KLIPSCH • BASS REPRODUCTION • VILLCHUR

OCTOBER 1957

Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

How to Improve Record Tracking

•

Understanding Flyback Systems

•

Control Unit–Preamplifier

•

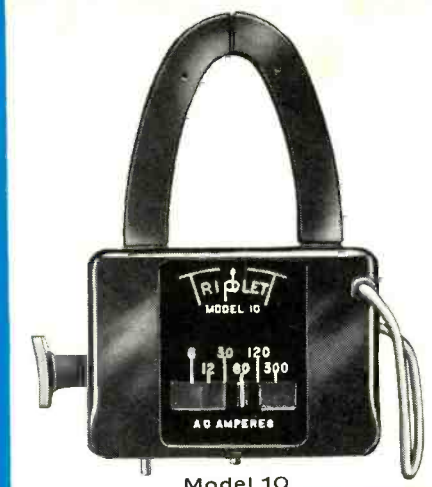
The Cardmatic Tube Tester

•

Audio Service As a Business

(See page 43)

35c
U.S. and Canada

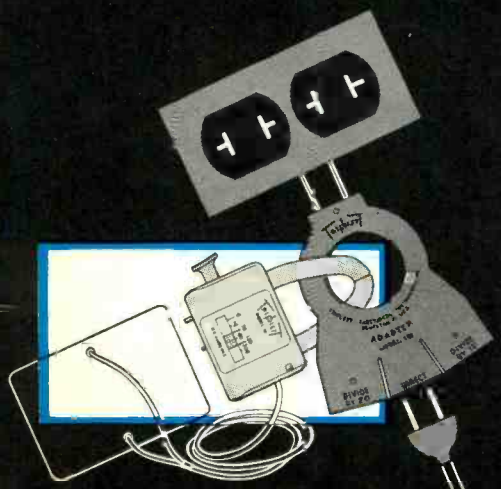


Model 10

Here is a real value—much more value than in any other clamp-on ammeter. Remember, In Triplett Model 100 you get not only a clamp-on ammeter but a genuine Triplett complete Volt-Ohm-Milliammeter with which you can measure AC volts, DC volts, AC and DC current, and Ohms.

BURTON BROWNE ADVERTISING

triple news from triplett



1st news: Triplett Model 10 Clamp-On Adapter

Just plug into any Triplett Model 310 Miniature VOM it becomes an AC clamp-on ammeter to measure AC amperes without cutting or opening current carrying wires. The split transformer yoke opens at the touch of a lever to fit around a single conductor or bus-bar for direct readings of AC amperes from 6 to 300 in 6 steps. Model 10 $14.50 net.

The Model 10 can be separated from the Model 310 as shown in the drawing at left by No. 311 lead attachment. This permits readings in difficult locations. No. 311 leads $1.90 net.

2nd news: Triplett Model 101 Line Separator

Serves to plug in at outlet to divide 2 conductor cords for clamp-on measuring. Makes accurate, rapid-testing of radio and TV sets, phonographs, appliances, motors, etc. possible without opening or splitting double conductors. Also serves to increase ammeter sensitivity 10X and 20X, if desirable, for easier reading. Model 101 $5.50 net.

3rd news: All four parts are available conveniently packaged in one handy, durable, high-quality carrying case. This complete package is known as Triplett Model 100 and is priced at $61.90 net.

Model 100 consists of Model 310 VOM, Model 10 Clamp-On Adapter, Model 101 Line Separator, No. 311 leads and carrying case with provision for all parts.

TRIPLETT

Triplett Electrical Instrument Company
Bluffton, Ohio

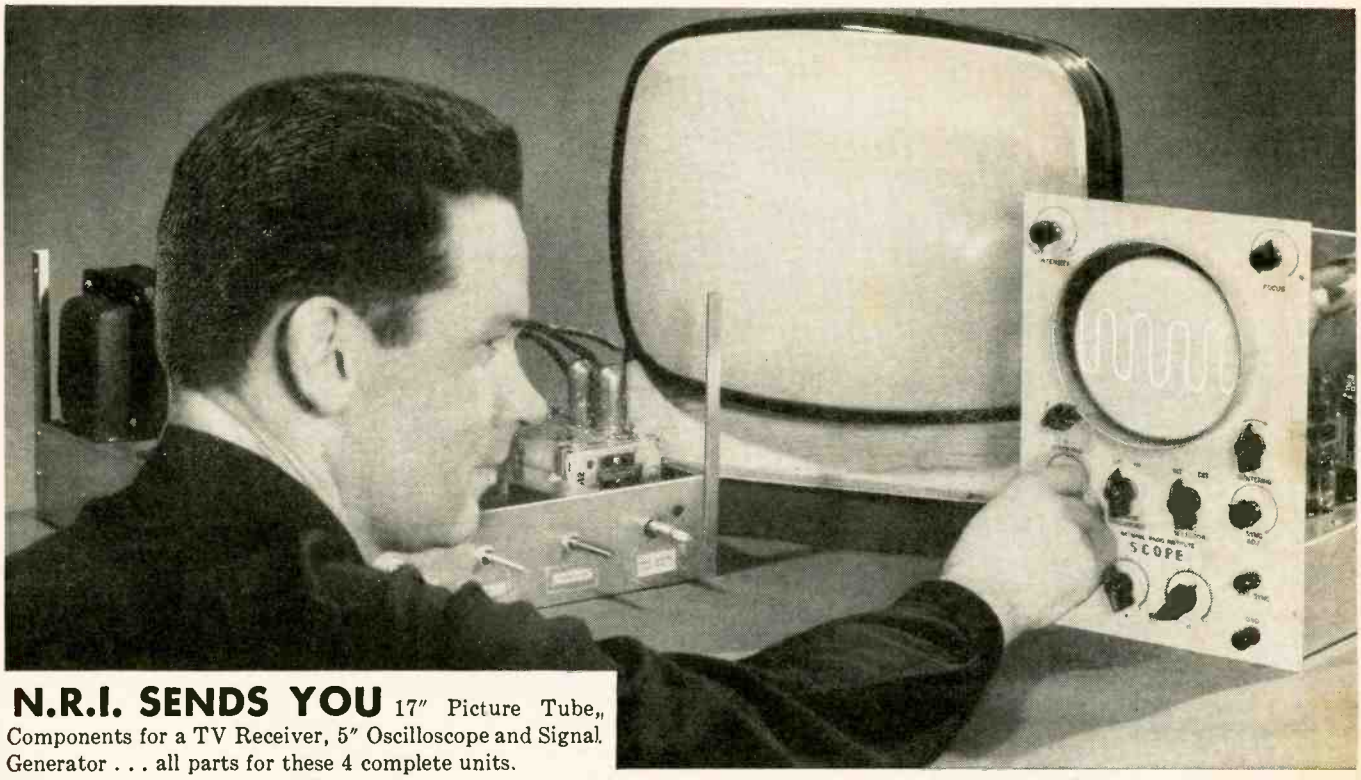
53 years of experience

In addition, to use with the Model 310, the Model 10 Adapter also can be used as a Clamp-On Ammeter with any Volt-Ohm-Milliammeter having a 3 AC volt scale at 5000 Ohms per volt such as Triplett Models 630, 630-A, 630-NA, 631, etc., by employing Triplett No. 611 leads, $1.90 net.

Triplett Model 100 gives you the world's most flexible test equipment for all electrical and electronic applications.


631 630-NA 630 630-A 310 630-T 666-HH 625-NA 666-R

Learn to be a PROFESSIONAL TV Technician AT HOME



N.R.I. SENDS YOU 17" Picture Tube, Components for a TV Receiver, 5" Oscilloscope and Signal Generator . . . all parts for these 4 complete units.

N.R.I. All-Practice Method Trains You in Spare Time to Fix TV Sets Quickly, Correctly, with Confidence

How many times have you day-dreamed of being your own boss? Or thought about what you could do if you were the man who made the decisions. The man who knows the answers — the well trained Technician—enjoys the prestige, gets the better jobs, higher pay.

It's time to stop dreaming. Here is the learn-by-practice training that shows you the way to be the boss, to earn top pay. Television Servicing needs well trained men.

