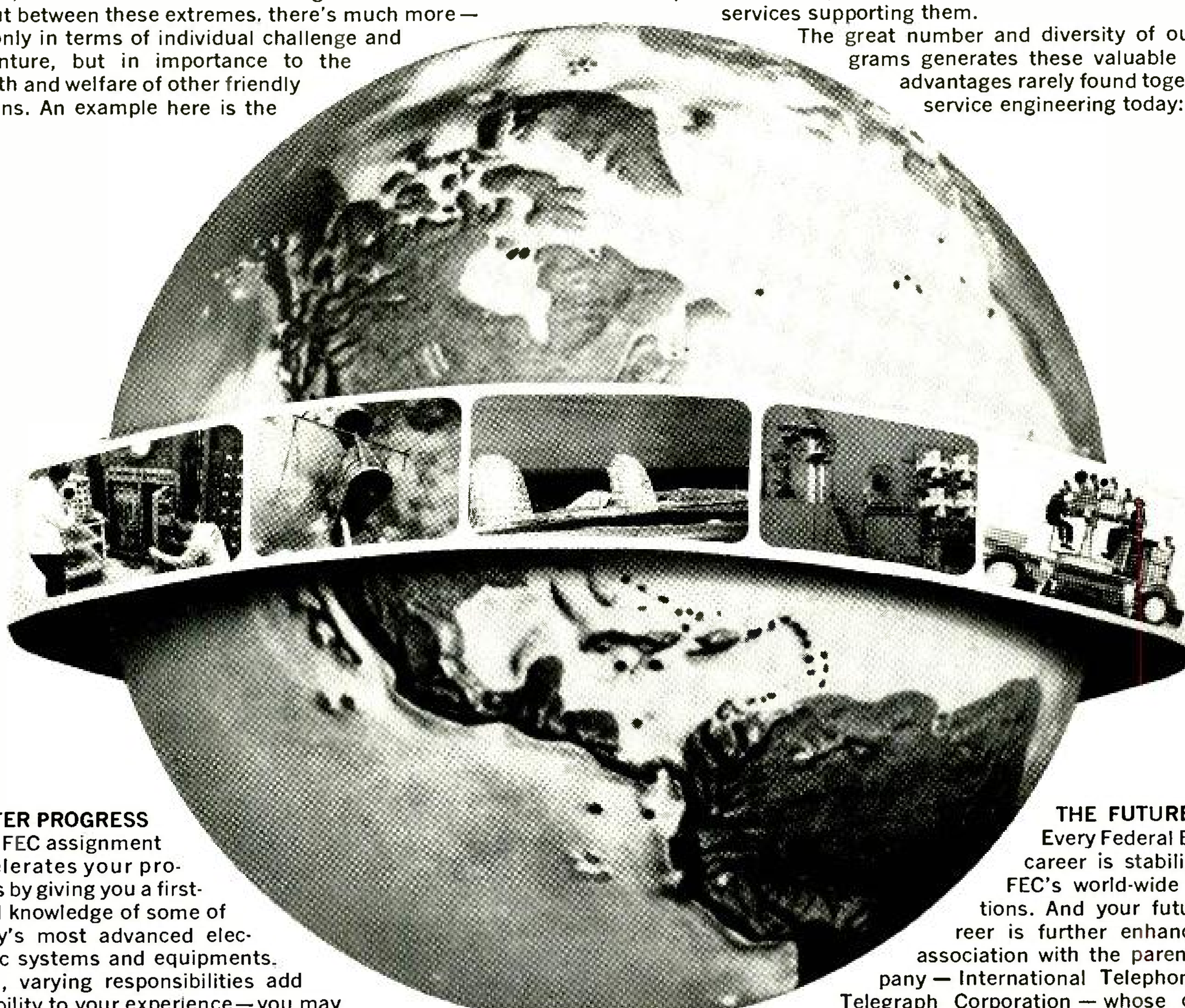
WORLD-WIDE ENGINEERING ASSIGNMENTS WITH ITT-FEDERAL ELECTRIC CORPORATION

Working in more than 30 countries across the free world, electronics technicians and engineers of ITT-Federal Electric Corporation install, service, maintain and manage an immense variety of electronic equipment and systems. These range from the 4,000 mile DEW Line across the frozen North, to the single instrumentation site on a lonely promontory jutting into the Ocean, down the Pacific Missile Range.

But between these extremes, there's much more — not only in terms of individual challenge and adventure, but in importance to the growth and welfare of other friendly nations. An example here is the microwave communications network linking 8 cities in South Vietnam.

Actually, at any point in time, FEC engineers and technicians are working on more than 100 active projects — installing, testing or operating almost every type of wire or wireless communication system in addition to radar, instrumentation and computer facilities, plus the multitude of ancillary systems and services supporting them.

The great number and diversity of our programs generates these valuable career advantages rarely found together in service engineering today:



FASTER PROGRESS
Your FEC assignment accelerates your progress by giving you a first-hand knowledge of some of today's most advanced electronic systems and equipments. Then, varying responsibilities add flexibility to your experience — you may teach navigational aids, direct emergency maintenance, supervise a radar installation, or become a field service administrator. And to help you forward faster, FEC reimburses you 100% for advanced study at leading universities and colleges or approved technical correspondence courses you complete.

ADVENTURE
An assignment may take you to Nepal — or to Africa, Alaska, Greenland, Europe, Canada or across the U.S. FEC field engineering operates in almost every climate and living condition in the world. Along with adventurous assignments in exotic countries, FEC field work often has a diplomatic side. For instance, teaching native workmen how to operate systems you're helping to install — a first-hand role in strengthening the good impression of our country by making friends abroad.

THE FUTURE
Every Federal Electric career is stabilized by FEC's world-wide operations. And your future career is further enhanced by association with the parent company — International Telephone and Telegraph Corporation — whose current annual sales and revenues now exceed a billion dollars. When a field job is completed, FEC men have priority for openings in other field assignments, as well as at headquarters in Paramus, New Jersey. Then too, you may find a future with one of the many subsidiaries and divisions of ITT who also seek qualified technical talent.

There are always interesting positions at many levels with FEC. However, openings change from day to day. If you would like to receive further information on current opportunities, please write to: Mr. A. Sheridan, ITT — Federal Electric Corp. Room 46-MH, Paramus Industrial Park, Paramus, N. J.

An Equal Opportunity Employer

ITT FEDERAL ELECTRIC CORPORATION

ELECTRONIC CROSSWORDS

By DONALD W. MOFFAT

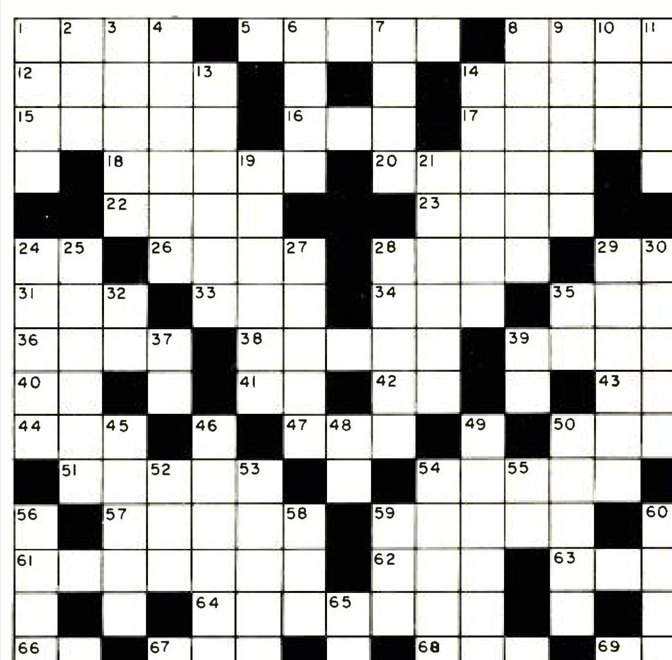
(*Answer on page* 93)

ACROSS

1. Preset condition.
5. Change in time relationship.
8. Shows station to which you are tuned.
12. Combination of two or more metals.
14. Frequencies which can be heard.
15. Record players are often mounted on one of these.
16. Broadcaster to Iron Curtain countries (abbr.).
17. Consumers.
18. Aquatic respiratory organs.
20. Part of the title of document guaranteeing civil liberties.
22. Valley between peaks.
23. Pedal extremities.
24. Type of circuit board (abbr.).
26. Human emotion.
28. Threaded rod attached to chassis.
29. Power ratio.
31. Unit of resistance.
33. Type of three-phase connection.
34. Affirmative.
35. Peruvian coin.
36. Output is dissipated across this.
38. Mends.
39. One-tenth (prefix).
40. Equally.
41. Ratio indicating usefulness of signal.
42. Transformer notation on schematic (abbr.).
43. Isotope of radon.
44. Color code for two.
47. Distress signal.
50. Earth.
51. Ability to perceive.
54. Production-line worker.
57. Wires attached to components.
59. Started from and returned to one place.
61. Receives and transmits signals.
62. Goods shipped (abbr.).
63. To be enjoyed.
64. Emits electrons.
66. Measure of noise generated by amplifier (abbr.).
67. Non-reactive impedance (abbr.).
68. Hit show ticket status.
69. Place for making measurement (abbr.).

DOWN

1. Part of transistor.
2. Sick.
3. Set properly.
4. Element found in salt.
6. Receptors for audio.
7. Man's name.
8. Tidied up the house.
9. Food for thought.
10. One vital commodity missing on the moon.
11. Attenuation.
13. Color code for four.
14. Containing gold.
19. Insurance underwriters.
21. Bear witness.
24. Pattern traced by some types of antennas and microphones.
25. Personal property (legal).
27. College administrators.
28. Locks signal to a reference.
29. Medical man.
30. Connection which must be made where it can't be seen.
32. Small current (abbr.).
35. Compass point (abbr.).
37. Radio navigation unit.
39. Unidirectional current (abbr.).
45. Type of three-phase connection.
46. Income from investments.
48. Computer function.
49. Female sibling.
50. Auto body type.
52. Born (Fr.).
53. Miss Oliver's namesakes.
54. Political subdivisions of a city.
55. Transistor schematic abbreviation.
56. Function performed by amplifier.
58. "Best" day of the week (abbr.).
59. Oscillator in receiver (abbr.).
60. Abrupt change to new voltage.
65. Transistor current amplification.



Two things you're sure to hear at a public event

Wherever people gather, wherever words and music must be heard with perfect fidelity, you're sure to hear University...largest selling P.A. loudspeakers in the world.

University **is** Public Address. The reasons can be summed up in two words, **high audibility—"High A"**, that special engineering factor built into University P.A. speakers to give them an extra degree of intelligibility, a clean, crisp, sound no other P.A. speakers can match. You hear the proof at political rallies and conventions, in the great churches, stadiums and arenas, in hospitals, factories, missile bases—everywhere from Presidential inaugurations to Little League play-offs.

You can't lose a P.A. customer when you have the superiority of over 62 different University speaker products in every price range behind you. Write Desk S-5 for our latest P.A. catalog:

UNIVERSITY LOUDSPEAKERS
80 SOUTH KENSICO AVE., WHITE PLAINS, N.Y.
A Division of Ling-Temco-Vought, Inc.

CIRCLE NO. 146 ON READER SERVICE PAGE

Twin-T Oscillators

(Continued from page 41)

From point C, an interesting signal of the same approximate amplitude is obtained. This is the high-pass filter leg and this signal is very rich in higher harmonics. The signal from point D is very small, having no direct use in the applications of this oscillator.

The following list indicates some of the uses to which the simple twin-T oscillators covered in this article have been applied or in which they could be applied: Organ tone generators; organ vibrato generators; power oscillator driver; portable electric timer source; superregenerative quench; supersonic generator; deluxe automobile horn; synthetic gong and chimes; remote control and telemetering (multi-channel tone source); time, fire, and emergency alarm; and stable test frequency. Undoubtedly this list could be easily expanded.

Triggered Twin-T Oscillator

A very interesting and useful effect of the twin-T oscillator should be noted. As the value of resistor $R3$ is increased, the free-running frequency becomes lower and finally oscillation stops. Right at this point and for some distance beyond it, the circuit acts exactly like a high-"Q" resonant circuit and high-gain amplifier, *i.e.*, it can be triggered by a very small sinusoidal input signal to full oscillation amplitude. This triggering takes place only at the resonant frequency and not at any of the higher or lower harmonics.

This effect can be used in various ways. For example, in signalling and selective-calling circuits, remote control, and other applications, twin-T oscillator senders, and twin-T triggered receptors can be used in a wide variety of arrangements.

Extensions of the same nomographic methods presented in this article can be applied to setting up such resonant circuits. ▲

"Sorry, but it's gonna have to go back to the shop for a couple of days."

14-Watt Hi-Fi Amplifier

(*Continued from page* 47)

the supply voltage until the full amount appears at test point B then re-adjust R3 for half the supply voltage at test point A. This completes the necessary test procedure.

The square-wave response of the amplifier is very good, representative of good transient response. The frequency response at 0.5 watt is ±0.5 db from 10 to 20,000 cps, as shown in Fig. 3.

The maximum sine-wave output is 14 watts into a 16-ohm load with a supply voltage of −50 volts. The power output becomes limited above 4000 cps by the maximum current of 500 ma. drawn by the amplifier. For this reason do not test the amplifier for maximum output at high frequencies. Prolonged testing at high frequencies can cause a rapid rise in junction temperature and cause thermal runaway. The fuse will normally prevent this but the output transistors are capable of drawing enough base current to destroy Q3 and Q5 before the fuse blows. The signal-to-noise ratio is better than 85 db below 10 watts. The output impedance is less than 0.25 ohm for good damping. The total harmonic distortion is 0.5%, (second = 0.15%, third = 0.25%, fourth = 0.1%).

With a loudspeaker connected, it is almost impossible to tell that the amplifier is turned on. With the absence of an output transformer, the low-frequency performance is limited only by the size of the coupling capacitor to the speaker. This low-frequency performance is, of course, where it is really needed. The author's first amplifier has been in constant use for over a year and a second unit has been operating in an auto almost as long. The clean sound from a transformerless transistorized power amplifier is a new experience in listening pleasure. ▲

RELAY BUZZER

By FRANK JACKOWIAK

IN THE course of some experiments, the author needed an audible signaling device and, not having a buzzer handy, removed the "D" ring (shading coil) from an a.c. relay.

The relay was then connected in a circuit and to a source of 117 volts a.c., and the required signaling device was obtained. The "D" ring is used on a.c. relays to prevent armature chattering. The lines of flux set up by the coil collapse on alternate half cycles. The current induced in the "D" ring tends to prevent the flux then existing in the shaded portion of the core from decreasing. The result is that the total pull from the main flux which occurs later never completely disappears. This combined pull holds the armature in place.

Shading coils are also used in shaded-pole motors to provide the starting torque. ▲

Stereo Indicator Light Circuit

By LARRY BLASER / Fairchild Semiconductor

Construction of transistor circuit to be added to FM stereo adapter to indicate presence of stereo signal.

OFTEN it is not immediately apparent that a station is broadcasting a stereo program when it is first tuned in. Therefore, a stereo indicator is a convenient and useful attachment for any stereo multiplex adapter or tuner in which one is not already included.

It is only necessary to select from the composite signal the 19-kc. pilot signal that is broadcast with stereo programs and amplify it sufficiently to operate a simple indicator such as a neon light. The three-transistor circuit shown in Fig. 1 may be used in conjunction with the transistorized multiplex adapter described in the March, 1962 ELECTRONICS WORLD by this author, or with vacuum-tube equipment. When used with this or other adapter having a separate 19-kc. channel, the first stage of the indicator light circuit can be eliminated. Connection is made from the top of the sensitivity control to a 19-kc. signal point, such as terminal 1 of T_2 in the adapter mentioned above.