Yes, if you have a basic knowledge of radio and electronics you can make *some* Television repairs *some* of the time. You can make some simply by trial and error. But sooner or later you will face Television Service problems you cannot solve. All the diagrams in the world won't help you then. And you can't get the training you need while customers wait.

NRI Is Oldest and Largest Home Study Radio-TV School

Forty years experience, and the record and reputation of NRI, back up this learn-by-doing Professional TV Servicing course. Instead of reading about TV problems, you build and conduct experiments on circuits in a TV receiver. Because you learn methods, "tricks of the trade" used and proved by top TV Servicemen, you recognize and repair defects quickly and accurately. Learn to fix any set . . . any make, any model . . . with confidence. Earn a Diploma that certifies to your training.

Television is Forging Ahead with More Sets, More Color, Hi-Fi

TV Servicing has only started to grow in importance. New sets, portables, color TV, constant changes, improvements make this a genuine "gold rush" for the man who is trained and ready. Know . . . so you can get ahead. Learning how to build and use a professional-type 5" Oscilloscope is part of the practice you get in this NRI All-Practice Training. Installing front-end channel selector strips, distinguishing between faulty blocking oscillator or a defect in the sync circuit, etc., are just a few of the important TV Servicing facts you learn through practice.

Not for beginners

Here is a course for men who know basic theory, either from Radio or TV Servicing experience or planned training, but realize the need for more knowledge to be able to forge ahead. Get details of this course now. Mail coupon today. Address: National Radio Institute, Dept. 7KFT, Washington 16, D.C.

Send for FREE BOOK

NATIONAL RADIO INSTITUTE
Dept. 7KFT, Washington 16, D. C.

Please send FREE copy of "How to Reach the Top in TV Servicing." I understand no salesman will call.

Name..... Age.....

Address.....

City..... Zone..... State.....

ACCREDITED MEMBER NATIONAL HOME STUDY COUNC

OCTOBER, 1957

Radio-Electronics

Formerly RADIO CRAFT ■ Incorporating SHORT WAVE CRAFT ■ TELEVISION NEWS ■ RADIO & TELEVISION*

EDITORIAL

AUDIO—HIGH FIDELITY

ON THE COVER

(Story on page 43)

Tape-recorder repair in progress on a typical service bench at the Sigma Electric Co., New York City, specialists in repair of high-fidelity equipment.

Ansco color original by Tom Carew

TECHNICAL REPORTS

TEST INSTRUMENTS

ELECTRONICS

RADIO

TELEVISION

NEXT MONTH: HYBRID AND TRANSISTOR AUTO RADIOS • A TWIN-COUPLED HI-FI AMPLIFIER

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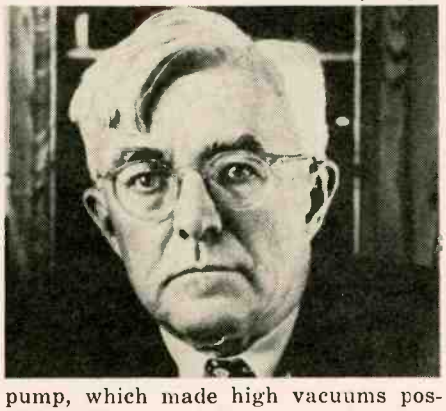
News Briefs

DR. IRVING LANGMUIR, one of America's great scientists, died Aug. 16, 1957. He was 76 years old. Dr. Langmuir was known best in the electronics field for his work on high-vacuum tubes and his invention of the mercury-vapor



pump, which made high vacuums possible. His specialty was, however, chemistry rather than electronics, and he taught chemistry at Stevens Institute of Technology until 1909, when he joined the staff of the General Electric research laboratory, where he remained until his retirement in 1950.

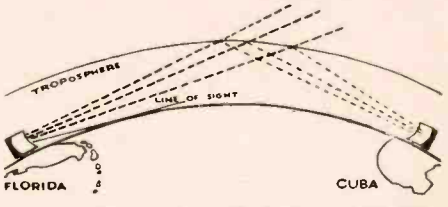
Early in his career at the laboratory, he developed the gas-filled lamp as an outgrowth of a "study of bad vacuums" on which he embarked, he said, because engineers were having trouble producing good vacuums. It was found that certain gases prolonged the life of the lamp rather than shortened it, and as a result it is said that he saved the American public nearly a billion dollars a year in electric-light bills.

His researches in oil films—which opened up the new field of two-dimensional or surface chemistry—made him the first American chemist to receive the Nobel Prize, which was awarded him in 1932. In later years his work—in connection with that of other G-E scientists — on artificial precipitation and cloud seeding may result in a measure of weather control which may ultimately prove more important than any of his other accomplishments.

Dr. Langmuir was a lifelong advocate of scientific investigation along the lines from which most knowledge could be gained, rather than with a particular application in view. He referred to this approach as the art of *serendipity*, which Webster defines as "the gift of finding valuable things not sought for," and stated of his work that "whatever has come in industrial applications has come incidentally from experiments followed for their interest alone."

Dr. Langmuir was a member of a large number of learned societies and received American and foreign awards and medals too numerous to list here. His wife, son Kenneth and daughter Barbara, all of Schenectady, N. Y., survive him.

OVER-THE-HORIZON communications link just completed between Florida and Cuba utilizes tropospheric scatter propagation for the 185-mile hop. The microwave beam (on the 692–880-mc band) is aimed slightly upward and portions of the signal scatter in the troposphere and are picked up by high-sensitivity receiving antennas. (See RADIO-ELECTRONICS, August, 1955, page



39, and September, 1956, page 37.) The Federal Telecommunications Laboratories' broad-band technique is used to provide a television path and 100 telephone channels. The Florida–Cuba link (both ends can send and receive) will be jointly operated by International Telephone & Telegraph and the American Telephone & Telegraph Co.

THREE-DIMENSIONAL COLOR TV system for remote servicing of reactors used in development of a nuclear aircraft propulsion system has been announced by General Electric. The closed-circuit system permits use of color-coded parts in reactor components and provides the degree of precise depth perception required for their correct positioning.

In use, the television camera is positioned inside the radioactive area. The camera is equipped with a dual optical system having a perspective similar to that of the observer's eyes. A rotating shutter in the special color TV camera alternately transmits the scene as viewed from the two points to the camera's tube. In the viewing console, light from the image formed on the cathode-ray tube passes through a drum composed of alternate segments of polarizing filters with axes of polarization at right angles to each other. This drum revolves in sync with the TV frame rate of the camera (90 per second) and polarizes alternate frames vertically and horizontally. Thus all left-eye pictures are polarized in one

(*Continued on page* 10)

Your Independent Service Advertising Program expands with your purchases of CBS tubes

One of a new series of full-page ads appearing in TV GUIDE

This family cook is your independent service-dealer. He's that busy neighbor who somehow finds time to be scoutmaster of his son's troop. He has his radio and TV service business in your town . . . and he knows he'll stay in business there only as long as he does superior work. In fact, when he works for you, he bets his family's bread and butter he'll do a better job . . . and he will.

for your radio and TV repairs, call the man who cares . . . your INDEPENDENT SERVICE-DEALER

He actually bets his family's bread and butter he'll do a better job for you . . . his business success depends upon it.

He is a highly skilled technician, trained and equipped to service promptly *all makes* of radio and TV sets at a fair price. So next time your radio or TV needs repairs, call the man who cares. Call your *independent* service-dealer.

Look for this emblem . . .

Whenever your set needs a new tube, ask to have it replaced with a CBS tube. There are no better tubes made.

For the best in entertainment tune to CBS.

©CBS-HYTRON, Danvers, Mass.
A Division of Columbia Broadcasting System, Inc.

We know you like your Independent Service Program and want it expanded. We know it from a nation-wide survey . . . and from your increasing purchases of CBS tubes. May we remind you: each time you buy CBS tubes, you support your own independent service-dealer campaign. Keep it going . . . keep it growing . . . always specify CBS tubes.

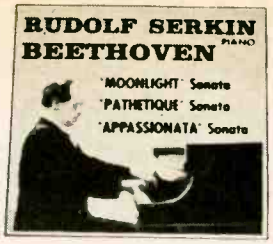
SUPPORTING MATERIAL ALSO EXPANDS

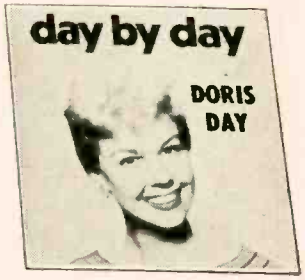
- "The Independent Service Business and Your Future" booklet
- Independent Service decal
- 10 new postal cards
- 16 new advertising mats
- Radio and television scripts
- Consumer booklet "On the Care of a Television Set"

Ask your CBS Tube distributor for this tie-in material . . . or write for illustrated broadside PA-181.

CBS-HYTRON—Danvers, Massachusetts
A Division of
Columbia Broadcasting System, Inc.

FOR THE BEST IN ENTERTAINMENT TUNE TO CBS





CHOOSE ANY 3 OF THESE HIGH-FIDELITY COLUMBIA (lp) RECORDS

FREE

when you join the Columbia (lp) Record Club—and agree to purchase 4 selections during the coming 12 months

YES! You may have, FREE, ANY 3 of these best-selling 12" Columbia (lp) records. We make this unique offer to introduce you to the money-saving program of the Columbia (lp) Record Club . . . a program that selects for you each month the greatest works in every field of music—performed by the world's finest artists, brilliantly reproduced on Columbia (lp) records.

HOW THE CLUB OPERATES: To enjoy the Club's benefits—mail the coupon, indicating which one of the four Club Divisions best suits your musical taste: Classical; Jazz; Listening and Dancing; Broadway, Movies, Television and Musical Comedies.

Each month you will receive free the Club Magazine which describes the current selections in all four Divisions. You may accept or reject the monthly selection for your Division . . . or you may take records from other Club Divisions . . . thereby assuring you the widest possible choice of recorded entertainment. Or you may tell us to send you NO record in any month.

Your only obligation is to purchase four selections from the more than 100 that will be offered during the next 12 months. The records you want are mailed and billed to you at only $3.98 (original cast Musical Shows somewhat higher), plus a small mailing charge.

FREE BONUS RECORDS GIVEN REGULARLY: The 3 records sent to you now represent an "advance" of the Club's bonus system — given to you at once. After you have fulfilled your membership obligation by purchasing four records, you will receive an additional free Bonus record of your choice for every two additional Club selections you accept. Bonus records are superb 12" Columbia (lp) records — the very best of the Columbia (lp) catalog — just like those shown here.

Indicate on the coupon which 3 records you want free, and the Division you prefer. Then mail the coupon at once. You must be delighted with membership or you may cancel it by returning the free records within 10 days.

COLUMBIA (lp) RECORD CLUB
Terre Haute, Indiana

®"Columbia" (lp), Marcas Reg.

FREE—ANY 3—VALUE UP TO $12.94—MAIL ENTIRE COUPON NOW!

COLUMBIA (lp) RECORD CLUB,
Dept. 237, Terre Haute, Ind.

Please send me as my FREE gift the 3 records indicated here: (Select the records you want by circling 3 numbers in the list at the right)

. . . and enroll me in the following Division of the Club:

(check one box only)

☐ Classical ☐ Listening and Dancing
☐ Broadway, Movies, Television and Musical Comedies ☐ Jazz

Each month you will send me the Columbia (lp) Record Club Magazine which describes the records offered in all four Club Divisions. I have the privilege of accepting the monthly selection in the Division checked above, or any other selection described, or none at all. My only obligation is to purchase four records in the next 12 months at the regular list price plus a small mailing charge. After accepting four records, I will receive a free Bonus record for every two additional records I purchase. If not delighted with membership, I may cancel within 10 days by returning all records.

Name.....
(Please Print)

Address.....

City.....Zone.....State.....

CANADA: Prices slightly higher. Address 11-13 Soho St., Toronto 2B 78

If you wish to have this membership credited to an established Columbia Records dealer authorized to accept subscriptions, please fill in the dealer's name and address:

Dealer's Name.....

Dealer's Address.....PA-1

CIRCLE THE NUMBERS OF THE 3 RECORDS YOU WANT

1. Beethoven: "Moonlight" Sonata; "Pathétique" Sonata; "Appassionata" Sonata Rudolf Serkin, piano.

2. The Voice Frank Sinatra in 12 songs that first made him famous — *Lover, Fools Rush In*, etc.

3. King of Swing: Vol. I Benny Goodman and Original Orch., Trio, Quartet. *Ridin' High. Moonglow* — 9 more.

4. My Fair Lady Original Broadway Cast recording with Rex Harrison and Julie Andrews. The complete score including *The Rain in Spain, I Could Have Danced All Night*—14 more.

5. The Great Melodies of Tchaikovsky Philadelphia Orch., Ormandy, conductor. 8 memorable selections.

6. Moonlight Becomes You Here's mood music in Hi-Fi — Paul Weston and his Music from Hollywood. 12 songs.

7. Ellington Uptown Duke Ellington and Orchestra perform *Skin Deep, The Mooche, Perdido* — 2 more.

8. Levant Plays Gershwin 3 works — *Rhapsody In Blue; Concerto in F; An American in Paris.*

9. Day By Day Doris Day sings 12 popular songs—including *The Song Is You, Autumn Leaves*, etc.

10. Rimsky-Korsakov: Scheherazade Philadelphia Orch., Ormandy, conductor. A superb performance of this exotic score.

11. Music of Jerome Kern Andre Kostelanetz and his Orchestra play 20 Kern favorites.

12. Concert by the Sea Erroll Garner in an actual jazz performance at Carmel, Calif. *Teach Me Tonight, Where or When, I'll Remember April* — 8 more.

direction and all right-eye pictures in the other.

An observer, wearing polarized glasses, sees the left optical path with his left eye and the right optical path with the right. The effective 45-frame-per-second rate gives him stereovision without an objectionable flicker.

The system is described as "currently not feasible for the American living-room" but is suited for adoption to other closed-circuit TV uses.

SIGNAL ENHANCEMENT, a technique which increases the effective power and range of radar in extremely large amounts, may give greatly increased protection against long-range guided missiles and bombers. Details are highly classified and all that has been released is that the discovery is a method of signal enhancement using frequency-modulation continuous-wave propagation. Announced by the United States Air Force and Columbia University, the new system does not increase the power used, but instead raises the strength of the reflected radar signal, compared to background noise received.

TWO NEW TV STATIONS began telecasting since our last issue:

WPST-TV, Miami, Fla.....10

KTVC, Ensign, Cimarron, Kans.....6

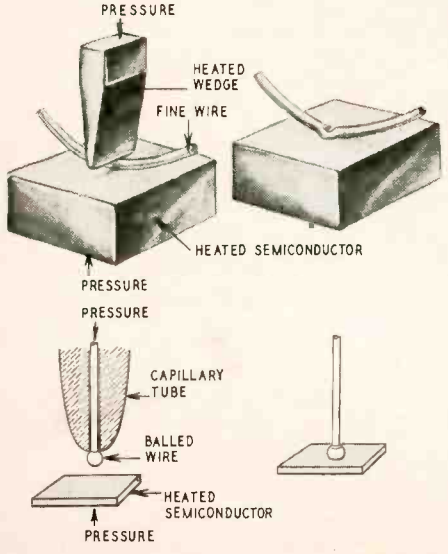
KVVG, Tulare–Fresno, Calif., Channel 27, has dropped out.

WUTV, Charlotte, N. C., channel 36, changed to its new call letters from WQMC.

We now have 503 operating U. S. stations (413 vhf and 90 uhf), 25 of which are noncommercial (6 uhf).

THERMO-COMPRESSION, a new technique for attaching leads to semiconductors, uses heat and pressure to form a bond between various soft metals and clean, single-crystal semiconductor surfaces. The bond formed by this process is stronger than the lead itself. Developed by Bell Telephone Laboratories, two methods of forming such a bond are shown in the diagram. One uses a heated wedge to press the wire lead against the heated semiconductor with sufficient

(Continued on page 14)



(Commercial)

FCC License Exams

your Guarantee of Success in Electronics

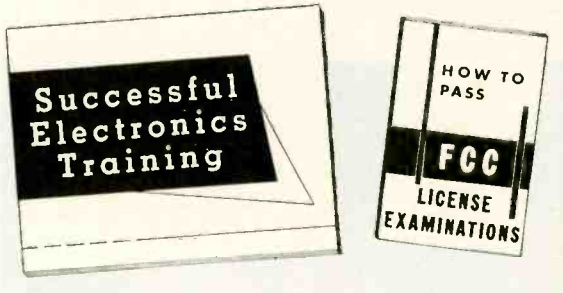
in a Minimum of Time

mail coupon NOW!

here's proof . . .