Operation of Circuit

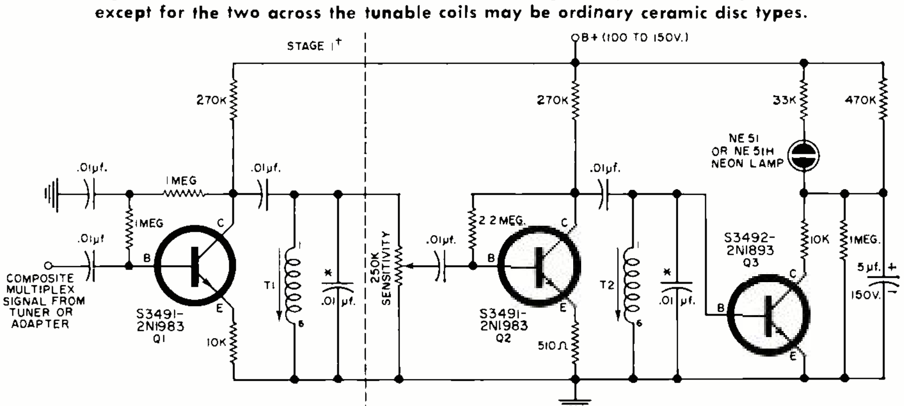
Operation of the circuit is straightforward. The input to transistor Q_1 is the composite multiplex signal, the signal that is fed to the adapter from the multiplex output jack on the FM tuner. It can be picked up either at the tuner or in the multiplex adapter. The tuned circuits of T_1 and T_2 are both adjusted to 19 kc. to select the pilot signal if it is present. Q_1 and Q_2 amplify the 19-kc. signal sufficiently so that the positive-going portion of the 19-kc. signal at T_2 causes Q_3 to conduct. The neon lamp in the collector of Q_3 then turns on. Q_3 is necessarily a high-voltage transistor and Q_1 and Q_2 are high-gain transistors. A sensitivity control is used for gain adjustment. The gain can be set so that a 19-kc. pilot signal will be just sufficient to turn on Q_3 but the noise between stations and the infrequent high-frequency tones from a monophonic station will not "trigger" the indicator circuit.

Adjustment

The circuit is adjusted as follows: Tune to a station that is known to be broadcasting stereo. Turn the sensitivity control until the neon lights and then back it off until the neon bulb just goes out. Adjust T_1 and T_2 until it lights again. Extinguish the neon again by reducing the sensitivity and again adjust T_1 and T_2. Repeat these steps until no further adjustment of T_1 and T_2 will light the bulb after the sensitivity has been slightly reduced. Finally, adjust the sensitivity so that all multiplex broadcasts turn on the neon lamp but between-station noise and monophonic broadcasts do not.

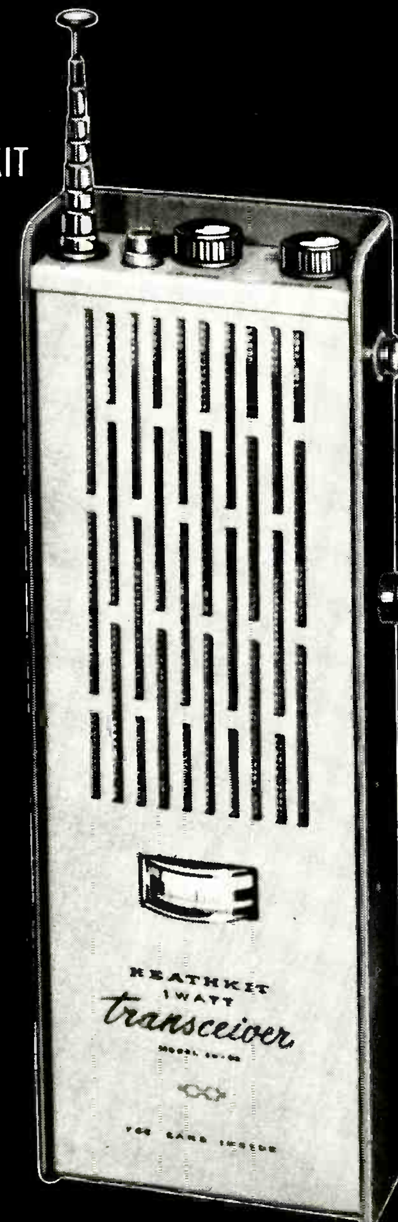
Transistors for the indicator circuit are available from *Fairchild* distributors. Names and locations of these distributors may be obtained by writing to the Sales Department, *Fairchild Semiconductor*, 545 Whisman Road, Mountain View, California. Reprints of the article "Transistorized FM-Multiplex Stereo Adapter" are also available from the above address. ▲

Fig. 1. Circuit diagram of the stereo indicator light amplifier. All capacitors except for the two across the tunable coils may be ordinary ceramic disc types.



NOTES: *MICA OR MYLAR CAPACITORS — ALL RESISTORS 10%, 1/2 WATT — T1,T2-MILLER COIL NO. 1354 (19KC.) — †MAY BE ELIMINATED WHEN TIED INTO ADAPTER (SEE TEXT)

NEW FROM HEATHKIT



1 WATT WALKIE-TALKIE

ONLY $74.95 ea.
Includes $20 heavy-duty rechargeable battery!

Order a pair and save! Only $139.95

Attention CB fans! Here is a tremendous new value in a portable two-way radio transceiver! . . . the new Heathkit GW-52. Nowhere will you find a transceiver of such outstanding quality, with so many high performance features at so low a price! Designed for rugged duty and reliable two-way radio communications over extended ranges, the new Heathkit GW-52 features a powerful 10-transistor, 2-diode circuit . . . long-range transmitter with 1-watt input . . . sensitive superheterodyne receiver with ½ microvolt sensitivity for 10 db signal-to-noise ratio . . . crystal-controlled transmitter and receiver . . . built-in squelch and automatic noise limiter for crisp, clear communications . . . a heavy-duty 10-cell rechargeable nickel-cadmium battery with 500 milliampere-hour rating that will outlast conventional batteries many times over . . . built-in battery condition meter . . . built-in battery charger and many more! "Solid" communications may be established at ranges of three to five miles between units and even more when used with Class "D" CB stations or external antenna. Batteries may be charged from 117 VAC source with built-in charger or from 12 volt car battery. Battery life is 1500 hours minimum (90% receive, 10% transmit duty cycle) and life expectancy is as high as 5000 hours (over two years in normal workday use) . . . a tremendous savings in operating costs! Easy circuit board assembly. Complete with two-tone aluminum case, shoulder and elastic hand straps, crystals for one channel (specify), rechargeable battery, power cords, earphone, FCC license pack and instructions. Order a pair and save!

Kit GW-52, 4 lbs. no money down, $8 mo. . . . .$74.95 ea.

Kit GW-52-2 (pair) 8 lbs., $13 mo. $139.95

FREE 1963 HEATHKIT CATALOG
100 pages, over 250 easy-to-build kits to fit your hobby, to give you better equipment at 50% savings. Send for your free copy today.

HEATHKIT
a subsidiary of Daystrom

HEATH COMPANY
BENTON HARBOR 15, MICHIGAN

Please Send My Free Heathkit Catalog

Name ____________________

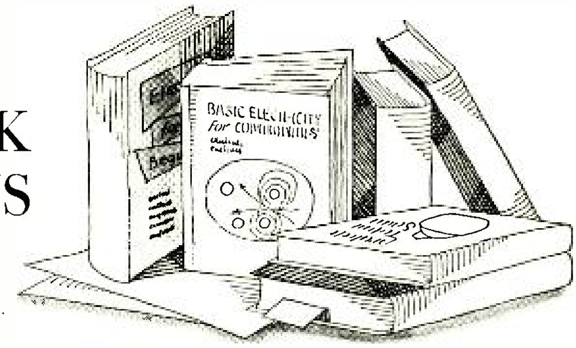
Address ____________________

City ____________ Zone ______ State ______

Prices & specifications subject to change without notice. Dealer & export prices slightly higher.

CIRCLE NO. 121 ON READER SERVICE PAGE

BOOK REVIEWS



"TECHNICAL TELEVISION" by A. V. J. Martin. Published by *Prentice-Hall, Inc.* 547 pages. $14.65.

Designed as a textbook at the technical or junior college level, this volume bridges the gap between the specialized engineering text and the more practical how-to-do-it service manuals. While a familiarity with radio fundamentals is prerequisite, it is not necessary to have advanced math at one's fingertips to use this volume. The material is divided into 23 chapters which deal individually with the TV receiver circuits, a discussion of TV transmitters, antennas, power supplies, auxiliary circuits, as well as complete receivers and color television and color-TV receivers. A complete schematic of a typical color-TV receiver is also included.

* * *

"ELECTRONIC ENGINEERING" by Charles L. Alley & Kenneth W. Atwood. Published by *John Wiley & Sons, Inc.* 640 pages. $10.50.

The authors of this volume designed it as a college classroom text in electronic engineering and it is based on class notes used in their courses at the University of Utah. The material is presented progressively and there are problems accompanying each chapter. There are 17 chapters in all, with three appendices including tube and transistor characteristics to make the volume self-contained. The treatment is mathematical hence those planning to use this as a home-study text should have their algebraic techniques well honed.

* * *

"BASIC SERVOMECHANISMS" by Ed Bukstein. Published by *Holt, Rinehart and Winston, Inc.* 183 pages. $5.25.

This is a basic discussion of servomechanisms rather than a how-to-design-it text. For this reason the treatment is less mathematical than is usual in such cases, hence the book is entirely suitable for the student and electronics technician without engineering background. The author covers closed-loop control systems, error detectors (potentiometers, synchros, and transducers), error correctors, error amplifiers (vacuum tube, transistor, magnetic, and rotary), servomechanism stability, and a wide range of applications for such devices. Readers of this magazine, familiar with the author's clear and concise style, will find this subject handled in the same vein.

* * *

"TRANSISTOR CIRCUIT DESIGN" by Texas Instruments Engineering Staff. Published by *McGraw-Hill Book Company, Inc.* 523 pages. $15.00.

Thirty-two members of the TI staff have cooperated in presenting this comprehensive handbook for the practicing circuit engineer. The book covers a wide range of basic circuit problems and design procedures and is intended to reduce to practice the most frequently used elements of transistor engineering.

The material covered ranges from the interpretation of data sheets and the measurement of transistor parameters to design procedures for v.h.f. power stages and the effect of complex thermal impedances on circuit stability.

* * *

"DIGITAL COMPUTER PRINCIPLES" by Burroughs Corp. Technical Training Dept. Staff. Published by *McGraw-Hill Book Co., Inc.* 500 pages. $10.95.

Originally designed as a training course for prospective computer technicians, engineers, and programmers, the material has now been revised and presented in textbook form for those interested in the field. The treatment is nonmathematical and progressive. The text is divided into three sections which provide (1) the basic background material on computers and transistors, (2) the computer circuits themselves, and (3) computer units. Three appendices deal with digital symbology, a glossary of computer terms, and a general bibliography. Each chapter is summarized and the inclusion of test questions makes this volume suitable for both classroom and home study applications.

* * *

"THE RADIO HANDBOOK" edited by William I. Orr. Published by *Editors and Engineers, Ltd.* 794 pages. $9.50.

This is the Sixteenth Edition of a handbook which advanced amateurs, radiomen, practical engineers and technicians have come to depend on as a source book for a wide range of technical information.

This edition has been revised and brought up to date with new subject matter inserted as required. There are 34 chapters covering everything from basic d.c. circuit theory to computers, workshop practice, electronic test equipment, radio mathematics, and calculations. As is customary with this "bible," the material is presented succinctly, in clear and readily understandable language, and with copious illustrations, schematics, graphs, and tables.

° ° °

"RADIO-TELEVISION-ELECTRONICS DICTIONARY" by NRI Teaching Staff. Published by *John F. Rider Publisher, Inc.* 190 pages including appendices. $3.50.

This dictionary encompasses 6500 subjects in the fields of radio, television, and electronics, including audio, communications, and computer terminology. The material is attractively presented and the type is clear and easy to read. Five appendices cover accepted abbreviations, vacuum tube and transistor symbols, modulation symbols, and graphic symbols which conform to ASA and IEEE standards.

° ° °

"TECHNICAL WRITING" by Richard W. Smith. Published by *Barnes & Noble, Inc.* 175 pages. $1.25.

This is one of this publisher's "College Outline Series" and covers the preparation of manuals, reports, proposals, and articles for both industry and the government. The text covers the functions of the technical writer; technical writing style; preliminary steps; the technical manual, report, proposal, and article: the duties of a technical editor; writing the technical film; technical advertising and publicity; the mechanics of the trade; and the future of technical writing. A self-testing section designed to be used both before and after studying the text is included. A "must" for would-be technical writers.

° ° °

"RF INTERFERENCE CONTROL HANDBOOK" by Barron Kemp. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 219 pages. Price $6.95.

Since r.f. interference has now assumed such proportions that it is of immediate concern to not only the FCC but the military as well as users of the equipment, this book's appearance is especially timely.

In 11 chapters the author discusses the theory of r.f. interference, interference measurements, interference measuring equipment, measurement problems, electrical-circuit noise, semiconductor-circuit interference, switches and contactors, suppression techniques, suppression in rotating machinery, suppression in ignition systems, and suppression at the system level. The techniques advocated by the author are all thoroughly practical and universal in their application. ▲

A Transient Evaluator
(*Continued from page 45*)

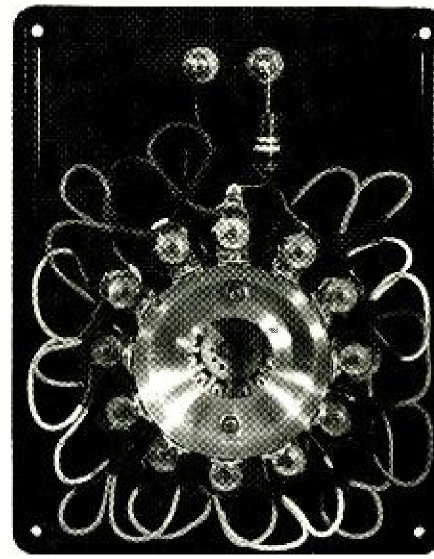


Fig. 3. A straightforward, interior layout parallels the schematic of Fig. 2.

by filing off the stop arm of the indexing cam and converting it to an indexing slot.

Sockets for the neon lamps (*Johnson* type 147-610) are held in place by an aluminum cup about 2¼ inches in diameter and ½ inch deep. The cup is held by the mounting bolts on the switch (Fig. 3). Holes made in the front panel over the sockets permit the lamps to protrude partly through the panel. Sockets, however, are positioned so that all metal of the lamps is below the panel. This protects against accidental contact with any live part of the circuit.

Although a specific instrument is described here, the general principle lends itself to a variety of formats and a very wide range of voltages. When other than 12 neon lamps are used, the current-limiting series resistor should have a value of about 10,000 ohms per lamp. If the instrument is to be used for measuring steady-state voltages, resistance should be increased to 100,000 ohms per lamp. ▲

SOUTH CAROLINA HAMFEST

THE annual "Ham-Fest" of the Blue Ridge Radio Society has been scheduled for Sunday, May 5th at Paris Mountain State Park, Greenville, South Carolina.

Tickets for adults are priced at $3.00 with children's tickets at $1.50. Advance reservations and additional information are available from L. H. Gregory, W4VWW, Secretary, 111 Coleman Court, Greenville, South Carolina. Tickets will also be available at the gate.

The committee has planned a varied program of interest to the whole family. A cordial invitation is extended to all—especially visiting hams who may be passing through the area on that date. ▲

EW Lab Tested

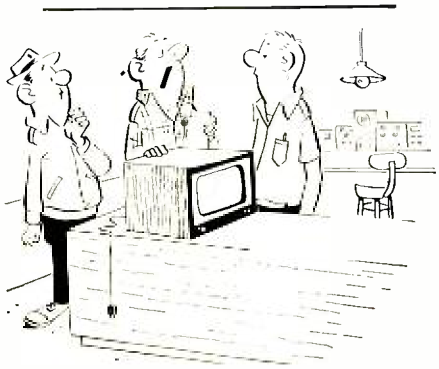
(*Continued from page* 16)

ponents eliminated. Being essentially all at 10 cps and below, it was inaudible under any conditions we could devise. The speed was exact and did not change with line voltages varying from 80 to 140 volts.