Name and Address	License	Time
Walter Eggers, Pacific Grove	1st	12 weeks
Paul Reichert, West Salem, Ohio	2nd	10 weeks
Harold Phipps, La Porte, Indiana	1st	28 weeks
John H. Johnson, Boise City, Okla.	2nd	12 weeks
James Faint, Johnstown, Pa.	1st	26 weeks

Get Both FREE



James Glen:

When Jim enrolled, he was a temporary employee of the City of Tacoma, Washington. In the space of 14 months, he completed the Master Course and received his first class license. He is now installing and maintaining mobile and microwave equipment.

James S. Glen, Jr.
2920 Knob Hill Road
Tacoma, Washington

To Cleveland Institute

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American Telephone & Telegraph Co.
Bendix Radio
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IBM
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Mohawk Airlines
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**Plus many others*

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Desk RE-10, 4900 Euclid Ave., Cleveland 3, Ohio

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- ☐ Military
- ☐ Radio-TV Servicing
- ☐ Manufacturing
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- ☐ Broadcasting
- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other .....

In what kind of work are you now engaged? .....

In what branch of Electronics are you interested? .....

Name ..... Age.....

Address .....

City ..... Zone..... State.....

Special Tuition Rates to Members of Armed Forces Desk RE-10

Sylvania TV Damper Tubes

...New design plus

New heater-cathode design helps Sylvania damper types pass this dynamic arc test with flying colors. Dynamic tests such as this have now been instituted by Sylvania on all important types in every critical TV function. It's Sylvania's way of helping you overcome problems which often make the difference between profit and loss and a happy or unhappy customer.

new dynamic tests produce high E.L.A.*

Sylvania damper tubes scored an **Earned Life Average* of 99.54% in a recent test of types in the 6AX4GT family. This means greater service reliability for you with an absolute minimum of trouble resulting from arcing, heater-cathode shorts and heater burnouts. It's the result of a new heater-cathode design introduced by Sylvania to meet your service needs.

Earned Life Average is an established method for evaluating tube life performance; for the service industry it serves as an index of protection against call-backs. These tests were performed in TV sets which simulated field service conditions where high line voltages are encountered.

109 Sylvania damper tubes performed for a total of 132,890 hours out of a possible 133,500 hours for an *Earned Life Average* of 99.54%.

To Sylvania this is satisfying evidence that the service industry has been provided with extra protection against the most common damper tube troubles. We think you'll agree too, that in the long run you'll profit more with Sylvania.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

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pressure to cause a slight deformation of the lead. Another useful connection is made by butting the balled (or headed) end of a wire against the heated semiconductor with a capillary tube. Temperatures of 200° to 300°C and pressures of 5,000 to 10,000 pounds per square inch are required by the process. These are not high enough to affect the electrical properties of the semiconductor material.

Calendar of Events

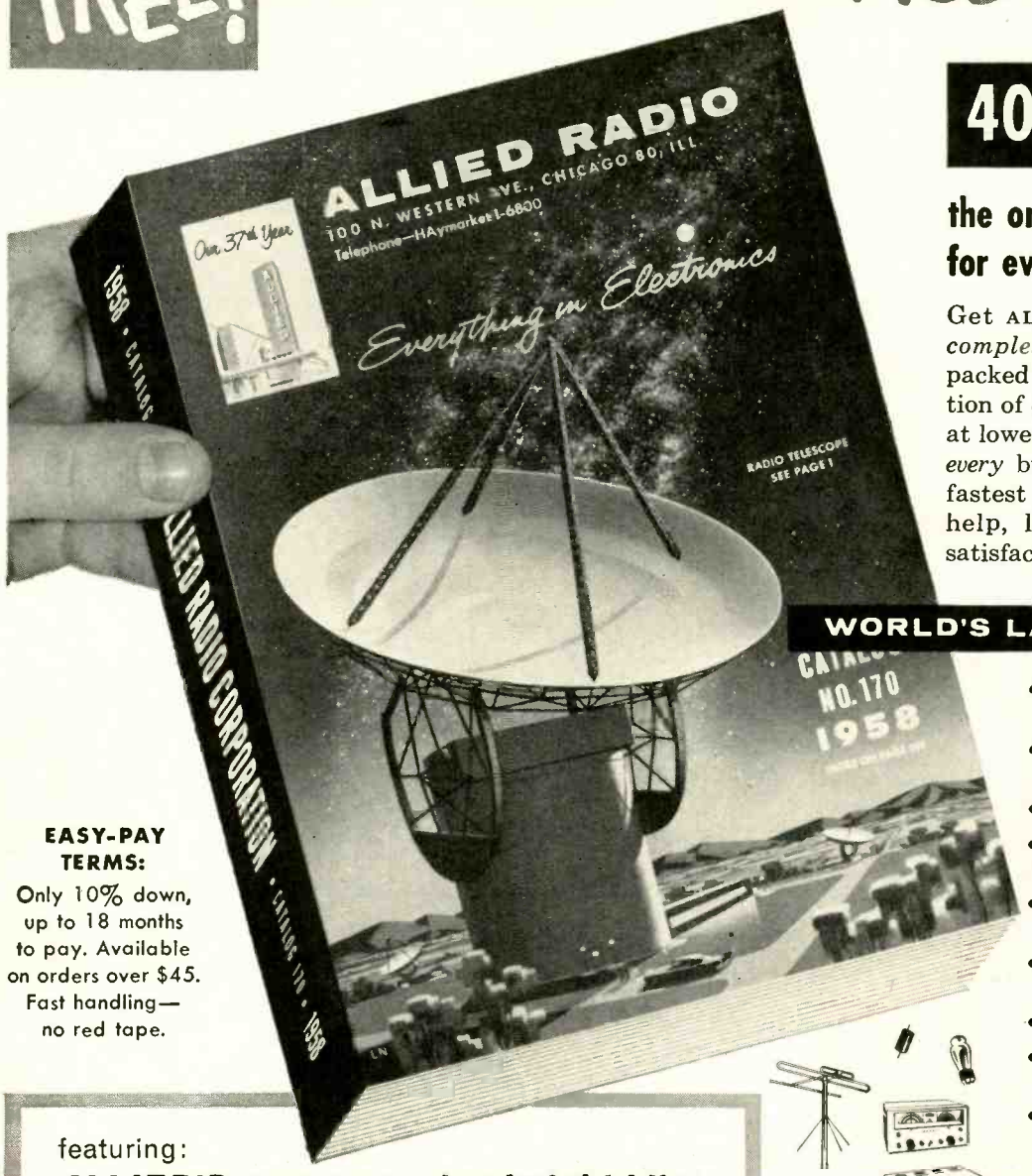
Society of Motion Picture & Television Engineers Convention, Oct. 6–11, Hotel Statler, New York.
National Electronics Conference, Oct. 7–9, Hotel Sherman, Chicago.
Fall General Meeting of American Institute of Electrical Engineers, Oct. 7–11, Morrison Hotel, Chicago.
New York High-Fidelity Show, Oct. 7–12, New York Trade Show Building, New York N. Y. (Annual Convention of the Audio Engineering Society will be held in conjunction with the show Oct. 9-12.) RADIO ELECTRONICS will exhibit in Room 526.)
Canadian IRE Show, Oct. 16–18, Automotive Building, Exhibition Park, Toronto, Ont., Canada.
New England High-Fidelity Music Show, Oct. 18–20, Hotel Touraine, Boston, Mass.
High Fidelity Show, Oct. 18–20, McAllister Hotel, Miami, Fla.
Ninth Regional NEDA Seminar, Oct. 20–22, Grossinger's Hotel, Grossinger, N. Y.
Fourth Annual Computer Applications Symposum, Oct. 24–25, Hotel Sherman, Chicago.
Fall Hi-Fi Festival, Oct. 26–27, Kansas Conservatory of Music, Kansas City, Mo.
Technical Conference of IRE Professional Group on Electron Devices, Oct. 31–Nov. 1, Shoreham Hotel, Washington, D. C.
High Fidelity Music Show, Nov. 1–3, Hotel Multnomah, Portland, Ore.
International Congress and Exhibition of Measuring Instrumentation and Automation (Interkama 1957), Nov. 2–10, Düsseldorf, Germany.
Puerto Rico Hi-Fi Show, Nov. 8-10 Normandie Hotel, San Juan, P. R.
High-Fidelity Music Show, Nov. 8–10, New Washington Hotel, Seattle, Wash.
Third Annual IRE Instrumentation Conference, Nov. 11–13, Biltmore Hotel, Atlanta, Ga.
EIA (RETMA) Radio Fall Meeting, Nov. 11–13, King Edward Hotel, Toronto, Canada.
New England Radio-Electronics Meeting, Nov. 15–16, Mechanics Hall, Boston, Mass.
High-Fidelity Music Show, Nov. 22-24, Statler Hotel, St. Louis, Mo.

RADAR MAP, which provides a plane's pilot with his exact position and true flight path has been designed by the Hycon Manufacturing Co. Fully automatic, the instrument makes a photographic record of radar information on a slow-moving strip of film. The film is then sent through a 10-second developer and is moved across a translucent illuminated plate for the pilot's inspection.

TV RECEIVERS IN EUROPE totaled 8.3 million, according to estimates made early this year. England leads with 6.6 million receivers. Germany, with 681,839, is second and France is third with 420,000. Italy has 360,000, Belgium 144,000 and Holland 99,000. At the bottom of the list is Finland with 2,500 receivers. By comparison, the United States has 44.5 million.

SYMPOSIUM on Industrial Electronics is being held at the Morrison Hotel, Chicago, Ill., on Sept. 24 and 25. The main theme of the symposium is the characteristics, use and integration of transducers into complete systems to measure and control processes from start to finish. END

FREE! ALLIED'S 1958 CATALOG



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Correspondence

HOT WORDS ON BOOSTERS

By telling a Radiological Safety Conference a few months ago that boosters used on aging picture tubes might convert them into sources of X-rays, Dr. James B. Kelley, a research consultant for the New York State Commerce Department started a mild radiation scare. He was reported to have said that he had personally seen TV sets "which had their anode voltages raised from the usual 15,000 to as high as 30,000 or 35,000 volts." (See "Radiation Scare," RADIO-ELECTRONICS, August 1957, page 6.)

It seemed inconceivable that any such set could exist but, after all, the doctor is an expert in his own field at least and would not be expected to circulate irresponsible statements. So we wrote to active individuals in a number of TV and electronic service associations, asking if either they or any of their members had ever seen TV's in which the anode voltage had been boosted as described.

Dear Editor:

It is true that a booster increases the filament voltage. However it *lowers* the high voltage. It does it this way: As a picture tube gets older it pulls less current and the high voltage, which is unregulated in the average set, goes up. If you put a booster on a set or replace the tube, the set draws more current from the high-voltage supply, which in turn lowers the high voltage.

FORREST L. BAKER
Texas Electronics Association
San Antonio, Tex.

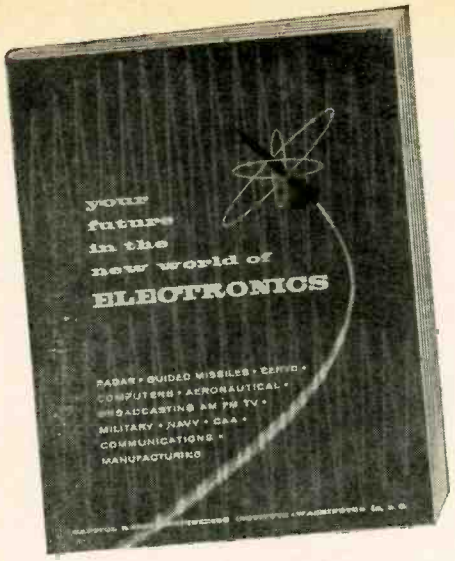
Dear Editor:

I am very puzzled by the comments of Dr. James B. Kelley who is cited as an "industrial consultant for the State Commerce Department" of New York. Either he is referring to some form of "booster" which I, in my 38 years experience in electronics, have never come in contact with or he is confused.

I have never seen one which raises the anode voltage. These devices generally operate on the principle of heating the cathode to a higher degree, thus allowing for more complete usage for the active cathode coating.

In my own service business we use boosters only as a last resort, to obtain the utmost in picture-tube life in hardship cases. We feel that the actual cost of a good picture tube per hour of use is so small as to make squeezing the last drop of highly unpredictable life hardly worth the effort. When a picture tube falls below proper operating level, it is time to buy a new one.

May I suggest that Dr. Kelly either prove his point by an actual demonstration of a standard booster, using standard TV chassis, high-voltage meters and Geiger counters, or cease



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Growing Peninsula Co. has openings for 1st class electronic technicians to work directly with engineering in development of new products. Only those with CREI or equal training and 3 years minimum commercial experience will be considered. Top salaries to qualified applicants. Call Mr. McQueeney, DA. 4-4733 for appointment.
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Industry Calls for CREI training By Name . . . SO SHOULD YOU!

Here you see an actual help wanted ad from the *San Francisco Examiner*, April 1, 1956, one of many which specify "CREI or equal" training. This shows that industry approves CREI training, even insists on it.

FILL OUT AND MAIL TODAY—BEFORE YOU FORGET IT!

CAPITOL RADIO ENGINEERING INSTITUTE
Dept. 1410-D, 3224 16th St., N.W., Washington 10, D.C.
ECPD Accredited Technical Institute Curricula - Founded 1927

Please send me your course outline and FREE Illustrated Booklet "Your Future in the New World of Electronics" . . . describing opportunities and CREI home study courses in Practical Electronic Engineering Technology **B**

CHECK FIELD OF GREATEST INTEREST
- ☐ Electronic Engineering Technology
- ☐ Broadcast (AM, FM, TV) Engineering Technology
- ☐ Aeronautical Electronic Engineering Technology
- ☐ Television Engineering Technology

Name..... Age.....

Street .....

City..... Zone..... State.....

CHECK: ☐ Home Study ☐ Residence School ☐ Veteran

To help us answer your request intelligently, please give the following information:

EMPLOYED BY.....

TYPE OF PRESENT WORK.....

SCHOOL BACKGROUND.....

ELECTRONICS EXPERIENCE.....

IN WHAT BRANCH OF ELECTRONICS ARE YOU MOST INTERESTED?

to attempt to alarm our customers. We have enough problems as it is.

FRANK J. MOCH
National Alliance of Television & Electronic Service Associations
Chicago, Ill.

Dear Editor:

While we were aware that using a TV filament booster causes no increase in anode voltage, a test was made by Warren Schei, our products director.

The results were "absolutely no increase in anode voltage."

To increase the normal 15,000 volts to 30,000 would necessitate a doubling of the horizontal output. This would almost immediately cause a voltage breakdown and shorting before the voltage could build up to that level. The commonly used rectifier tubes have maximum inverse voltages of from 16,000 to 21,000.

There is merit, however, to the dangers of X-ray radiation. The Minnesota Television Service Engineers, Inc., in cooperation with the University of Minnesota and Setchell-Carlson, Inc., are planning tests on radiation. The results should give us answers as to the amount of radiation and its dangers. If there were no dangers manufacturers would not need to include disclaimers in rectifier-tube cartons, on picture tubes or in service notes. If we must "live with it," what have we got? We hope to find out.

JOHN HEMAK
American Institute of Television Service
Minneapolis, Minn.

DR. KELLEY REPLIES

Dear Editor:

I am sorry that I was unable to answer your letter of July 1 sooner but I have been out of the country for some time and as a consequence have fallen behind on my mail.