The arm tracking error, when it was carefully set according to instructions, was between 0.4 and 1.0 degree/inch of record radius. An offset of only 2.5 degrees in the mounting of the cartridge in the shell would have reduced this to 0.25 degree/inch. The rated tracking error is 0.32 degree/inch. Actually, even our measured tracking error was quite low, and certainly could not affect the audible or measured performance of the arm. *(Editor's Note: We have learned from the manufacturer that the error in offset angle is not a design error but a production error on the particular unit tested. The condition is repairable under the product guarantee.)*

The arm handles very well, with a good "feel" and no tendency to "run away" when handled, even at tracking forces on the order of 1 gram. The viscous damping worked well, and we could not hear any wow when playing a piano record with a ¼" warp. No acoustic feedback resulted from placing the turntable on or in front of our speaker system, playing at high volume and with considerable bass boost. The arm and turntable are so thoroughly isolated from their surroundings that the motorboard can be pounded with the fist or struck with a rubber mallet without producing any sound in the speakers or any groove jumping. The complete freedom from acoustic feedback imparts a refreshing clarity to recorded material.

The turntable comes complete with base, plastic dust cover, stylus overhang gauge, screwdriver, lubricating oil, and a balance-type stylus force gauge. At its price of $58.00 complete, the *AR* record player is an outstanding value. It would be hard to match at several times its price. ▲



"Let's not quibble over an additional $75, Harry. You know Mr. Armquist doesn't want a hashed-up job!"

Recording-Storage Tubes

(*Continued from page* 24)

plays may contain 10-mc. components of information. On the other hand, a normal telephone line can pass frequencies of only a few kilocycles. If it is desired to transmit a picture over a telephone line, it would therefore be necessary to convert the frequencies downward to allow them to pass through the narrow bandwidth allotted. This can be done by storing the picture in a storage tube and then reading out using a very slow scanning speed. All frequencies in the picture will be reduced by the ratio of the scanning speed used in writing divided by the scanning speed used in the reading.

With a system such as this, it would be possible to transmit a scan-converted radar picture from the northernmost outposts of our Dew Line down to the military bases in the United States using only telephone lines as the communications link. For commercial applications, such a system could permit transmitting pictures from FBI headquarters to local police stations or the picture of a depositor or a file card from a central bank office to one of its branches. At the receiver end, the slowly arriving information can be fed into another storage tube, and then recreated into a display on a TV monitor. In a continuous-information slow-down video system, it is possible to show a still of the input picture until the next picture is ready for presentation.

Other Applications

The ability of a Recording-Storage Tube to store a single frame of television information makes possible several "stop-motion" applications. In the freight-car situation described earlier, some railroads want to use television cameras to observe the numbers on each freight car entering the yard. However, the cars are moving so fast that the numbers become blurred and the operator of the equipment cannot fully recognize them. By using a storage tube and a triggering circuit, each freight car could hit a switch and electronically photograph itself into a storage tube. A still picture of that freight car would remain on the screen until the next freight car hit the switch. Thus, instead of seeing a moving freight car in the television system, the observer would see stills of each freight car consecutively. He could then record the numbers on each freight car entering a yard, while sitting in a heated office, rather than using the more conventional technique of sending men into the yard to look at each car and record its particular number.

Obviously this stop-motion capability could also be used in athletic events, such as to obtain an electronic photo-finish of a race so that it could be observed instantly not only by the judges but, if there are TV monitors in the stands, by the patrons as well.

Still pictures of fast-moving events are also desired in industrial situations where one wants to analyze the motions of automatic equipment or the causes of failures in such equipment. By means of a strobe light, synchronized with a TV system, and a storage tube, it would be possible to study individually the different phases of motion of equipment.

The examples described cover only a few of the typical applications for Recording-Storage Tubes. A number of electronic firms are presently manufacturing systems using these tubes in new applications for both military and commercial use. ▲

A NOVEL ANTENNA MATCH

By ARTHUR L. MUNZIG, W6BY

DID YOU ever wish you could feed a yagi with six reflectors and a director and get a good match? Here's how it is done.

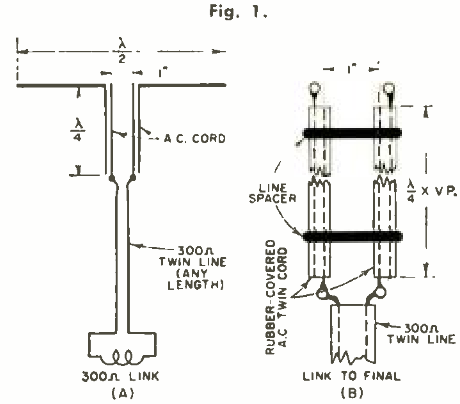
In Fig. 1A is a method of automatically matching a 300-ohm line to any antenna load. This system will match any balanced line to antennas having high or very low radiation resistances. The system is suitable for feeding rhombics, V-beams, folded dipoles, all-channel TV antennas, stacked arrays, and many other types of antennas requiring two-wire feedlines.

Referring to Fig. 1B, the spacing between the a.c. cords in the λ/4 section should produce the same impedance as that of the feedline. The 1-inch spacing shown is approximately the same impedance as that of the 300-ohm TV feedline employed.

The line spacers shown in Fig. 1B can be constructed of Bakelite or polystyrene strips. Drill a hole just large enough to allow the a.c. cord to slip through snugly, and evenly space them on the λ/4 matching line.

In determining the length of the λ/4 matching section, the velocity of propagation (v.p.) length can be considered to be approximately 10% less than half of the calculated antenna length. ▲

Fig. 1.



Importers of Japanese Radios

(Continued from page 39)

Brand Name	Importer and Address	Mfgr. and Address
Toshiba	Transistor World Corp. 513 W. 24th Street New York, N.Y.	Tokyo Shibaura Electric Co., Ltd. 3 Ginz Nishi 4-chome Chu-ku, Tokyo
Trancel (See Toshiba importer only)		
TWI	Transworld Industrial Corp. 5404 Hudson Avenue West, New Jersey	
Universal (See Olympic)		
Viscount	Consolidated Sewing Machine 1115 Broadway New York, N.Y.	
Wilco (See Onkyo)		
Windsor	Valiant Importers 1200 Sixth Avenue Brooklyn 17, N.Y.	
Yaekon		Yamada Electric Industrial Co., Ltd. 3 Shiba Sinbashi 6-chome Minato-ku, Tokyo, Japan
Yaou (See Alpha)		
Yashica	Yashica, Inc. 50-17 Queens Blvd. Woodside 77, N.Y.	Yashica Co., Ltd. 8 Nihonbashi Muro-machi 1-chome, Chuo-ku, Tokyo, Japan
York	N.Y. Transistor Corp. 150 Fifth Avenue New York, N.Y.	
Zephyr	Eastern Associates, Inc. 40 Spear Street San Francisco, California	

UPGRADING SIMPLE FM TUNERS

By E. W. CASSADAY

Simple circuit changes and adjustments will improve sensitivity and the tuning of inexpensive FM tuners.

THE past decade has provided the field of FM broadcasting with a host of new circuits for FM tuners. One of the simplest and most ingenious designs is the one-tube grounded-grid r.f. amplifier and reflex converter for FM tuner "front ends." This one-tube front end, coupled with a good three-can i.f. strip, a stable limiter, and a balanced ratio detector, has been the basis for many fine FM tuners. When used and not abused, this circuit often performs as well as the most refined hybrid circuits costing 3 to 5 times as much. However, this simple circuitry has some drawbacks which are quite easily overcome, as this article will attempt to point out.

R.F. Circuit Limitations

One tube, or for that matter, reflex-type transistor FM front ends, can exhibit cross modulation, interference, and repetition of the same station at several points on the dial due to overloading. Another phenomenon occurs due to overloading the front end and is easily detectable in circuits where the a.f.c. can be defeated or is non-existent. The local oscillator can be synthetically frequency-shifted due to r.f. amplifier saturation. The local oscillator output level can't match the r.f. amplifier's distorted output level. The mixing operation is performed with two signals greatly unmatched in level, causing an effective, but synthetic, shift in local oscillator tracking. It appears to the listener as though the station were very broad on the dial, having no apparent center when observed with either a tuning meter or eye.

To the hobbyist or technician, it is more readily detected by observing, with a v.t.v.m., the a.g.c. d.c. bias voltage at the limiter's control grid. As the dial is tuned through a station, the a.g.c. level monitored here seems to have no definite sharp peak as it should when the center frequency is passed through. This last test is a good way to detect FM circuit overloading for almost any type of tuner with the a.f.c. in the defeat position. Of course overloading an FM front end usually causes some objectionable audio distortion which, initially, causes the owner or technician to look for tuner troubles.

Unloading the Front End

The cure for overloaded FM front ends follows quite naturally—unload them! The use of an impedance-matched r.f. signal attenuator will restore to the FM front end the proper r.f. levels with which it was designed to cope. These can be purchased from TV service shops or from various high-fidelity component sales outlets and radio parts dealers. A cheaper, but still effective, way to reduce r.f. signals is to couple the FM tuner to the antenna with a lapped but unconnected splice, using 300-ohm twin-lead. The lap splice can be from 1 inch to 6 inches in length, so that various amounts of r.f. coupling can be achieved, dependent upon lap length.

The r.f. signal should be reduced until the a.g.c. or tuning indicator gives a definite center-of-channel indication on the most powerfully received station on the dial. The reason for using the most powerful station to check the r.f. tuner antenna coupling is that normal one-tube front ends use an untuned r.f. amplifier. This type r.f. amplifier will then by its nature be saturated more easily by the most powerful station. All other stations should then be received at satisfactory r.f. levels.

Upgrading the Limiter Circuit

To keep price tags within reason, the manufacturers of these less expensive tuners usually use three i.f. cans followed by a partial limiter. Experience shows that a large amount of limiting can't be used with the moderate gain of the simple three-can i.f. strip without reducing the detector output significantly. Therefore not much limiting is normally used in this type circuit. It is true that ratio detectors can be driven with less limiting than other detection systems and still achieve passable audio quality under most receiving conditions. However, in high-level signal areas or where reflected signals as well as direct signals are fed into the FM antenna, the resulting multipath distortion due to inadequate limiting and to i.f. response-curve asymmetry makes this simple FM tuner's audio quality poor. Audio distortion due to multipath distortion is typified by a breaking up of the high audio frequencies of solo instruments such as a piano or piccolo or on sustained violin notes.

With some minor circuit changes it is possible to achieve more limiting, to correct for i.f. curve response asymmetry and to reduce the audio distortion without sacrificing too much receiver gain. By injecting a little positive feedback into the limiter tube and by adjusting the limiter time constant (as per Patrick Halliday's article "Reducing Multipath Distortion" in the October 1961 issue of this magazine), the audio distortion can be significantly reduced even under the poorest of receiving conditions. We have the *BBC* to thank for their rather thorough study of the causes and cures of multipath distortion. It is through their efforts and others that cheaper but higher quality FM tuners are being designed. It was found in modifying the limiter of one tuner that it was necessary to realign the ratio-detector transformer to maintain stage gain and achieve good AM rejection. The reader may find realignment necessary on the tuner he modifies. Under the assumption that the i.f. cans haven't been disturbed from their original alignment, the ratio detector can easily be retrimmed.

Realigning the Ratio Detector

With the a.f.c. defeated, monitor the a.g.c. signal occurring at the control grid of the limiter tube with a v.t.v.m. With the tuner connected to a suitable antenna, observe the v.t.v.m. peak as a strong station is tuned in. Now with the dial left set with the a.g.c. peaked, place the v.t.v.m. across the ratio detector's stabilizing capacitor and peak the ratio primary detector. Next place the v.t.v.m. across the output of the ratio detector preceding the de-emphasis network and trim the ratio detector secondary for a zero voltage output on the v.t.v.m. The zero or null voltage indicates the secondary's maximum AM suppression alignment. This alignment procedure comes in handy when you don't have a signal generator for aligning the ratio detector. With care, excellent results can be obtained on almost any tuner where the a.f.c. can be defeated.

Boosting Audio Output

The modifications performed to increase the limiting and reduce the i.f. asymmetry distortion results in some loss of stage gain. In tuners that couple the ratio detector directly to a cathode-follower output amplifier, the audio output level will be somewhat reduced but still usable with systems using speakers of moderate efficiency. Where the tuner is used in a system employing low-efficiency speakers, the extra gain of an added audio amplifier stage in the tuner would be useful. The extra audio stage can be added quite easily by replacing the cathode-follower tube (usually a 6C4) with a 12AU7A dual triode. The first triode can be a straight voltage amplifier while the second half of the 12AU7A can be the equivalent of the original cathode-follower 6C4. In tuners where the last half of a 12AU7A already serves as a cathode-follower, a separate 6C4 would be necessary to add the extra audio stage.

Performance

In applying the preceding modifications and techniques to FM tuners, it was the author's experience to notice audible improvement with every tuner modified. The modification in no way affected the audio passband. In tuners of sufficient quality for stereo use, the modifications did not impede but rather improved the phase distortion figures in all cases. Although some reduction in detector output is observed, the attenuation is not great enough to interrupt the 19-kc. pilot synchronization between the tuner and a fairly sensitive adapter. ▲

BAFFLING A.V.C. PROBLEM

By ELWOOD C. THOMPSON

RECENTLY, while working on a Zenith Model 6R631 a.c.-d.c. radio, a strange phenomenon was encountered while measuring a.v.c. voltage. The voltage would rise and fall while a small test signal was applied. A complete check of components—resistors, bypasses, i.f. transformers, and tubes—indicated no faulty component. Still the a.v.c. voltage was erratic.

In this particular model, a mica compression antenna trimmer was mounted on top of the two-section tuning capacitor. Removing one side of this trimmer stabilized the a.v.c. voltage. This trimmer had a slight bit of corrosion bonding the two plates together. Out of curiosity, a v.t.v.m. was connected across the trimmer. To our surprise, a voltage of .75 volt was measured. The corrosion bonding the two trimmer plates together was forming a small battery, which would charge and discharge according to the a.v.c. voltage.

(Editor's Note: As proof, the author sent along the trimmer capacitor he had removed from the radio. We had heard of other cases where corrosion in a component had set up a rectifying junction at a point where dissimilar materials made contact with each other. One resistor, for example, showed the properties of a semiconductor diode. Thinking that this might have occurred, with the writer misinterpreting the evidence, we used an ohmmeter to check forward and reverse resistance. When this proved fruitless, we checked across the trimmer with a low-scale d.c. voltmeter. Sure enough, although the "battery" appeared to have drained somewhat, giving us a lower reading than he reported, there was a definite, fixed voltage. Unless someone can offer a better explanation, we think that the electrochemical change during corrosion turned the component into a small cell.) ▲

Proposed CB Regulations

(*Continued from page 28*)

Paragraph **19.74** requires the licensee to have a current copy of Part 19—Citizens Radio Service.

Comment: *Ignorance of the law was never a legal excuse. But, it's a good thing to have in writing that every licensee must keep up-to-date with current regulations. It almost means that every CB-er will have to subscribe to FCC Rules and Regulations, Volume 6, or perhaps the service could be provided by publications in the field in such a way that the licensee could clip out from such magazines any new rules.*

Paragraph **19.92** now covers remote control and interconnection. Important to class D users is the provision in subparagraph (b) which specifically prohibits connection of a station physically, capacitatively, inductively, or otherwise to public telephone toll or exchange facilities.

Comment: *The wording "public toll telephone or exchange facilities" is a little confusing. If the Commission means public telephone facilities, why not say so. The implication to those unfamiliar with Commission wording is that connection to long distance, outside pay phones, or telephone exchanges is prohibited. But, what about the telephone in your office? Actually, the prohibition is against connection to any public telephone company equipment and, as such, would not seem to work any serious hardship against the business or personal business use of class D Citizens Band. It is mainly designed to prevent Aunt Tessie from calling you by telephone and having you "phone patch" a conversation* via *your CB radio with Cousin Lil who also has a CB outfit.*

Paragraph **19.93** specifically covers the use of CB for Civil Defense purposes. Its chief provisions are that you may use your CB transceiver, under your own license number, in connection with official Civil Defense activities by the Civil Defense Authority having jurisdiction over your area, provided that:

1. Such use is on a voluntary basis.
2. Such communications are conducted under the direction of Civil Defense Authorities.
3. Official tests or drills of radio units only, not involving participation by some other division or branch of the Civil Defense organization, shall be limited to a total on-the-air time of 1 hour per month. When such drills involve participation of other divisions or branches of Civil Defense, the 1-hour-per-month time limitation does not apply. It does apply to such things as CD roll calls.
4. As soon as possible after the beginning of such use, the licensee shall send notice both to the Commission in Washington and the Engineer-in-Charge of his FCC district. One notification on behalf of all licensees will suffice for this purpose. Notification must also be given of any changes or termination of any such tests or drills.

Comment: *This clears up many questions that have been in doubt about Civil Defense activities. At first, it may seem that the one-hour-per-month limitation would work hardships on large CB Civil Defense organizations. But, if the operation were sectionalized, as it is done in some areas, then different sections of the same Civil Defense organization could hold their roll calls on different channels, but at the same time. By doing this, the one hour limitation would be easily met.*

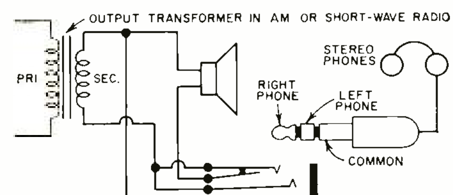
In conclusion, the author can see nothing unusual or alarming in any of these proposed regulations. They should result in better use of the band and better enforcement of the regulations, because many things which were in dispute before are now more clearly spelled out. Many provisions represent liberalization over former interpretations. The person using CB for legitimate purposes should find these regulations a real help. The gabber is going to suffer. These new regulations may make him see the light and put him on the ham bands where gabfesting is an acceptable and pleasurable pastime. ▲

USING STEREO PHONES FOR MONO LISTENING

By ART TRAUFFER

THE author owns one of the fine stereo headsets having a three-conductor plug, as shown in the diagram. Because of the excellent fidelity of these stereo phones, it was desired to use them also for mono listening to AM broadcasts and short-wave radio. The problem of plugging a stereo-connected headset into a radio for mono use, without making any changes in the phone plug, was solved by installing a three-conductor circuit-closing jack in the speaker circuit, as shown.

The jack automatically connects the two phones in parallel for mono use. When the phones are plugged in, the speaker cuts out. Mount the jack at any convenient place on the back of the radio. If your receiver happens to be of the a.c.-d.c. type having one side of the speaker voice coil connected to the chassis, it is best to isolate the voice coil and transformer secondary from the chassis to avoid possible shock. ▲



Quarter-Track Mono Crosstalk Remedy

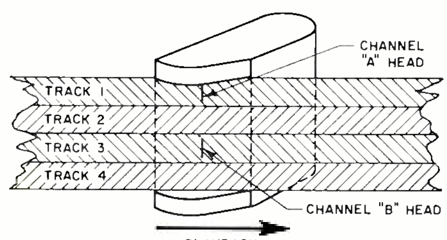
By MONROE CORN

ONE of the advantages of having quarter-track stereo tape equipment is the ability to record four mono tracks. This feature is useful for copying mono records as it affords good quality and permits twice as much recording time as quarter-track stereo.

A problem that may be encountered using this technique is crosstalk between alternate channels. For example, when the channel "A" playback head scans track 1, the channel "B" head scans track 3. (Fig. 1.) If the recorded material were stereo, any crosstalk would be unnoticed since there is very little difference in the sound content of the two tracks and the normal volume level of each channel is such that any crosstalk would be well covered. When the recorded material is mono, the preamp gain control for the unwanted channel is normally set to a minimum. However, magnetic coupling between the two heads, each of which is scanning recorded material on the tape, may be sufficient to make crosstalk objectionable. This is especially true if the sound content of the tracks being scanned is noticeably different, as a soft violin passage *versus* a Dixieland combo. There is a 50-50 chance that the phasing of any particular stereo installation will permit nulling the crosstalk to inaudibility without any modification to the equipment.

It is assumed that the stereo amplifier is adjusted for mono operation, that the tape recorder gain control for channel "A" (scanning track 1) is advanced to a convenient listening level, and that the gain control for channel "B" (scanning track 3) is at minimum. If crosstalk from track 3 is audible, advance the channel "B" preamp gain control slightly. If the phase of the signal coupled magnetically between the two heads is opposite to the phase of the signal as it emerges from the channel "B" preamp, a null point will be found. It is best to make this adjustment at a point on the tape where there is no recorded material on track 1 so that the null point can be clearly found. ▲

Fig. 1. Passage of tape past playback head.



Modern Capacitors

(*Continued from page* 44)

cathode strip is not similarly affected.

It is important to note that the cathode strip serves only as a contact with the electrolyte, and that it is the oxide film, not the saturated gauze, which serves as dieletric. This film has a high dielectric constant and is capable of withstanding considerable voltage.

The depth of the oxide coating is determined by the voltage used to form it. The working voltage at which the capacitor can be used is then somewhat less than the forming voltage. Very thin films are formed with low voltages. Therefore, capacitors intended for low voltage use can be made quite small, while larger units are required for high voltage applications.

Very refined aluminum must be used, otherwise small impurities of copper and iron, when immersed in the electrolyte, form little batteries, which cause hot spots and leakage currents that eat away the foil. This process is called "local action." Shelf life is limited because of this factor and also because the aluminum oxide tends to dissolve after a period of time.

Tantalum capacitors, which offer the highest microfarad-volt rating per cubic inch to be found in any capacitor, offer a number of advantages over aluminum types. Tantalum is more inert than aluminum, so it is possible to use much thinner sheets without incurring a risk of puncture due to local action. Tantalum sheets ½-mil thick are used, compared with 2- to 5-mil sheets of aluminum. This permits a great size reduction in the case of tantalum capacitors. Futhermore, shelf life is extended indefinitely.

Tantalum electrolytics are also made with sintered anodes (Fig. 10) instead of the more conventional foil. Capacitors of this kind are constructed with a porous, sintered slug which, when immersed in a suitable electrolyte, serves as the anode. The porous material provides a very large area over which an oxide film is formed. As a result, they are much smaller than foil types for equivalent voltage and capacitance ratings. Units of this kind have been made which can be used at temperatures as high as 200°C.

The sintering technique is not a new one to electronics, being used to form the electrodes of some battery types and other components. It involves the application of heat to form a powdery substance into a single mass, without actual melting.

The development of solid-dielectric tantalum capacitors represents a major advance. These devices employ a solid-sintered tantalum slug that has been previously anodized. The solid electrolyte is introduced into the pores of the slug, usually as a solution of manganese nitrate or sulfate. It is then converted to manganese dioxide by heating.

Solid-dielectric tantalum capacitors have longer life expectancy and improved electrical characteristics. The fact that no liquid is involved permits them to be employed at temperatures as low as −80° C.

The element niobium has characteristics very similar to tantalum, and developmental work is underway to produce niobium-foil electrolytic capacitors. A niobium capacitor should have exactly the same capacitance as a tantalum capacitor of the same volume. Although niobium has twice the dielectric constant, the anodic film which is grown on it is twice as thick as that of tantalum, so the net result is a capacitor of comparable rating.

As experimentation goes forward, however, this type may exhibit other characteristics, now unrecognized, that will make it distinctively useful in certain applications. If it does, it will merely serve to demonstrate further that there is still room for refinement and improvement of a common component type that has been in use for decades. ▲

TRANSISTOR-CIRCUIT PROTECTION

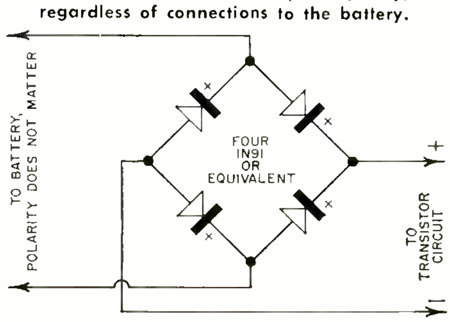
By IRWIN MATH

IT IS a well-known fact that reversing the battery in a transistor circuit can easily ruin the transistors. By employing the inexpensive bridge circuit shown here, such circuits can be made virtually immune to burn-out due to wrong polarity.

As can be seen from the diagram, four 1N91 diodes are connected in a full-wave bridge circuit. No matter which way the batteries are installed, the output terminals are always "+" and "−" as indicated. The 1N91 diodes were chosen because they are readily available and have a very low forward resistance. Any silicon diode with the proper voltage ratings can be used in this circuit with equally good results.

In one application, four high-current diodes were used to protect a transistorized television set. Purposely reversing the battery had no effect whatsoever on the receiver. ▲

Connected to the input of transistorized equipment, this bridge permits the passage of d.c. in the correct polarity only, regardless of connections to the battery.



Touch Control

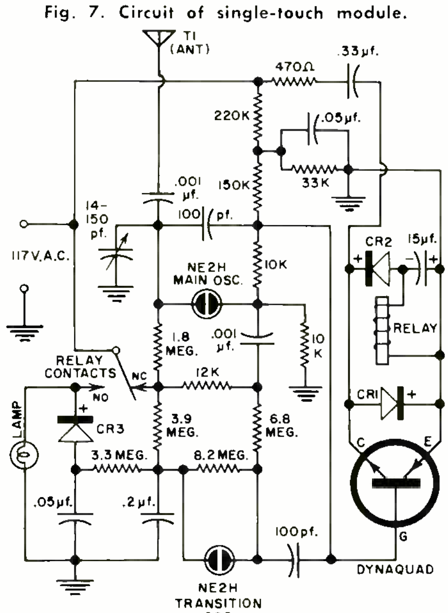
(*Continued from page* 37)

the switching action must be achieved by successively touching the single available surface. While this can be done with a stepping relay, it can also be accomplished with the arrangement shown in Fig. 7.

The reader will recall that the neon-lamp circuitry of Fig. 2 generates pulses, the direction of which depends on the polarity of the voltage applied to the oscillator. Accordingly, by changing this polarity it is possible to alter the action of the circuit, changing it from the mode where added capacity reduces the signal to the opposite mode where added capacity increases the signal applied to the "Dynaquad." In Fig. 7 when the relay is normally closed, *i.e.*, not energized, the lamp is off and the main neon oscillator is powered with straight a.c. as in Fig. 5. When the single antenna, *T*1, is touched, the firing signal is lowered so the relay is energized, the lamp is turned on, and the a.c. is removed from the oscillator. When turning on the lamp, power is also applied to diode *CR*3 and a time-delay network composed of the 3.3-megohm resistor and the .2-μf. capacitor. This means that the oscillator is now powered with a negative d.c. potential and the touch action is now in the opposite direction.

Because of the delay in application of power to the oscillator, the operator has sufficient time to remove his hand from the touch surface before the new mode is effective. Likewise, in returning to the original mode it is necessary to keep the "Dynaquad" fired for a few seconds in spite of the tendency of the operator's hand to remove the firing signal when the oscillator is in this condition. This is achieved by means of an auxiliary or transition neon oscillator which generates an overwhelming firing signal regardless of the presence of any capacity loading at the touch point.

Fig. 7. Circuit of single-touch module.



This transition oscillator is energized partly from the a.c. line through the 12,000-ohm and 6.8-meg resistors and partly from the residual d.c. potential appearing across the .2-μf. capacitor. Due to the values of the components, neither of these voltages is sufficient to fire the neon oscillator alone. Thus, this transition signal begins only when the armature of the relay reaches the normally closed (NC) position and continues only as long as there is sufficient charge in the .2-μf. capacitor. If the operator's hand remains on the touch point, the load will be alternately turned on and off but at a slow enough rate so that, in practice, this condition presents no problem.

The circuits discussed are only a few typical methods of using the balanced neon oscillators in combination with solid-state devices for touch-control switching. These circuits feature long life, compactness, negligible standby power, and have numerous applications.

The author wishes to acknowledge the invaluable assistance of Robert Ziolkowski of the *Tung-Sol* Engineering Staff for his work in this field. ▲

Hysteresis-Loop Plotter

(*Continued from page* 31)

made in such a way that the width and height of the hysteresis loops are the same in both cases. This is important since the determination of losses is a relative measurement in which loop area is considered in relation to the total loop height. The higher the losses, the greater is the ratio of the loop area to the loop height.

This example is shown in Fig. 6D where identical magnetizing currents were used but where the gain setting on the vertical input to the scope was adjusted so that the heights of the two hysteresis loops belonging to the different laminations became equal. The loop with the larger surface area corresponds to the lamination sample with the larger losses.

For further theory about magnetic circuits, the following references are suggested to the constructor:

BIBLIOGRAPHY

Truxal, John G.: "Control Engineering Handbook," McGraw-Hill Book Co., New York, 1958. Pages 7-9 and 7-15.

Knowlton, A. E.: "Standard Handbook for Electrical Engineers," McGraw-Hill Book Co., New York, 1941. Pages 2-61, 3-320, 4-332.

Pender & Del Mar: "Electrical Engineering Handbook," John Wiley & Sons, Inc., New York.

Stratton, J. A.: "Electromagnetic Theory," Pages 2-16, 125.

Langford-Smith, F.: "Radiotron Designers Handbook," RCA, Harrison, N. J. Fourth Edition. Pages 229-233.

Smith & Wiedenbeck: "Electrical Measurements," McGraw-Hill Book Co., 1959. Page 193. ▲

NEW PRODUCTS & LITERATURE

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 17.

COMPONENTS • TOOLS • TEST EQUIPMENT • HI-FI • AUDIO • CB • HAM • COMMUNICATIONS

SERVICE-TYPE V.T.V.M.

1 **Heath Company** is now offering an improved and redesigned version of its service-bench v.t.v.m. as the Model IM-13.

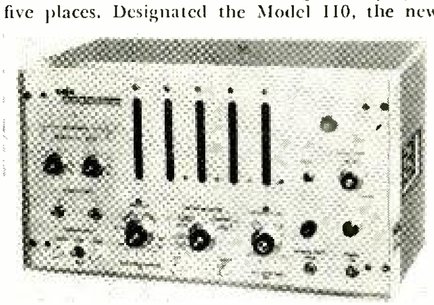
A special gimbal bracket permits bench, shelf, or wall mounting with the meter tiltable to any

desired angle for best viewing. An easy-to-read 6" 200-μa. meter is incorporated in the circuit.

The usual v.t.v.m. meter ranges and functions are included, plus broad frequency response, precision 1% voltage divider resistors and 11-megohm input, db calibrations in 10-db steps, and separate 1.5- and 5-volt a.c. scales for low-voltage a.c. readings. The kit comes complete with test leads. The unit measures 5"x 12¾"x 4⅝" and operates from 105-125 volts, 50-60 cycle a.c.

ELECTRONIC COUNTER

2 **Electronic Designs Division of Maxson Electronics Corporation** has recently introduced a new electronic counter with digital display to five places. Designated the Model 110, the new



instrument can be used for measuring pulse time, lapsed time, and frequency.

Operating ranges include frequency 10-120,000 cps; time 10 μsec. to 100,000 seconds, and period from .00001 to 10,000 cps. Stability is 10 p.p.m./week.

PRINTED-BOARD SPLICERS

3 **Colman Electronic Products** is marketing a printed-circuit-board aid which permits the leads of faulty components to be snipped off and new ones spliced into position. The splicers are slipped over the stubs, the new component is installed, then the splicers are soldered.

MEDICAL MONITOR

4 **Telemedics Inc.** has developed a six-patient wireless intensive-care monitor which enables the cardiac function of ambulatory as well as confined patients to be monitored around-the-clock.

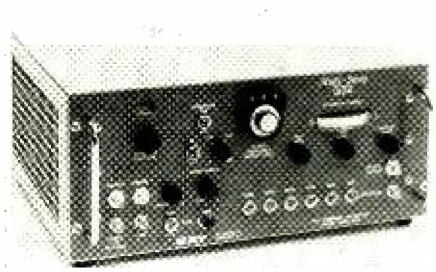
Known as "Guardian 6000," the system broadcasts the electrocardiogram and heart rate from miniaturized radio transmitters carried by or alongside of each patient. The data is beamed to a central display console. Since there are no connective wires between the patient and the console, he has complete freedom of movement.