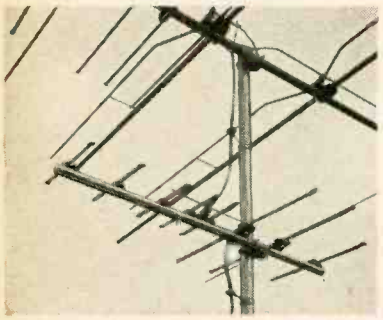
With regard to the question you raise concerning a report of research done on television boosters I should like to correct what is apparently a misunderstanding on your part. At a Radiological Safety Conference held from June 12 to June 14 at Canisius College in Buffalo, N. Y., I delivered a paper entitled "Basic Physical Principles of Ionizing Radiation." I did not discuss television in that paper. However, in an interview with a reporter for the *New York Times* which I gave after I had delivered my paper I mentioned the fact that I had seen television receivers that had had their voltages boosted to levels which were approximately those at which soft X-rays might be given off.

Since the term booster has a technical significance in the television repair business, there was some confusion over my use of the word boost in a generic rather than technical sense. My opinions are based on sets which I have seen which had very high voltages and also on the fact that color television sets will have substantially higher voltages than black-and-white receivers. What I said was in the nature

(Continued on page 22)

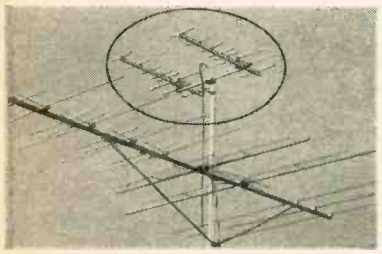
WHAT'S NEW FROM

Now...2 Ways to Add UHF to Your Fringe Area Color'ceptor



Here's something really new!

A UHF antenna (Winegard Mod. GG-1) that connects in series with the same lead used for the VHF Color-'ceptor. No couplers . . . no loss . . . no interaction. Perfect results every time! Can be oriented independently from CL-4 or CL-4X. Same general features as on GG-2 shown below. Completely gold anodized. **Only $7.95.**



New UHF Colinear Yagis Model GG-2 mounted with CL-4X Color'ceptor

High gain UHF antenna has 4 col. driven elements, 10 directors, 6 reflectors. Pin point directivity. No minor lobes. Flat frequency response. Can be stacked up to 16 bays for up to 21 db gain. Completely gold anodized. Can be ordered factory peaked to favor your channels. **Only $14.95.**

NEWS NOTE: Color'ceptor, the favorite fringe area antenna of professional installers everywhere, is now even better! —*NEW* TDM insulators. Low loss, unbreakable—*NEW* special alloy plus extra reinforcing used in reflectors. Four times more durable—*NEW* sunfast gold finish. Permanently anodized.

. . . NEW . . . SUPER *twilight**

FOR THE TWILIGHT* TV AREA

Biggest Advance Yet In Antenna Design!

Something new and wonderful has happened to antennas! Now you get the "whole ball of wax" . . . mast, lead-in, Antenna, mount . . . everything factory-assembled—factory-engineered into one simple, integral unit!

- **NO loose parts to assemble**
- **NO wires to strip**

Just take your Twilight out of the box . . . pop it open . . . put it up as easy as driving 3 nails . . . it's as simple as that!

Now you can make a complete installation (in most cases without even getting on the roof) in no more time than it takes to pull a TV chassis for repair! Twilight is so easy . . . it's a breeze to install.

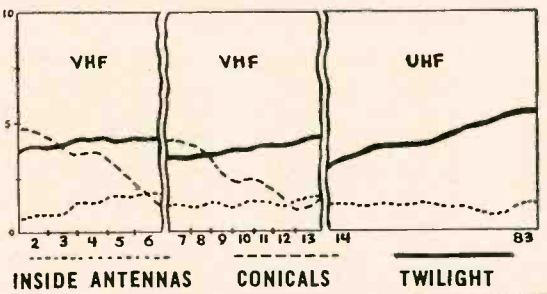
Engineered for results . . . styled to sell . . . as new and modern as today!

LOOK AT THESE ALL NEW *EXCLUSIVE* ENGINEERING INNOVATIONS

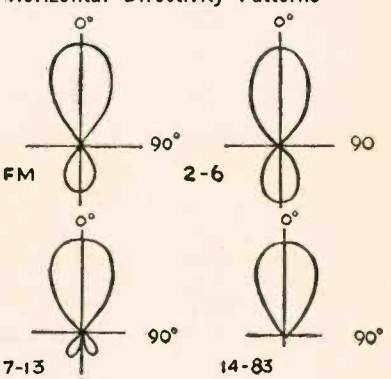
1. **UNIVERSAL MOUNT*** goes up in minutes . . . super-sturdy . . . eliminates ugly guy wires, chimney brackets . . . fits all surfaces, flat, sloping and vertical.
2. **SPECIAL DRIVE FASTENERS** go in like nails, hold like screws . . . special gaskets seal roof automatically.
3. **SNAP-OUT MAST CLAMP** . . . automatic, self-aligning. No tools.
4. **SERIES-FED UHF** new intermixed design. No loss, no interaction, one lead-in. Can't become obsolete. And at no extra cost!
5. **ELECTRO-LENS HIGH GAIN DIRECTOR SYSTEM** for ultra linear frequency response and no ghost-catching minor lobes on any channel.
6. **DUAL "T" MATCHED DRIVEN ELEMENTS** . . . end-fire phased. Accurate 300 ohm impedence match.
7. **PERMANENT NON-CORROSIVE ANODIZED FINISH** in Sunfast Gold, Twilight Blue or Starbrite Silver . . . looks better, sells faster . . . makes all other antennas look as old-fashioned and out-of-date as they really are.

SENSITIVITY COMPARISON CHART

Note extremely linear frequency response of Twilight



Horizontal Directivity Patterns



*Patent Pending

NEW PEEK-A-BOO PACKAGE

Makes beautiful display . . . lets customer see merchandise without opening carton . . . has complete sales story pitched to your customers on back of carton.

Winegard Co.

Winegard

COMPACT... POWERFUL!

Note:
50 ft. heavy 80-mil 300 ohm lead-in wire with set terminal clip.

WINEGARD TWILIGHT, MOD. TL-283

All Channels 2-83 plus FM Color or Black and White

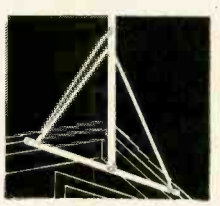
All aluminum construction . . . can't stain roof. The Twilight* installation includes: antenna with mast, lead-in wire and set terminal clip attached; universal mounting base with special drive fasteners, roof-sealing gaskets and stand-off insulators. Antenna width: 87"—Height including mount 53". Net wt.: 4½ lbs., Shpg. wt.: 6 lbs. Can be mailed parcel post.

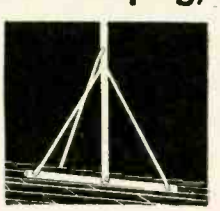
You can buy Twilight two ways: complete installation, Mod. TL-283, list $29.95; Twilight head only with standard mast clamp, Mod. 283, list $19.95.

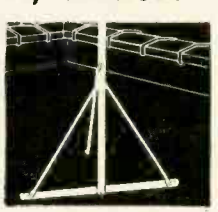
Absolutely Nothing Else To Buy

Twilight Mounts on ANY Surface—Sloping, Flat, Vertical

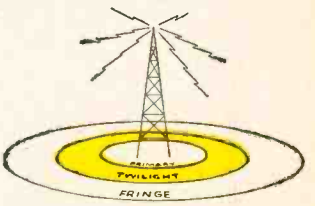

Side of roof


End of roof


Peak of roof


Flat or trailer

THIS IS THE TWILIGHT AREA



The "in-between" Twilight area (5 to 35 miles) presents reception problems all its own. Most set owners living within its boundaries have been enjoying neither the finest TV reception nor the poorest.

Because the Twilight area has many of the reception difficulties of both the fringe and primary areas, almost every type of antenna from rabbit ears to large arrays is used here. None of which were actually designed with the Twilight area's actual requirements in mind.