Disposable electrodes are applied to each patient. These connect to a thin wire which carries the EKG to the patient's transmitter. The signal is then broadcast to the monitoring apparatus located in another room. When the alarm is sounded, it triggers an electrocardiograph recorder which makes a tracing of the episode for the physician's permanent record.

WIDE-RANGE SWEEP OSCILLATOR

5 **Kay Electric Company** is now offering a new wide-range video-v.h.f. sweeping oscillator which provides a full 300 mc. of swept-frequency output by all-electronic frequency-modulating techniques.

The Model 300 provides a linear swept frequency output, with a.g.c. for constant output over the frequency band. It also includes provision for the insertion of external oscillators to



generate variable birdie-bypass type markers on all frequencies. A calibrated frequency dial permits use of the unit as an i.f.-v.h.f. oscillator with continuously variable center frequency and sweep width.

RECHARGEABLE BATTERIES

6 **Sylvania Electric Products Inc.'s** Electronic Tube Division is in pilot production on a compact, rechargeable nickel-cadmium battery for use in transistorized equipment.

The batteries serve as semi-permanent components or energy tanks. In field service, they may be recharged from solar cells, thermoelectric or vehicle generators, power lines, or other energy conversion devices.

The first unit in what promises to be a entire line is the Type SRB-3428, a 500 ma./hour, 12-volt pack which weighs only 0.5 pound. It consists of ten strapped cells, jacketed in molded epoxy.

CCTV EQUIPMENT

7 **Video Systems of America, Inc.** is offering a fully transistorized television camera for closed-circuit TV applications as its Model V-500. The unit, which incorporates a vidicon tube and offers 500-line video resolution, measures 9" x 6" x 3" and weighs 5.7 pounds. An automatic light sensor and compensator is built into the circuitry and functions with a variety of standard, telephoto, wide-angle, zoom, and closeup lenses.

The camera is designed to be used with any of several matching monitors in the firm's Model VM-100 series.

TRANSISTORIZED ANTENNA AMP

8 **The Winegard Company** is in production on a new, low-cost antenna amplifier which is being marketed as the "Red Head."

This Model RD-300 has a high-pass interference filter, built-in two-set coupler, and is fully a.c.-operated with no polarity problems. It is designed to be used in areas where all signals are less than 20,000 μv. The circuit uses an MADT transistor.

PC BOARD PRINTER

9 **American Screen Process Equipment Co.** is marketing and servicing the French-built **Dubuit** circuit-board screen printer, Model D-361.

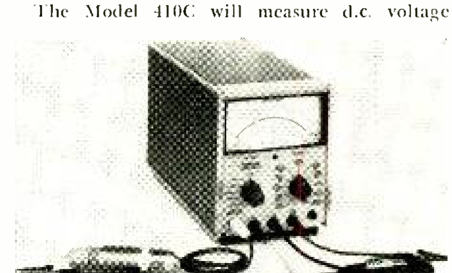
According to the company, the new machine prints circuit boards, nameplates, glass, tile, and other flat precision-printed objects.

The screen printer is especially designed for close-tolerance printing on electronic parts. It is available in semi-automatic and automatic models. Key parts, technical controls, and motor equipment are to American specifications. The distributor handles a complete stock of replacement parts.

MULTI-FUNCTION METER

10 **Hewlett-Packard Company** is marketing a new multi-function meter which it claims is so stable that no zero adjustments are required for measuring resistance, d.c. voltage, or d.c. current.

The Model 410C will measure d.c. voltage



±2% from 1.5 mv. to 1500 volts; d.c. current ±3% from 0.15 nanoamp to 150 ma., and resistance from 0.2 ohm to 500 megohms. With an optional plug-in probe, a.c. voltages (20 cps to 700 mc.) from 50 mv. to 300 v. may be measured. Floating d.c. voltages up to 400 volts above instrument ground can be measured with complete safety.

TRANSISTORIZED SCOPE

11 **General Atronics Corporation** is now offering an accessory battery pack unit which makes its all-transistorized, all-militarized oscilloscope, Model K-106, completely portable.

The battery pack is contained in a cover which clamps onto the rear of the instrument and is easily attached without any circuit modifications. The accessory adds but 9½ pounds to the 18 pound total weight of the scope. Its use allows up to four hours of remote operation, while an a.c. connector on the rear of the battery-pack chassis provides for a.c. operation and simultaneous battery charging.

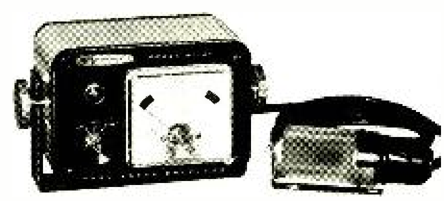
The rechargeable silver-cadmium battery is capable of up to 500 cycles of recharging with up to four hours operation on each cycle.

THERMOELECTRIC COOLERS

12 **Atlee Corporation** is now offering a line of thermoelectric coolers for operation with temperature-sensitive components in space-limited environments. The unit has a temperature operating range of −100 degrees C to +125 degrees C with a maximum heat pumping capacity of 350 mw. With a power requirement small enough to be integrated into a circuit, the unit allows cooling of a specific component, eliminating the need for refrigerating an entire package.

FUEL-VAPOR DETECTOR

13 **Heath Company** has introduced a fuel-vapor detector in kit form as the Model MI-41. Designed for all powered craft, the instrument warns against dangerous build-up of flammable fumes in enclosed engine compartments. A "safe-dangerous-explosive" meter scale shows



whether any fumes are present, before the motor is started. Provision is made for connection of an external alarm device such as a buzzer or bell.

The circuit is transistorized; insensitive to drafts, temperature, or voltage variations; and has a built-in self-tester. It requires 12 volts d.c., negative- or positive-ground for operation.

IDENTIFICATION MARKER

14 **Panduit Corporation** is now marketing a new, all-nylon "Sta-Strap" identification marker for wiring harnesses and cables. The marker strap can be hand- or tool-installed and is available in two sizes 0-1-3/4" and 0-4". The straps meet applicable military specifications, are self-extinguishing, and available in ten colors. Temperature range is −65 to +350 degrees C.

CLASSROOM CCTV CAMERA

15 **Blonder-Tongue Laboratories, Inc.** is now offering its "Observer-2," a closed-circuit TV viewfinder camera designed especially for classroom applications.

The unit features a high-quality vidicon pickup tube and associated camera circuitry plus an 8" viewfinder screen. The operator can see exactly what the camera is viewing and adjust for sharp, dramatic pictures.

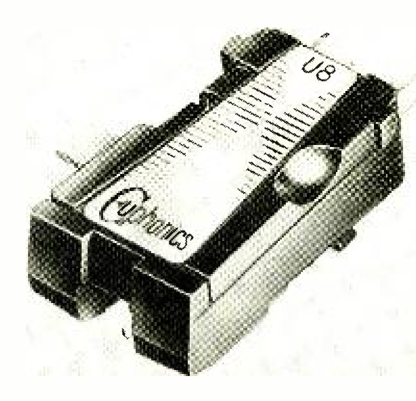
To meet a variety of educational needs, the new camera is available in three different models: video output, r.f. output, and studio net versions.

HI-FI—AUDIO PRODUCTS

STEREO CARTRIDGES

16 **Euphonics Corp.** has announced the availability of a new stereo ceramic cartridge series designed as replacement components for all types of ceramic cartridges.

The "Orbit Action" U-8 and U-9 have dual styli for playing stereo and mono records, including 78's. The two needles used in the cartridge are both integral parts of the needle assembly and are in the same horizontal plane. Flipping the selector lever "orbits" the desired needle into playing position and moves the other needle to the "rest" position, decoupling it from the circuit completely.



A snap-in mounting bracket makes needle assembly replacement easy and fast. Tracking force is 2 grams and 4-terminal lead connections are standard, with a jumper for 3-terminal installations. The U-8 has two sapphire styli while the U-9 has one diamond and one sapphire stylus.

TRANSISTOR ELECTRONIC ORGAN

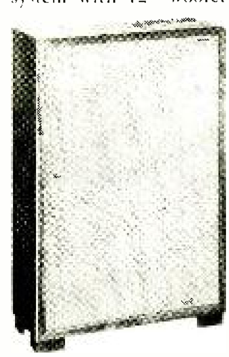
17 **The Wurlitzer Company** is now offering an all-transistor electronic organ as its Model 4040.

The new organ features a slide effect, instrumental sustain percussion, two full 44-note keyboards, 22 tone-control tabs, and a 13-note balanced pedalboard.

A square-wave electronic pattern produces such voices as woodwinds, stopped flutes, and tibias. A saw-tooth impulse produces strings, open flutes, reeds, brass voices, and diapason. These two basic electronic impulses replace traditionally used signals. Eighty-seven computer-type diodes and 84 transistors classified for computer use are employed.

THIN-LINE SPEAKER SYSTEM

18 **Allied Radio Corporation** has recently introduced a new three-way, thin-line speaker system with 12" woofer.

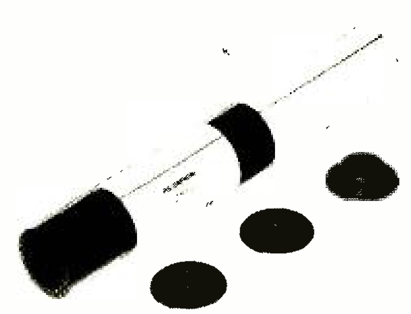


Designated the "Knight KN-2250," the system is only 6⅞" deep assembled. It combines a 12" thin-type woofer, a 6" closed-back mid-range unit, and a dome lens compression tweeter. Frequency response is 35-19,000 cps and the system will handle 45 watts. Impedance is 8 ohms.

This 25" x 17" x 6⅞" system is available in either kit or assembled versions. The kit version is supplied with four sides of the enclosure assembled and prefinished in oiled walnut.

CALIBRATING SOUND SOURCE

19 **B & K Instruments, Inc.** is marketing a small battery-driven, precision sound source as its Model 4220. The unit permits quick and accurate direct calibration of sound-measuring



equipment and sound tape recordings to check absolute sensitivity of condenser microphones. Accuracy of calibration is 0.2 db. The "Pistonphone" is useful as a laboratory standard for sound-pressure level and for calibrations in the field. Since the unit is 9" long x 1.4" diameter and weighs 1½ pounds, it can be operated with one hand.

SHALLOW-SPEAKER SERIES

20 **Utah Electronics Corporation** has begun distributing a series of thin speakers, including two 8" models and a 6" x 9" model. The 8" round model has a total depth of only 2-3/16"; the p.a. version has an 8-ohm voice coil, while the replacement type has a 3.2-ohm voice coil. The 6" x 9" replacement speaker, with a total depth of only 2¼", is also currently available. All models have ¾" voice coils and 2.15 ounce Alnico V magnets.

BACKGROUND MUSIC SYSTEM

21 **Sound Corporation of America** is now offering a packaged background music system which consists of a four-track playback unit, which will handle tape cartridges, and two

speakers which may be spaced ten feet from the main unit.

The "Channel-matic 1" is housed in a 14" x 14" cabinet which is finished in hand-rubbed walnut with gold and black trim.

TURNTABLE CONVERSION KIT

22 **Acoustic Research, Inc.** has announced the availability of a conversion kit permitting the firm's single-speed turntable to be converted to a two-speed model. The kit consists of a two-step pulley, a 45-rpm spindle adapter, and instructions for installation. The parts are of aluminum, machined to an accuracy of .0005 inch. The conversion can be done easily and rapidly, usually in less than a minute.

MOBILE P.A. AMPLIFIER

23 **Allied Radio Corp.** is now offering the KN-3230M, a 30-watt public-address amplifier that weighs only 11 pounds and features an all-transistor design.

At full rated power the unit draws only 4.5 amps with idling current of ¼ amp. The unit is housed in a black cabinet with aluminum-

finish panel and measures 3½" x 10¾" x 6".

Frequency response is 100-10,000 cps ± 3 db. There is one microphone and one phono input. Controls are mike volume, phono volume, master tone, "off-on," and trumpet protector switch. Impedances are 4, 8, and 16 ohms.

An a.c. power-supply converter is available for this unit at additional charge. Also available as optional equipment is a "phono-top" which will play all records up to 12 inches at 33, 45, and 78 rpm.

PAGING SPEAKER

24 **Atlas Sound Division** is offering a completely new Model EC-10 paging speaker for a wide range of applications.

The speaker is weather-proof, will handle 6 watts, and is low in cost. The entire horn as-

sembly is molded of a tough, all-weather acrylic plastic and the speaker uses a new type of ceramic magnet for increased conversion efficiency.

The unit comes equipped with an adjustable steel mounting bracket. The light beige and shell brown color scheme is designed to blend with any decor.

RADIO PAGING SYSTEM

25 **Electra International** is now marketing a radio paging system under the tradename "Miniphone."

The system's components can be selected and operated by untrained personnel. The base station may be either the short-range Model 600 transmitter-receiver or the longer-range Model 800. The base station is used with any number of Model 200 receivers or Model 400 transmitter-receivers. Except for the Model 800 base-station transmitter which operates in the CB service, none of the units require licensing.

WIDE-RANGE 8" SPEAKER

26 **Sonotone Corporation** has just released its new Model WR8-BH wide-range, 8-inch hi-fi speaker which has been especially designed for use in a bookshelf enclosure as an extra stereo speaker, in mono applications, or in communications work.

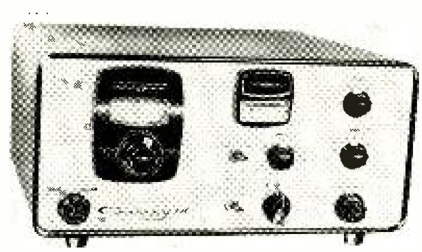
The speaker has a controlled frequency response which is smooth over the range 45-20,000 cps. Its extended range is made possible through a special high-frequency cone radiator. Crossover frequency is 6000 cps. The unit measures 8" x 4½" deep.

CB-HAM-COMMUNICATIONS

SSB TRANSCEIVERS

27 **World Radio Laboratories** is now offering a new high-power SSB ham radio transceiver as the "SSB Galaxy 300."

Designed for both home and mobile operation, the transceiver covers the 80-, 40-, and 20-meter bands. There is 200-kc. coverage on 80 and 20 meters and 300-kc. coverage on 40 meters. A 175-watt AM input insures reliable communications. The unit measures 7" high x 14" wide x 13"



deep and has a hinged lid for easy access to all tubes and components. An a.c. power supply with built-in speaker, styled to match the transceiver, is available at extra cost.

SCREEN-REFLECTOR YAGIS

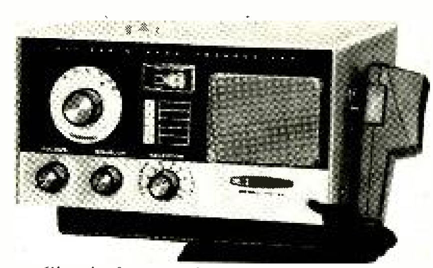
28 **Technical Appliance Corp.** has announced the current availability of 31 screen-reflector yagis, each specifically engineered to cover a required frequency range from 100 to 470 mc.

These TV, communications, and special-purpose antennas offer high gain and have front-to-back ratios many times those of conventional yagis. Each model features heavy-duty welded construction with gain up to 15.2 db over an isotropic source. They may be mounted for either horizontal or vertical polarization and are particularly adapted to tower mounting.

MARINE CB RADIO

29 **Heath Company** is now marketing its Model MW-33, a marine version CB transmitter-receiver which can also be used in cars and for general all-around applications.

A built-in power supply permits operation on 6- or 12-volt battery power or standard 117-volt

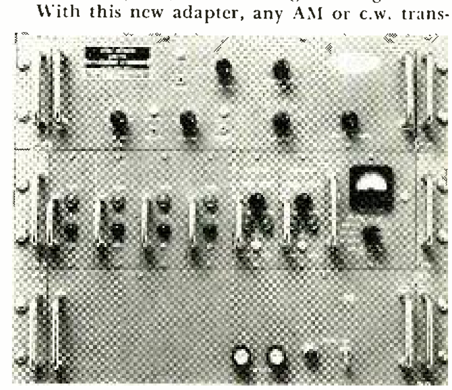


a.c. Circuit features include an r.f. amplifying stage for long-distance reception, half-lattice crystal filter for greater adjacent-channel selectivity, built-in low-pass filter, and improved push-to-talk circuitry for all-electronic switching. There is adjustable squelch and automatic noise limiting.

SSB TRANSMITTER ADAPTER

30 **Kahn Research Laboratories, Inc.** has developed a transistorized SSB transmitter adapter employing its envelope elimination and restoration (EER) method of generating SSB.

With this new adapter, any AM or c.w. trans-



mitter with modulator can be converted to single-sideband or two independent sidebands without modification. Frequency range is 4 to 28 mc. with manual or optional remote-control switching to any of four (more optional) preset crystal-controlled frequencies.

The Model SSB-62-1A adapter occupies only 15¾" of rack space.

CB "WALKIE-TALKIE" KIT

31 **Allied Radio Corp.** has added an all-transistor two-way portable CB transceiver to its "Knight-Kit" line.

Featuring a compact 9-transistor circuit and 1-watt r.f. input, the crystal-controlled transceiver is easy to build. The superhet receiver has an automatic noise limiter and variable squelch to reduce background noise and keep the speaker silent between calls.

Plug-in crystal sockets allow channel flexibility. Crystals are available for both transmit and receive from channels 1-22. The unit measures 10⅜" x 3⅝" x 4 17/32" and weighs 32 ounces. The transceiver is powered by eight "C" cells. The kit includes all necessary parts, transistors, wire, solder, case, vinyl carrying strap, and FCC-permit application form. Crystals and batteries are available extra.

FM MONITOR RECEIVERS

32 **Hammarlund Manufacturing Company** has recently introduced a line of crystal-controlled, fixed-frequency FM communications

monitor receivers for the 25-54 mc. and 144-174 mc. bands.

These double-conversion superhets are available in narrow-band (±5-kc. deviation) and wide-band (±15 kc. deviation) types and in single-channel and multi-channel versions, with front-panel selection of up to six channels. The receivers are available with and without internal tone decoders and can be used with external frequency-division and coded tone-pulse selective-signaling devices.

MOBILE TWO-WAY RADIO

33 **Aeronautical Electronics, Inc.** has added a 35-watt v.h.f. FM mobile radio set to its line of two-way radio equipment.

The "Slimline '35'" is designed for up-front mounting in any vehicle, with optional remote control available. A channel-selector switch permits the selection of up to four channels. The unit is supplied with one channel as standard equipment with three others available at extra cost. An accessory plug-in "Unicall," a two-way tone-activated channel-quieting device, is available at a modest additional cost.

The unit measures 4⅞"x 11"x 8½" and weighs less than 9 pounds.

MANUFACTURERS' LITERATURE

LABORATORY TEST EQUIPMENT

34 **Telonic Industries, Inc.** has published a comprehensive catalogue covering its entire line of laboratory-type sweep generators, r.f. attenuators, r.f. filters and detectors, and coaxial switches. All pertinent electrical, mechanical, and performance information is provided along with details on accessories, prices, and applications.

TOOL-KIT LITERATURE

35 **Xcelite, Inc.** has issued a single-page illustrated data sheet which provides a complete description and price of its recently developed double-duty pocket tool kit.

Bulletin N163 is available on request.

INTERCOM BROCHURE

36 **Bogen Communications Division** has prepared a 6-page pocket-sized brochure entitled "Cost Accounting Your Inter-Office Communications" which describes how independent intercom systems can save time and money. Different systems are illustrated along with photographs of some of the units making up the firm's line of such intercom equipment.

SERVICE DATA INDEX

37 **Howard W. Sams & Co., Inc.** is offering without charge a 64-page guide to "Photofact" service data covering virtually every model of home-entertainment electronic equipment produced since 1946.

The index is a quick guide to the service data covering over 54,000 listings of all types of equipment.

TRACKING ANTENNAS

38 **Radiation Incorporated** is offering a new 12-page illustrated brochure describing automatic-tracking antenna systems.

The brochure discusses antenna systems currently being used to track IRBM, ICBM, deep-space probes, and satellite launchings from both the Atlantic and Pacific missile ranges. The brochure also lists in chart form the operating characteristics of typical automatic-tracking antenna systems, from high-speed trackers to a system with a giant 85-foot diameter reflector.

RELIABILITY GLOSSARY

39 **Autonetics** has issued a "Reliability Glossary" containing more than 600 terms common to electronics and aerospace reliability specialists.

Originally introduced at the Ninth National Symposium on Reliability and Quality Control, the new 73-page book is aimed at the promotion of greater product reliability through better understanding and communication of the terms and phrases peculiar to the field.

EDUCATIONAL TV SYSTEMS

40 **Adler Electronics, Inc.** is offering an illustrated 6-page brochure describing the various methods available for expanding educational horizons through the use of such television techniques as broadcasting, on-air closed-circuit, cabled closed-circuit, and microwave.

CONDENSED SEMICONDUCTOR DATA

41 **Raytheon Company's** Semiconductor Division has issued a free 24-page booklet which describes the firm's complete line of germanium and silicon, miniature and subminiature, transistors and diodes; silicon rectifiers; and "Circuit-Pak" and "Weld-Pak" circuit modules by means of charts, drawings, and photographs.

VOLTAGE-CONTROL HANDBOOK

42 **General Radio Company** has issued a 40-page "Handbook of Voltage Control with the 'Variac' Autotransformer." Contents include principles of autotransformers, descriptions and diagrams of circuits, and information on the use of autotransformers for incandescent and fluorescent dimming, for maintaining color temperature in photography, and for various lab, heating, and motor-speed applications. Over 80 circuit diagrams, charts, and photographs are included.

SWEEPING-OSCILLATOR DATA

43 **Kay Electric Company** has issued a single-page, two-color data sheet on its Multi-Sweep Model 121-A. In addition to pinpointing special features of the instrument, the brochure carries technical specifications and performance data, plus a photograph of the unit.

R.M.S. VOLTMETER BROCHURE

44 **Ballantine Laboratories** is offering copies of its new 4-page illustrated brochure which gives details on its True R.M.S. Voltmeter Model 320-A.

The instrument, which is useful for measuring a wide range of waveforms, has a frequency range of 5 cps to 4 mc., a voltage range of 10 $\mu v.$ to 300 volts, and a basic accuracy of better than 2%.

Complete electrical specifications are included in the brochure.

INDICATOR LIGHT CATALOGUE

45 **Drake Manufacturing Company** has just issued its Catalogue 6302 covering an extensive line of indicator lights for a wide variety of industry applications.

Included in this listing are the new "Glo-Lites" for use in appliances and instruments, "MF" units with rectangular lenses for missile and electronic equipment use, as well as deluxe molded indicator lights. The firm's standard line is also covered thoroughly in this new catalogue.

COMPUTER-CONTROL SYSTEM DATA

46 **Bailey Meter Company** is offering a new 10-page illustrated brochure which describes the firm's Anticipator-Computer Control System. The new system anticipates possible variations in process end-point values and continuously computes the proper action required to maintain stability and improve productivity, product uniformity, and plant capacity.

The brochure illustrates this action through diagrams and case histories.

SUBMINIATURE TRIMMER POTS

47 **Weston Instruments & Electronics Division** is offering copies of a technical data sheet on the **Daystrom** 310 Series "Squaretrim" subminiature trimming potentiometers. With a range of 10 ohms to 65 kilohms, operating temperature range of −55 to + 175 degrees C. and power rating of 2 watts, these units can be used for the adjustment of computer, control, telemetering, missile, and other critical military and industrial electronic circuits.

In addition to actual-size photographs, the data sheet includes detailed electrical, mechanical, and environmental specifications.

GLASS-TO-METAL COMPONENTS

48 **Robert R. Orgain Co.** has issued a single-page data sheet describing its facilities and techniques for fusing glass to the various metals employed in miniature and subminiature electronic and instrument components.

The literature illustrates nine typical parts produced by the firm and denotes specifics so that industry can project its own needs more directly.

INDUSTRIAL TUBING

49 **Alpha Wire Corp.** is now offering a 20-page catalogue describing a complete line of "Alphlex" industrial tubing.

Catalogue AT63 features a 12-page section on shrinkable tubing products, complete data on a line of insulating tubing, and full descriptive data on polyvinyl-chloride, Teflon, zipper, and impregnated fiberglass tubings as well as lacing cord and shield tape.

SOLDERING-IRON DATA

50 **Hexacon Electric Co.** has issued a single-page data sheet showing its line of soldering irons for microminiature soldering. Detailed specifications and construction are described on the front page, including a full-size illustration of the product, with dimensions.

On the reverse side the soldering kit with spare tips and cleaning sponge is shown along with sketches of fifteen different long-life iron-coated tips with dimensions.

INDUSTRIAL-SWITCH CATALOGUE

51 **Switchcraft, Inc.** has issued an 8-page, 2-color catalogue covering its line of stack-switch components and assemblies for industrial electronic applications.

Catalogue S-308 features general-purpose stack switches and stack-switch components for computers, telephone relays, microminiature switching, and various other control devices. A complete list of stack-switch components kits is also included.

BATTERY REPRINTS

52 **Sonotone Corporation** has made available illustrated reprints of a technical paper on sintered-plate nickel-cadmium battery cells, originally presented at a technical symposium by two of the company's engineers.

The 12-page reprint shows detailed cross-section views, physical and electrical characteristics, and operational curves on the firm's nickel-cadmium battery cells. The publication is designated BA-112.

METER CATALOGUE

53 **Honeywell Precision Meter Division** has issued a 16-page catalogue, No. 35, illustrating the firm's complete line of meters available through authorized distributors and listing the

PHOTO CREDITS

Page	Credit
14	H. H. Scott Inc.
16	Acoustic Research, Inc.
22, 24	Raytheon Co.
32 (top left)	Mastercraft Medical & Industrial Corp.
32 (top right)	Machlett Laboratories
32 (bottom)	Sperry Rand Corp.
33 (top left)	Radio Corporation of America
33 (center right)	Bendix Corp.
33 (bottom right)	Westinghouse Electric Corp.
37	Tung-Sol Electric Inc.
42, 43 (Fig. 5)	Corning Glass
43 (Fig. 2)	Cornell-Dubilier
43 (Fig. 3), 44 (top)	Erie Resistor Corp.
44 (bottom)	P. R. Mallory & Co., Inc.

MOVING?

ATTACH LABEL HERE

If you've recently changed your address or plan to in the near future, be sure to notify us at once. Place magazine address label here and print your new address below.

NEW ADDRESS:

NAME ____________________
PLEASE PRINT

ADDRESS ____________________

CITY __________ ZONE ____ STATE __________

MAIL COPIES TO NEW ADDRESS STARTING WITH __________ ISSUE.

If you have any other questions about your subscription be sure to include your magazine address label when writing us.

Mail to: ELECTRONICS WORLD, 434 So. Wabash Avenue, Chicago 5, Illinois

specifications, dimensions, and prices for each product.

The catalogue contains easy-to-read selection tables which show types of meters available by model number, ranges, and resistance for each meter size. All models are illustrated and detailed drawings indicate dimensions.

DISTRIBUTION-SYSTEM MANUAL

54 **The Winegard Company** is now offering two new instruction aids for service dealers who are interested in installing home and master antenna systems.

A 16-page manual provides easy-to-understand information on laying out and installing both large and small antenna systems and includes methods for figuring system losses, the proper equipment to use for various types of installations, guide charts, typical systems, a glossary of common terminology and other useful aids.

PRODUCTS AND FACILITIES

55 **Litton Industries'** Electron Tube Division has issued a new 36-page illustrated summary of products and review of capabilities. More than 60 new products are included in the quick-reference catalogue. Complete specifications and photographs are given for unclassified magnetrons, klystrons, travelling-wave tubes, millimeter wave tubes, beam switching tubes, crossed-field amplifiers, CRT's, fibre optic tubes, power supplies, and tube-related equipment.

PHOTOCONDUCTIVE CELLS

56 **Clairex Corporation** has prepared a 16-page reference manual covering the use of photoconductive cells under various light, circuit, and application conditions.

Special illustrated sections are devoted to light measurement; tabulated characteristics of almost 50 standard types of cells; graphical presentations of spectral response, resistance, and other parameters; a discussion of fields of application including typical circuits; special cell configurations; and a history of the photocell.

TWO-WAY ANTENNA CATALOGUE

57 **Andrew Corporation** is now offering copies of its 16-page "Fixed Station Antenna Catalog" for mobile radio users.

Catalogue F lists 26 antennas, foam "Heliax" cables, connectors, and mounts applicable to base-station installations. Detailed electrical and mechanical specifications are listed for all units. The publication keys individual antennas to recommended mounts, cables, and connectors.

DIRECTIONAL-COUPLER DATA

58 **Microlab** is offering copies of its 11-page illustrated brochure describing quarter-wavelength and resistive-loop directional couplers for monitoring separately the incident or reflected wave on a transmission line.

The brochure describes directional couplers in general and then provides details on specific models and applications. ▲

(Answer to Puzzle on page 68)

B	I	A	S		D	E	L	A	Y		D	I	A	L
A	L	L	O	Y		A		L		A	U	D	I	O
S	L	I	D	E		R	F	E		U	S	E	R	S
E		G	I	L	L	S		C	A	R	T	A		S
		N	U	L	L				T	O	E	S		
P	C		M	O	O	D		S	T	U	D		D	B
O	H	M		W	Y	E		Y	E	S		S	O	L
L	O	A	D		D	A	R	N	S		D	E	C	I
A	S		F		S	N		C	T		C		T	N
R	E	D		U		S	O	S		S		S	O	D
	S	E	N	S	E		R		W	I	R	E	R	
G		L	E	A	D	S		B	A	S	E	D		S
A	N	T	E	N	N	A		F	R	T		A	R	T
I		A		C	A	T	H	O	D	E		N		E
N	F		R	E	S		F		S	R	O		T	P

APN-12 3-INCH SCOPE

Has vertical and horizontal sweep with focus and intensity controls, coaxial antenna changeover motor. Complete with 11 tubes and 3JP1 CR Tube. For 115 V. 400 cycle AC and 24 V DC. Circuit diagram included. **LIKE NEW** **$14.95**

LM FREQUENCY METER

Crystal calibrated modulated. Heterodyne. 125 Kc to 20,000 Kc With Calibration book **Complete, Like New** **$58.50**

BC-906 FREQ. METER—SPECIAL

Cavity type 145 to 235 Mc. Complete with antenna. Manual and original calibration charts included. **BRAND NEW. OUR LOW PRICE** . . . **$12.88**

BC-221 FREQUENCY METER

SPECIAL BUY! This excellent frequency standard is equipped with original calibration charts, and has ranges from 125 Kc to 20,000 Kc with crystal check points in all ranges. Excel. Used with original Calibration Book, Crystal, and all tables—LIKE NEW!

Unmodulated . . . **$72.50** Modulated . . . **$129.50**

BC-221 1000 Kc Crystal Brand New.......... **$8.95**

TEST SET TS-175/U. Portable crystal controlled heterodyne type unit used in field testing of CW or MCW RF Transmitters and Signal Generators. Range 85 to 1000 Mc. Power requirements: 6V DC and 135 VDC. Exc. Cond........... **$269.50**

TS-170/ARN-5 TEST OSCILLATOR, portable, battery-operated, crystal controlled, for frequencies: 332.6 Mc., 338.6 Mc., and 335 Mc. Power input 1.5 VDC and 90 VDC. Less Batteries. Exc. Cond. **$22.50**

SCR-625 MINE DETECTOR

Complete portable outfit in original packing, with all accessories. Brand New **$27.50**

APR-1 Navy VHF-UHF radar search Receiver. 80 Mc to 950 Mc in 2 bands. **BRAND NEW** **$79.50**

TUNING UNITS for above: TN1, TN2, TN3, **in stock**

EE-8 FIELD PHONES

Talk as far as 17 miles! Dependable 2-way communication at low cost! Ideal for home, farm, field. Up to six phones can be used on one line. Each phone complete with ringer. Originally cost govt. $65.00 each.