An extensive survey made by the Winegard Company in the Twilight areas of some of our larger cities brought to light these amazing facts:

- 42% of the TV owners were not really satisfied with their reception
- 72% of these dissatisfied TV viewers were using set-top antennas
- 53% didn't like antennas on top of their set
- 34% said set-top antennas were too difficult to adjust
- 49% thought outside antennas were too big and unsightly
- 34% thought outside antennas were too susceptible to corrosion-stained roofs . . . and were ruined by weather
- 49% of all set owners questioned were willing to spend up to $30.00 for a TV antenna that would overcome all these objections. 7% would spend up to $60.00

With the above information, Winegard engineers went to work to produce the first antenna designed specifically for the needs and wants of TV set owners in the Twilight area.

We call this new electronic masterpiece . . . appropriately enough . . . the Twilight!

SELL THE LINE THAT HELPS YOU SELL!

As Advertised in LIFE The Saturday Evening POST Better Homes & Gardens

List price established nationally in Life magazine at $29.95. Extra long discount structure so you can allow trade-ins or free installation if you wish . . . *and still make your normal profit.*

Mr. Dealer: See Your Winegard Distributor and Mail Coupon Today!

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- ☐ Complete information on Twilight plus sales aids.
- ☐ Other Winegard Do-It-Yourself antennas and kits as low as $14.95.
- ☐ Complete information on high powered Color'ceptor.

Dealer Firm Name.....

Address.....

City.....State.....

of a warning telling people to be careful, particularly where children are concerned, that they do not put their faces too close to the receiving set (I recommended a distance of 6 feet from the set). It is my feeling that so little is known about both the short- and long-range effects of radiation that, when one is dealing with any instrument potentially dangerous in this area, extreme caution is always advisable. It is a caution I use with my own children and a caution a great many of my colleagues also use.

I had been referring to an increase in the anode voltage and not the serviceman's low-power "booster," which, incidentally, I have on my own TV.

I do not know how widely special glasses are used on commercial television receivers. I do know that one of the large manufacturers of the glass envelopes uses barium glass on the face of the viewing tube. This, however, is something that has been developed only in the last several years. I understand from this same manufacturer that a barium lead glass will be used on the color glass envelopes he manufactures. The reason he gave me in both instances was that, while most information to date would seem to indicate that the radiation of a television viewing tube is quite low, he would rather be sure than make a dangerous mistake. The plate glass which is usually in front of the tube is of the same composition as that found in ordinary windows.

JAMES B. KELLEY

Consultant,
Technical Industrial Research

BASEMENT TECHNICIAN

Dear Editor:

I am a part-time "basement technician." So this is how I see things!

For one thing, I do not have the necessary capital—or name—to open up a nice successful full-time service business. Maybe I should go to work for some service company. Well, I admit I might not get the pay I'm enjoying from my present full-time job. And with five kids it's hard to take a cut.

You full-timers have many good arguments and I'm with you on them. The part-timer is inclined to be cut-rate. I'm one who isn't! In my locality I believe a service call should be about $5. They once were! Now it's $3.50.

I put in some 16 months at a full-time radio school (plus a little Navy training). I put a lot of cabbage into test equipment, other than screwdrivers and emission tube testers, so catch me at cut-rating and I'll eat it all.

One thing I would like to know. How many of you full-time boys were once part-timers?

About licensing, I'm for it! No license, no servicing. However, I'd want the license awarded on the basis of *technical knowledge* and *ability*.

All I ask is a fair chance to show I'm not an incompetent. If you have a "dog," I'd like to try myself against it.

LARRY SCHWARTZ

Canton, Ohio

END

LEARN ELECTRONICS! EARN MORE MONEY!

F.C.C. LICENSE—THE KEY TO BETTER JOBS

An F.C.C. *commercial* (not amateur) license is your ticket to higher pay and more interesting employment. This license is Federal Government evidence of your qualifications in electronics. Employers are eager to hire *licensed* technicians.

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Grantham School of Electronics *specializes* in preparing students to pass F.C.C. examinations. Correspondence training is conducted from Washington and Hollywood; resident DAY and EVENING classes are held in both cities. Either way, we train you quickly and well—NO previous training required. A beginner may qualify for his first class F.C.C. license in as little as 12 weeks.

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offers you complete preparation for F.C.C. examinations required for a *first class F.C.C. license*. Even though it is planned primarily as preparation for F.C.C. examinations, it is *not* a "cram course" but prepares you by TEACHING you electronics.

HERE'S PROOF that Grantham Students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Wks.
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Carl Deare, Jr., P.O. Box 467, Jeanerette, La.	1st	11
Robert Umthun, 1918 Eye St., NW, Washington, D.C.	1st	21
Tommy Lesley, 422 Wood St., Maysville, Ky.	1st	9
Dan Breece, Station KOVE, Lander, Wyo.	1st	12
Robert Todd, Station WWBG, Bowling Green, Ohio	1st	13
Jackson York, 1029 N. Quincy St., Arlington, Va.	1st	15
Paul Chuckray, 6874 Weber Rd., Affton, Mo.	1st	11

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To better serve our many students throughout the entire country, Grantham School of Electronics maintains two complete schools—one in Hollywood, California and one in Washington, D.C. Both schools offer the same rapid courses in F.C.C. license preparation, either home study or resident classes.

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Grantham Schools, Desk 74-R

821 - 19th Street N.W. Washington 6, D.C. **OR** 1505 N. Western Ave. Hollywood 27, Calif.

Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

Name _____ Age _____

Address _____

City _____ State _____

I am interested in: ☐ Home Study, ☐ Resident Classes

AR-22

TR-2

TR-4

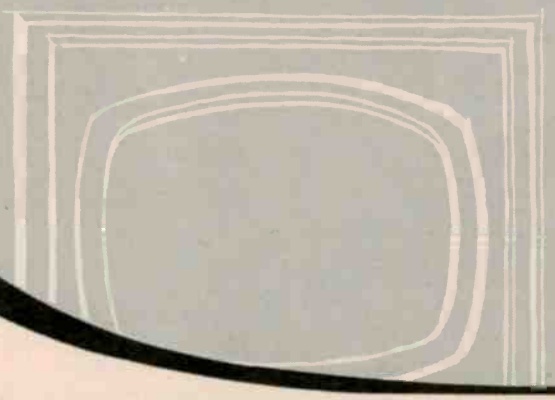
5-star feature...

1 the best color TV picture

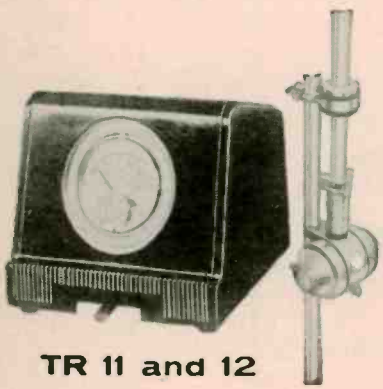
the growth of color TV means an even greater demand for CDR Rotors for pin-point accuracy of antenna direction.

2 a better picture on more stations

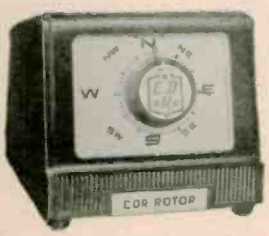
CDR Rotors add to the pleasure of TV viewing because they line up the antenna perfectly with the transmitted TV signal giving a BETTER picture . . . and making it possible to bring in MORE stations.



CDR ROTORS



TR 11 and 12



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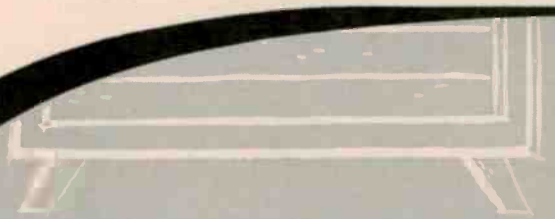


3 tested and proven dependable

thousands and thousands of CDR Rotors have proven their dependability over years of unfailing performance in installations everywhere in the nation. Quality and engineering you know you can count on.

4 pre-sold to your customers

the greatest coverage and concentration of full minute spot announcements on leading TV stations is working for YOU . . . pre-selling your customers.

5 the complete line

a model for every need . . . for every application. CDR Rotors make it possible for you to give your customer exactly what is needed . . . the right CDR Rotor for the right job.