Excellent Condition, checked out, perfect working order, complete with all parts. Each **$12.95**

MICROPHONES Checked Out, Perfect

Model	Description	EXC. USED	BRAND NEW
T-17D	Carbon Hand Mike	$4.45	$7.95
RS-38	Navy Type Carbon Hand Mike	3.95	5.75

HEADPHONES Checked Out, Perfect

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.49	$4.75
HS-33	Low Impedance	2.69	4.95
HS-30	Low Imp. (featherwt.)	.90	1.65
H-16/U	High Imp. (2 unts)	3.75	7.95

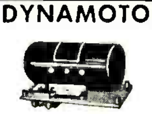
TELEPHONICS—600 ohm Low Impedance HEADSETS. BRAND NEW. PER PAIR **$3.95**

CD-307A Cords, with PL55 plug and JK26 Jack **.99**

Earphone Cushions for above—pair.......... **.50**

MOBILE-MARINE DYNAMOTOR

Model DM35



Input 12V DC. Output: 625 V DC @ 225 Ma, for press-to-talk intermittent operation. Shpg. wt. 14 lbs.

BRAND NEW **$14.95**

Type	Input	Output	Excellent Used	BRAND NEW
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A	575V .16A		
	28V 7A	540V .25A	2.95	4.45
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-36	28V 1.4A	220V .080A	1.95	2.95
DM-37	25.5V 9.2A	625V .225A	2.95	4.22
DM-43	28V 23A	925V .220A		
		460V .185A	—	14.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
PE-73C	28V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

(OTHER DYNAMOTOR VALUES)

DM-42A DYNAMOTOR. Input 12 V DC @ 39 Amps. Output 515 V DC @ 215 Ma. and 1030 V DC @ 260 Ma. Wt. 38 lbs. BRAND NEW, each **$6.95**

DM-37 DYNAMOTOR. Input 25.5 V DC @ 9.2 A. Output 625 V DC @ 225 Ma. BRAND NEW. Each **$3.25**

CARTER GENEMOTOR

INPUT: 5.9 V DC @ 32 Amps.
OUTPUT: 405 V DC @ .270 Amps.
BRAND NEW, special **$8.95**

INVERTER made by Bendix. INPUT: 24VDC @ 1 Amp., OUTPUT: 26 VAC 400 cycles @ 6 volt-amps. .4 power factor, single phase. Mounted on filter base. LIKE NEW **$3.25**

2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery. Model #20-2. 3" x 4" x 5½" high **$2.79**
1—2V. 7 prong Synchronous Plug-in Vibrator **1.49**
1—Quart Bottle Electrolyte (for 2 cells) **1.45**

ALL BRAND NEW! Combination Price **$5.45**

IMPORTERS—EXPORTERS of ELECTRONIC EQUIPMENT

We specialize in the export of military surplus electronic equipment:

- All at LOWEST PREVAILING PRICES.
- In addition to items shown on this page, we have in stock or can obtain for export customers, military electronic equipment make for World War II, Korean War, and later.
- **IF YOU DON'T SEE WHAT YOU WANT HERE, WRITE US YOUR NEEDS. LET US QUOTE ON ANY GOV'T SURPLUS ELECTRONIC EQUIPMENT YOU SEE ADVERTISED ANYWHERE. INQUIRIES WELCOMED.**
- All packing and shipping is made directly from our own warehouse in NYC to give you substantial savings in handling costs!

LORAN APN-4

FINE QUALITY NAVIGATIONAL EQUIPMENT

Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.

INDICATOR ID-6B/APN-4, and RECEIVER R-9B/APN-4, complete with tubes, Exc. Used, checked out, guaranteed to be in perfect working order **$79.50**

BRAND NEW, Checked Out **$99.50**

Receiver-Indicator as above, BRAND NEW **$88.50**

Shock Mount for above **$2.95**

INVERTER POWER SUPPLY for above APN-4. INPUT: 24 V DC @ 75 A. OUTPUT: 115 V AC @ 10.5 Amps, 800 cycles. Complete with two connecting plugs BRAND NEW **$49.50**

12-Volt Inverter Power Supply for above APN-4. Like New. P.U.R.

We carry a complete line of spare parts for above.

LORAN R-65/APN-9 RECEIVER & INDICATOR

Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. **Exc. used**, checked out, guaranteed perfect working order.... **$104.50**

Used, with all parts, less tubes, crystal and visor .... Special **$29.50**

INVERTER POWER SUPPLY for above APN-9. INPUT: 24 V DC. OUTPUT: 115 V AC. 800 cy. NEW **$49.50**

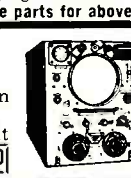
12-V. Power Supply for APN-9, like New P.U.R.

Shock Mount for above **$2.95**

Circuit diagram and connecting plugs available.

We carry a complete line of spare parts for above.

LORAN APN/4 OSCILLOSCOPE



Easily converted for use on radio-TV service bench.

LIKE NEW! Less tubes, but including 5" Scope, type 5CPI only **$14.50**

BENDIX DIRECTION FINDERS

For commercial navigation on boats.

MN26Y 150-325 Kc; 325-695 Kc; 3-4.7 Mc. Complete with tubes, dynamotor, BRAND NEW **$19.50**
MN28Y Receiver Control Box .... **$ 4.95**
MN26C Receiver 150-1500 Kc continuous tuning with 12 tubes and dynamotor, Used... **18.95**
MN26C Receiver as above, BRAND NEW **27.50**
MN20E Rotatable Loop for above............ **4.95**
MN52 Azimuth Control Box **2.95**

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc	12.45	17.95
BC-455	Receiver 6-9 Mc	11.50	13.95
1.5 to 3 Mc.	Receiver Brand New		$17.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions **$8.95**
Factory wired, tested, ready to operate. . **$12.50**

SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only **49c**

2.1 to 3 Mc. Transmitter, Brand New **$12.95**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal, BRAND NEW.. **$9.75**
Like New **$7.95**

BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal.
BRAND NEW **$10.95**
Like New **$7.95**

BC-696 TRANSMITTER 3-4 Mc Complete with All Tubes & Crystal. Like New **$11.95**

BC-456 Modulator .... **USED 3.45 NEW 5.95**

ALL ACCESSORIES AVAILABLE FOR ABOVE

SCHEMATIC DIAGRAMS For most equipment on this page, each.. **65c**

Please include 25% Deposit with order—Balance C.O.D., or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

G & G RADIO SUPPLY CO.

Telephone: CO 7-4605

77 Leonard St. New York 13, N. Y.

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc

$69.50 exc. used

Complete with Tubes

Famous Collins Autotune Aircraft Transmitter, AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price!

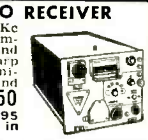
AN/ART-13 XMTR, as above, LIKE NEW, checked out, guaranteed to be in perfect working order **$119.00**

0-16 Low Freq. Osc. Coil for ART-13....... **7.95**
24V Dynamotor for ART-13.............. **11.95**

We carry a complete line of spare parts for above.

AN/APR-4 RECEIVER only. 38 to 4000 Mc in 5 tuning unit ranges. High precision lab instrument. Input 115 V60 cy. **Like New** **$79.50**
Tuning Units TN16, 17, 18 each **$39.50**
Tuning Unit TN19, **Brand New** **$89.50**
Tuning Unit TU54 .... **$149.50**

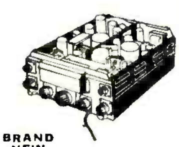
NAVY AIRCRAFT RADIO RECEIVER



ARB/CRV 46151—190 to 9050 Kc in 4 bands. 6 Tube Superhet communications receiver, with local and remote tuning, band change. Sharp and broad tuning, AVC, CW, Illuminated dial. Complete with tubes and dynamotor.
BRAND NEW **$49.50**
Pwr Supply 110 V. AC. Wired **14.95**
All Accessories for ARB Receiver in Stock

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC



BRAND NEW

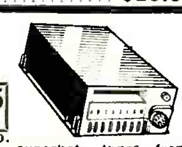
Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc, fixed and mobile 450-460 mc. television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.

Shipping weight 25 lbs. **SPECIAL!**.... **$19.50**

PE-101C Dynamotor, 12/24V input........... **$7.95**
UHF Antenna Assembly.................... **2.45**
Complete Set of 10 Plugs.................. **5.50**
Control Box **2.25**

SPECIAL "PACKAGE" OFFER:
BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW, While Stocks Last.................. **$29.50**

ARC-3 RECEIVER!



Complete with All Tubes Exc. Used **$19.95**

Like NEW .... **$29.50.**

Crystal-controlled 17-tube superhet, tunes from 100 to 156 MC., AM., on any 8 pre-selected channels. 28-volt DC power input. Tubes: 1-9002, 6-6AK5, 1-12SH7, 3-12SG7, 1-9001, 1-12H6, 2-12SN7, 1-12SL7, 1-12A6.

110 V A.C. Power Supply Kit for above 15.00
Factory Wired and Tested............ **19.95**

ARC-3 TRANSMITTER

Companion unit for above, tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used .... Only **$18.95**
Like new condition **$28.50**
ARC-3 PUSHBUTTON CONTROL BOX **$5.95**

APR-5A UHF RECEIVER

The APR-5A is a superhet receiver with 2 frequency ranges: (1) from 1000 to 3100 megacycles, (2) from 3000 to 6000 megacycles continuous by means of interchangeable mixers using a single dial tuning control. It has a 10 meg. I.F. band width of 30 megacycles center. Operates from 80-115 V. 1 phase, 60-2600 cycles. Variable I.F. gain by use of a pot. Use for frequencies above 1000 megacycles to supplement range of APR-4 receivers. Like New, with all tubes **$69.50**

ACCESSORIES for BC-603, 683 RECEIVERS

EXTRA SET OF 10 TUBES FOR ABOVE brand new in original boxes **$4.95**

12 or 24V Dynamotor for Above.
Exc. Used $4.25.............. Brand New **$5.50**

AC POWER SUPPLY FOR BC603, 683
Interchangeable, replaces dynamotor. Has On-Off Switch. NO RECVR. CHANGE NEEDED. Provides 220 VDC @ 80 Ma. 24VAC @ 2 Amps **$12.95**

Complete 240-page Technical Manual for BC-603, 604 .... **$3.15**

BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr. above. With all tubes. BRAND NEW **$8.95**

4-Section Antenna for BC-604, 684 Transmitters. Complete with mounting base. BRAND NEW. . **$4.95**

We carry a complete line of spare parts for above.

ARC-5/T-23 TRANSMITTER 100-150 Mc., includes tubes: 2-832A, 2-1625. BRAND NEW, with tubes **$21.50**
Excellent Used, less tubes.................. **$5.95**

ARC-5/R-28 RECEIVER, 2-meter superhet, 100 to 156 Mc in 4 crystal channels, complete with 10 tubes
Excellent Used, with tubes.................. **$23.50**

TG-5-B TELEGRAPH SET

Made for USA Army Signal Corps. A dandy little field set for 2-way communication. Sturdy metal container, 6¾"x4¾"x4", with hinged covers, complete with telegraph key and headset. BRAND NEW, in carrying case with shoulder strap **$9.95**

CIRCLE NO. 117 ON READER SERVICE PAGE

ELECTRONICS MARKET PLACE

RATE: 60¢ per word. Minimum 10 words. July issue closes May 5th. Send order and remittance to: ELECTRONICS WORLD, One Park Ave., N. Y. C. 16, N. Y.

ELECTRONICS ENGINEERING AND INSTRUCTION

USED Correspondence Courses and Books sold and rented. Money back guarantee. Catalog Free. (Courses Bought.) Lee Mountain, Pisgah, Alabama.

ELECTRONICS! Associate degree—29 months. Technicians, field engineers, specialists in communications, missiles, computers, radar, automation. Start February, September. Valparaiso Technical Institute, Dept. N, Valparaiso, Indiana.

FCC LICENSE in six weeks. First class radio telephone. Results guaranteed. Elkins Radio School, 2603C, Inwood, Dallas. Texas.

"DRAFTING, Reading Blueprints, Schematics. Send $2.00 first lesson, complete home course $25.00. Prior, Inc., 23-09 169 Street, Whitestone 57, New York."

ENGINEERING and Art Degrees earned through home study. Electronics, mechanical, liberal arts, major accounting. When writing specify course desired. Pacific International College of Arts & Sciences, primarily a correspondence school. Resident classes also available. 5719-C Santa Monica Blvd., Hollywood 38, California.

ELECTRONIC Explanations Superheterodyne Converter Description, Components Function, Servicing Procedure. $1.00. AJAN, Box 4154, Hamden 14, Conn.

FOR SALE

TV Tuners—Rebuilt or Exchanged $9.95 complete—all types—fast, guaranteed service. Send tuner with all parts to: L. A. Tuner Exchange, 4611 West Jefferson Blvd., Los Angeles 16, California.

OIL 4uf/600v 39¢; 5654, 69¢; others. Abramson, 3238 Eliot Blvd., Oceanside, N.Y.

SAVE Manufacturers Surplus Condensers popular values 25 for 1.25. 500 MA silicon Rectifiers 400 PIV 5 for 2.00. Controls 4 for 1.00 455 IF 2 for .99. Fonder Electronic Distributing Company, 11750 Frankstown, Pittsburgh 35, Pa.

CB transmitters $6.00. Other bargains, send 10¢ for list. Vanguard, 190-48 99th Ave., Hollis 23, N.Y.

FREE literature keeping you informed on the latest work-saving, money-making test equipment. Learn how Easy Budget Payment Plan lets you pay out of increased earnings. Top engineered test instruments are priced for tremendous value. Write today. Century Electronics, 352 Maple Ave., Westbury, N.Y.

DIAGRAMS for repairing radios $1.25. Television $2.50. Give make, model. Diagram Service, Box 672-E, Hartford 1, Conn

CANADIANS—Giant Surplus Bargain Packed Catalogs. Electronics, Hi-Fi, Shortwave. Amateur, Citizens Radio. Rush $1.00 (Refunded). ETCO. Dept. Z, 464 McGill, Montreal, Canada.

MILITARY Discount—Name Brands Free Recording Tape and Stereo Handbook. Include Rand and Serial Number. Electronics International, Inc., Box 3066, Charlottesville, Virginia.

Save dollars on radio, TV-tubes, parts at less than manufacturer's cost. 100% guaranteed. No rebrands, pulls. Request Bargain Bulletin. United Radio 1000-W, Newark, N.J.

TRANS-NITION electronic ignition. Negative ground kit $25.00, Positive $32.00. Coil, manual Special $8.50. Manual $2.00. Anderson Engineering, Wrentham, Massachusetts

ANALOG electronic computer heath, complete and operational. For simulating and solving problems, missle, aircraft, nuclear, automotive and other fields. Send inquiries to Box 86, West Trenton, N.J.

INTERESTED in new electronic musical instruments? Send for free copy of "MoogMusic" to R. A. Moog Co., Dept. I, Box 263, Ithaca, N.Y.

AUTOMATIC Telephone Answering machines, used, $150.00-$200.00. Slim's, 2025 Sunkist, Waukesha, Wisc.

CONVERT any television to sensitive, big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans, $2.00. Relco, Box 10563, Houston 18, Texas

NEW 301 Garrard Transcription Turntable $50. Rolyans Inc., Oakland, Maryland.

GOVERNMENT Surplus Receivers, Transmitters, Snooperscopes, Parabolic Reflectors, Picture Catalog 10¢. Meshna, Malden 48, Mass.

INVESTIGATORS, free brochure, latest subminiature electronic listening devices. Ace Electronics, 11500J NW 7th Ave., Miami 50, Florida.

TRANSISTORIZED Products importers catalog, $1.00. Intercontinental, CPO 1717, Tokyo, Japan.

TUBES

TUBES—TV, Radio, Transmitting And Industrial Types At Sensibly Low Prices. New, Guaranteed, 1st Quality, Top Name Brands Only. Write For Free Catalog or Call WAlker 5-7000, Barry Electronics Corp., 512 Broadway, New York 12N, N. Y.

BEFORE you buy receiving tubes, test equipment, Hi-fi components, kits, parts, etc. . . . send for your giant free Zalytron current catalog, featuring Standard brand tubes: RCA, GE, etc.—all brand new premium quality individually boxed, one year guarantee—all at biggest discounts in America! We serve professional servicemen, hobbyists, experimenters, engineers, technicians. Why pay more? Zalytron Tube Corp., 461 Jericho Turnpike, Mineola, N. Y.

FREE Catalog—name brand tubes 65% discount, phono needles 80% or more discount, phono cartridges, picture tubes 75¢ inch, parts, parts kits, silicon and selenium rectifiers, transmitting tubes, 7" T.V. test tube $6.99, imported batteries, tube testers etc. Want to swap or sell tube inventory? Send us your offering. Arcturus Electronics Corp., Dept. Z.D., 502 22nd St., Union City, N.J.

RADIO—T.V. Tubes Wholesale List. Lumar, Box 473, West Hartford 7, Conn.

WANTED

CASH Paid! Sell your surplus electronic tubes. Want unused, Clean radio and TV receiving, transmitting special purpose, Magnetrons, Klystrons, broadcast types. Want military and commercial lab test equipment such as G.R.H.P., AN/UPM prefix. Also want commercial Ham Receivers and Transmitters. For a Fair Deal write: Barry Electronics Corp., 512 Broadway, New York 12, N. Y. (Walker 5-7000).

QUICKSILVER, Platinum, Silver, Gold. Ores Analyzed. Free Circular. Mercury Terminal, Norwood, Massachusetts.

ARMY Sets or Parts—GRC—PRC—FRR/URR—TCC—SB—SCR—Send Listings—Quick Cash. Anker Electronics, 1617 So. Main St.. Box 26, Wilkes-Barre, Pa.

WANTED: Transistors, Tubes All Types, Test Equipment, Ground Equipment, PRC, GRC, TS, URM, UPM. Aircraft Communications & Navigation Equipment. Write Or Phone. V & H Radio, 2053 Venice, RE 50215, L.A. 6, Calif.

TAPE AND RECORDERS

TAPE Recorders, HI-FI Components. Sleep Learning Equipment. Tapes. Unusual Values. Free Catalog. Oressner, 1523 EW Jericho Turnpike, New Hyde Park 10, N.Y.

RENT Stereo Tapes—over 2,500 Different—all major labels—free catalog. Stereo-Parti, 811-G, Centinela Ave., Inglewood 3, California.

SELF-Hypnosis. New concept teaches you quickly by tape or LP-record. Free literature. McKinley Publishers, Dept. T6, Box 3038, San Bernardino, California.

SAVE 30% Stereo music on tape. Free bargain catalog/blank tape/recorders norelco speakers. Saxitone, 1776 Columbia Road. Washington. D.C.

4/TR Stereo Tapes—bought, sold, rented, traded! Bargain closeouts! Catalog/COLUMBIA, 9651 Foxbury, Rivera. California.

WELCOME to Global Tape Recording Exchange Hobby Club, 4518 N. 8th Place, Phoenix, Arizona, Members in 30 Nations.

HIGH-FIDELITY

PRICES? The Best! Factory-sealed Hi-Fi Components? Yes! Send for free catalog. Audion, 25T Oxford Road, Massapequa, N.Y.

DISGUSTED with "Hi" Hi-Fi Prices? Unusual Discounts On Your High Fidelity Requirements. Write. Key Electronics, 120 Liberty St., New York 6, N. Y. DI6-4191.

RECORDERS, Components! Free wholesale catalogue! Carston. 125-R, East 88, N.Y.C. 28.

LOW, LOW quotes: all components and recorders. Hi-Fi, Roslyn 9. Penna.

REPAIRS AND SERVICING

TV Tuners Rebuilt and Aligned per manufacturers specification. Only $9.50. Any Make UHF or VHF. We ship COD Ninety day written guarantee. Ship complete with tubes or write for free mailing kit and dealer brochure. JW Electronics, Box 51B, Bloomington, Indiana.

TV TUNERS rebuilt or exchanged, $9.95. Fast, guaranteed. Complete crystal alignment. Valley Tuners, 5641 Cahuenga, North Hollywood, Calif.

RECORDS

RARE 78's. State Category. Write Record-Lists, P.O. Box 2122, Riverside, Calif.

BOOKS

FIELD Engineering, where the money is. I toured Europe at no expense, you can too. No degree. My book tells all. How To Get Into Field Engineering. $1.00. J.N.C., Box 831, Westminster, Maryland.

GOVERNMENT SURPLUS

GOVERNMENT Surplus Direct From Government. Jeeps $264.00. Radios $2.53, Typical Prices. Guns, Typewriters, Cameras, Tools, Thousands More. Amazing Low Prices. How, Where To Purchase, Merchandise Available, Etc., Only $1.00 To: Surplus, P.O. Box 50512, Dept. R, New Orleans 50, Louisiana.

JEEPS—$223.83, Transmitters—$6.18, Typewriters—$4.15, Receivers—$5.65, Oscilloscopes, Multimeters, Speakers, Walkie-Talkies. Typical government surplus prices. Exciting details free. N.Y. Enterprises, Box 402-B3, Jamaica 30, New York.

NEW Electronic components. Discount prices. Catalog on request. JRB Surplus Sales Co., P.O. Box E, Pismo Beach, California.

BUSINESS OPPORTUNITIES

"ESTABLISHED 60-year-old business group is looking for a good small electronics business which needs our capital, credit, management, technical skill to realize its full growth potential; to operate in our area. Please write fully. Kents Electronics Division, 1214 Atlantic Blvd., Atlantic City, N.J."

ELECTRONIC Manufacturer, tax exempt, offers experienced production and/or engineering facilities for your product. Lower costs for your product. Milles Engineering, Las Marias, Puerto Rico.

SHOPPING GUIDE CLASSIFIED

A HANDY GUIDE TO PRODUCTS, NOT NECESSARILY ELECTRONIC, BUT OF WIDE GENERAL INTEREST.

PHOTOGRAPHY—FILM, EQUIPMENT, SERVICES

MEDICAL FILM—Adults only—"Childbirth," one reel, 8mm $7.50; 16mm $14.95. International W, Greenvale, L.I., New York

SCIENCE Bargains—Request Free Giant Catalog "CJ"—144 pages—Astronomical Telescopes, Microscopes, Lenses, Binoculars, Kits, Parts. War surplus bargains. Edmund Scientific Co., Barrington, New Jersey.

STAMPS AND COINS

TERRIFIC Stamp Bargain! Israel-Iceland-San Marino-plus triangle set—Plus Antigua-Borneo-Virgin-Scouts-Congo-Russia-Plus large stamp book—all four offers free—Send 10¢ for mailing cost. Empire Stamp Corporation, Dept. Z2, Toronto, Canada.

EDUCATIONAL OPPORTUNITIES

LEARN While Asleep, hypnotize with your recorder, phonograph. Astonishing details, sensational catalog free! Sleep-Learning Association, Box 24-ZD, Olympia, Washington.

LEARN while asleep. Remarkable, scientific. 92% effective. Details free. ASR Foundation, Box 7021, Dept. e.g., Lexington, Kentucky.

COLLEGE Home Study courses from leading universities. Full credit towards Bachelor's or Master's degree. 5,000-course directory $2.00. College Research, North Highlands, Calif.

HELP WANTED

EARN Extra money selling advertising book matches. Free Samples furnished. Matchcorp, Dept. MD-13, Chicago 32, Ill.

BUSINESS OPPORTUNITIES

I Made $40,000.00 Year by Mail Order! Helped others make money! Start with $10.00—Free Proof. Torrey, Box 3566-N, Oklahoma City 6, Oklahoma.

ASSEMBLE artificial lures at home for stores. Materials supplied free. Profitable! Write: Lures, Ft. Walton Beach 1, Florida.

$100 weekly possible. Complete mailing lists and address envelopes for advertisers. Home—spare time. Particulars free. National Service, 81, Knickerbocker Station, New York City.

MAKE $25-$50 week clipping newspaper items for publishers. Some clippings worth $5.00 each. Particulars free. National, 81, Knickerbocker Station, New York City.

MISCELLANEOUS

HYPNOTIZE Unnoticed, quickly, effortlessly, or refund! Thousands satisfied! $2, Timner, Box 244, Cedarburg, Wisc.

PUBLISH your book! Join our successful authors: publicity advertising promotion, beautiful books. All subjects invited. Send for free appraisal and detailed booklet. Carlton Press, (Dept. ZDQ) 84 Fifth Avenue, N.Y.C. 11.

INVESTIGATORS. Security Officers—Professional surveillance and alarm systems. Free literature. American Recording Company, Box 332, Springfield, Virginia.

AUTHORS! Learn how to have your book published, promoted, distributed. FREE booklet "ZD," Vantage, 120 West 31 St., New York 1.

ELECTRONICS WORLD MAY 1963
ADVERTISERS INDEX

Printed in U.S.A.

CIRCLE NO. 144 ON READER SERVICE PAGE →

BEST FOR YOU—
IT'S MOST VERSATILE

TRIPLETT

MODEL 850 ELECTRONIC VOLT-OHMMETER

USES UNLIMITED:
Field Engineers • Application Engineers • Electrical, Radio, TV, and Appliance Servicemen • Electrical Contractors • Factory Maintenance Men • Industrial Electronic Maintenance Technicians • Home Owners, Hobbyists

MODEL 850 $79.50

FACTS MAKE FEATURES:

1 Long 7″ easy-to-read scale.

2 .5 D.C. volt range for transistor circuits.

3 HIGH STABILITY. Meter connected in cathode circuit of 12 AU7.

High Input Impedance (11 MEGOHMS) and wide Frequency Ranges give this extremely versatile Electronic Volt-Ohmmeter considerable advantage in the measurement of DC voltages, AC RMS and Peak-to-Peak voltages. It measures directly the Peak-to-Peak values of high-frequency complex wave forms and RMS values of sine waves on separate scales. Exclusive Triplett BAR-RING instrument is fully self-shielded; high flux magnet and spring-backed jewels for ruggedness. Wired circuit.

ADDED PROTECTION. Meter is shorted out in OFF position for greater damping, meter safety during transit, electrically protected against accidental overload. ZERO CENTER mark for FM discriminator alignment, plus other galvanometer measurements.

New pencil thin test probe used for all functions: DC, AC, and ohms. No need to change cables. Beautifully styled case for professional appearance and functional utility, 7⅝″ x 6⁷⁄₁₆″ x 3¾″.

Carrying handle can be used as a tester stand to place the tester at 25° angle for ease in reading.

Frequencies to 250 MC may be measured with auxiliary Diode. Probe, **$7.50** extra. DC voltages to 50 KV may be measured with auxiliary High Voltage Probe. **$20.50** extra.

CARRYING CASE
Case 859—OP—Black leather Padded Carrying Case. **$19.50** Net

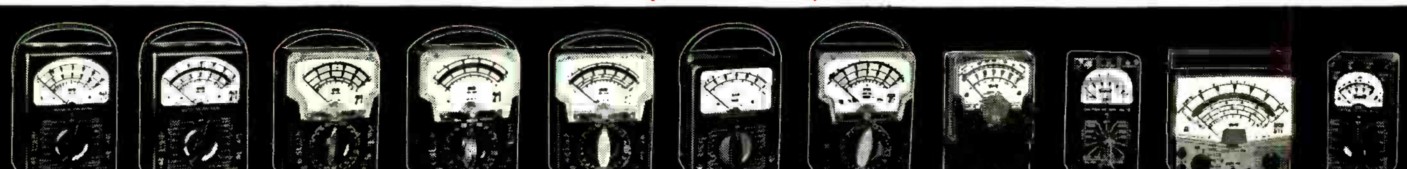
RANGES

8 DC VOLTS RANGES	0-.5-1.5-5-15-50-150-500-1500
7 AC RMS VOLTS RANGES	0-1.5-5-15-50-150-500-1500
7 PEAK-TO-PEAK VOLTS RANGES	0-4-14-40-140-400-1400-4000
7 RESISTANCE RANGES	0-1000-10,000-100,000 OHMS; 1-10-100-1000 MEGOHMS.

FREQUENCY RANGE 15 CPS to 3MC; (Up to 250 MC with accessory diode probe available extra.)

INPUT IMPEDANCE DC Volts 11 Megohms; AC Volts minimum of .83 Megohms.

TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO



630 | 630-A | 630-PL | 630-APL | 630-NA | 630-T | 631 | 310 | 666-HH | 800 | 666-R

THE WORLD'S MOST COMPLETE LINE OF V-O-Ms. AVAILABLE FROM YOUR TRIPLETT DISTRIBUTOR'S STOCK

NEW ADDED FEATURES—NEW LOW COST

The Famous RCA

SENIOR VOLTOHMYST®

NOW AVAILABLE AS A KIT FOR ONLY $57.95*


RCA WV-98C (K)
Senior VoltOhmyst Kit

Added features for extra versatility. An improved kit version of the famous RCA SENIOR VOLTOHMYST.

Most important new feature: a half-volt full-scale DC range for more accurate measuring of low voltages used in transistor circuits.

Extra plus feature: Pre-assembled, factory-tested DC/AC-OHMS probe (WG-299D) included with every kit.

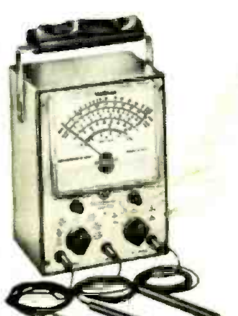
Other deluxe features:

- Big 6½" meter—one of the most readable ever designed into a VTVM—electronically protected against burnout
- Color-coded scales differentiate peak-to-peak and rms readings
- ±3% accuracy full-scale on both AC and DC measurements.
- Less than 1% tracking error
- Precision multiplier resistors accurate to ±1%
- Rugged die-cast aluminum case with leather handle
- Brushed aluminum control panel with etched markings

MEASURES:
- AC voltages (0.1 to 4200 volts peak-to-peak and 0.1 to 1500 volts rms)
- DC voltages (0.005 to 1500)
- Resistances (0.2 ohms to 1,000 megohms)

RCA Senior VoltOhmyst WV-98C, also available factory-wired and calibrated, $79.50*

OTHER OUTSTANDING RCA KIT VALUES



RCA VOLTOHMYST® KIT WV-77E(K)

Only $29.95*

Famous VoltOhmyst® quality and performance at a low price! Special test features include: separate 1.5-volt rms and 4-volt peak-to-peak scales for accurate low AC measurements. Measures AC and DC voltages to 1500 volts, resistances from 0.2 ohm to 1,000 megohms. Complete with ultra-slim probes, long flexible leads, special holder on handle to store leads.

RCA WV-77E available factory-wired and calibrated: $43.95*

RCA WV-38A(K) VOLT-OHM-MILLIAMMETER KIT

Only $29.95*

The V-O-M with the extras! • 0.25-volt and 1.0-volt DC ranges • Big easy-to-read 5¼" meter • Non-breakable sealed plastic case—no glass to crack or shatter • Jacks located below switches to keep leads out of the way • Spring clips on handle to hold leads • Attractive, scuff resistant, rugged carrying case, only $4.95* extra.

RCA WV-38A available factory-wired and calibrated: $43.95*

RCA SUPER-PORTABLE OSCILLOSCOPE KIT WO-33A(K)

Only $79.95*

Now in kit form. A 'scope you can carry anywhere! Rugged and compact, yet weighs only 14 pounds. Just right for in-the-home and shop troubleshooting and servicing of black-and-white and color TV, radio, hi-fi components, tape recorders, etc. Ample gain and bandwidth for the toughest jobs. Scaled graph screen and internal calibrating voltage source for direct reading of peak-to-peak voltage.

RCA WO-33A available factory-wired and calibrated: $129.95*

Call your Authorized RCA Test Equipment Distributor

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

RCA®

The Most Trusted Name in Electronics

*User Price (Optional)