CORNELL-DUBILIER
SOUTH PLAINFIELD, N. J.

THE RADIART CORP.
CLEVELAND 13, OHIO

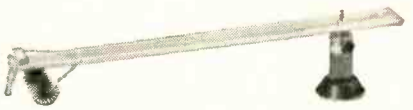
Removes all static and dust while record is played; new moving coil microphones and transistor amplifier

ESL DUST BUG

The automatic record cleaner

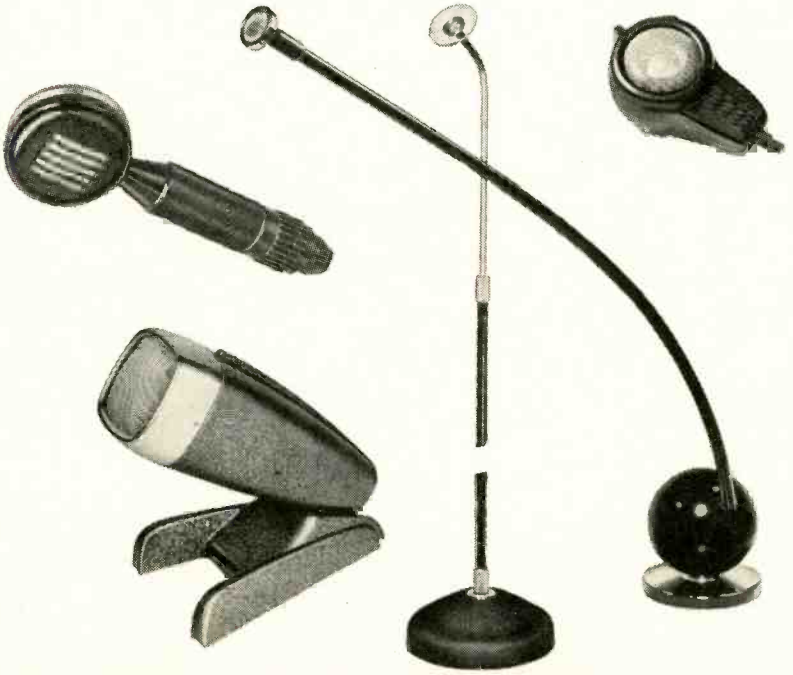
The problems of dust, lint, and static buildup on phonograph records and pickup styli have been solved by this ingenious new invention which cleans the record as it is being played. The plush pad is slightly moistened with special, harmless activating fluid supplied in a replaceable applicator. This helps to loosen groove dust and dirt, which is then collected by the pad. It also neutralizes the static charge present in all records. Every point on an LP record is cleaned by the wide pad approximately one hundred times during a single play.

ESL Dust Bug, complete with Dust Bug Fluid in applicator **$5.75**



ESL MOVING COIL MICROPHONES

Highest fidelity at moderate cost



Electro-Sonic Laboratories is pleased to announce a complete new line of superb moving coil microphones, microphone transformers, and miniature earphones. For every application—broadcasting, professional recording, home recording, dictating machine, and public address—there is a low impedance ESL microphone specifically designed to provide the highest quality of performance at sensible cost.

A brochure describing the entire line of ESL moving coil microphones and accessories is available free upon request.

ESL TRANSISTOR AMPLIFIER

Hum-free low impedance amplification

This hum-free, low-distortion amplifier can provide improved performance with moving coil microphones, for which it is a preamplifier, and with ESL electrodynamic cartridges, for which it is a pre-preamplifier. As its frequency response is flat and unequalized, it does not replace the conventional phono preamplifier. It permits use of greatly superior low-impedance microphones—such as the ESL—with medium-price tape recorders.

Voltage gain: *20-30 db (1:10-1:20 voltage step-up)* • Signal-to-noise ratio: *minus 50 db* Frequency response: *20-20,000 cps* ± ½ *db* • IM distortion: *1/10 of 1%* • Input impedance: *100 ohms* • Output impedance: *2,000 ohms* • Battery life: *1 year* • Hum level: *zero*

ESL-1A, complete with battery **$16.50**

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"I am now Studio Engineer at Television Station KATV. Before enrolling for the NRI Course, I was held back by limitation of a sixth grade education." BILLY SANCHEZ, Pine Bluff, Ark.

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"Since finishing NRI Course I have repaired more than 2,000 TV and Radio sets a year. NRI training certainly proved to be a good foundation." H. R. GORDON, Milledgeville, Ga.

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"Quite early in my training I started servicing sets. Now have completely equipped shop. My NRI training is the backbone of my progress." E. A. BREDA, Tacoma, Wash.

Have the High Pay, Prestige, Good Future of a Skilled TV-Radio Technician

People *look up to* and depend on the Technician, more than ever before. Offices, plants, homes everywhere are obliged to buy his knowledge and services. His opportunities are great and are increasing. Become a TV-Radio Technician. At home, and in your spare time, *you* can learn to do this interesting, satisfying work—qualify for important pay. To ambitious men everywhere *here* in the fast growing Television-Radio field is rich promise of fascinating jobs, satisfaction and prestige as well as increasing personal prosperity.

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A steady stream of new Electronic products is increasing the job and promotion opportunities for Television-Radio Technicians. Right now, a solid, proven field of opportunity for good pay is servicing the tens of millions of Television and Radio sets now in use. The hundreds of TV and Radio Stations on the air offer interesting jobs for Operators and Technicians.

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NRI students find it easy and profitable to start fixing sets for friends and neighbors a few months after enrolling. Picking up $10, $15 and more a week gives substantial extra spending money. Many who start in spare time soon build full time TV-Radio sales and service businesses.

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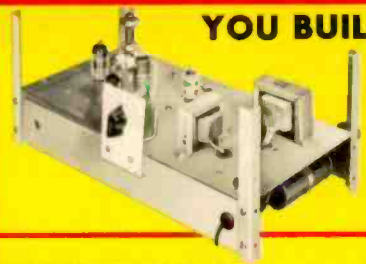

YOU BUILD Signal Generator

You build this Signal Generator. Learn how to compensate high frequency amplifiers, practice aligning typical I.F. amplifiers in receiver circuits. Make tests, conduct experiments.

YOU BUILD Broadcasting Transmitter

As part of NRI Communications Course you build this low power Transmitter, learn commercial broadcasting operators' methods, procedures. Train for your FCC Commercial Operator's License.

YOU BUILD Vacuum Tube Voltmeter

Use it to earn extra cash fixing neighbors' sets; bring to life theory you learn from NRI's easy-to-understand texts.

For Higher Pay, Better Jobs
Be a Television-Radio Technician

Servicing Needs More Trained Men

Portable TV, Hi-Fi, Transistor Radios, Color TV are making new demands for trained Technicians. Good opportunities for spare time earnings or a business of your own.

Broadcasting Offers Satisfying Careers

4000 TV and Radio stations offer interesting positions. Govt. Radio, Aviation, Police, Two-Way Communications are growing fields. Trained Radio-TV Operators have a bright future.

J. E. Smith, Founder

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NRI is America's oldest and largest home study Television-Radio school. The more than 40 years' experience training men for success, the outstanding record and reputation of this school—benefits you in many ways. NRI methods are tested, proven. Successful graduates are everywhere, from coast to coast, in small towns and big cities. You train in your own home, keep your present job while learning. Many successful NRI men did not finish high school. Let us send you an actual lesson, judge for yourself how easy it is to learn.

No Experience Necessary—NRI Sends Many Kits for Practical Experience

You don't have to know anything about electricity or Radio to understand and succeed with NRI Courses. Clearly written, well-illustrated NRI lessons teach TV-Radio-Electronic principles. You get NRI kits for actual experience. All equipment is yours to keep. You learn-by-doing. Mailing the postage-free card may be one of the most important acts of your life. Do it now. Reasonable tuition. Low monthly payments available. Address: NATIONAL RADIO INSTITUTE, Washington 16, D. C.

NRI Graduates Do Important Work

Now Quality Control Chief
"Had no other training in Radio before enrolling, obtained job working on TV amplifiers before finishing course. Now Quality Control Chief." T. R. Favaloro, Norwich, N. Y.

NRI Course Easy to Understand
"I opened my own shop before receiving my diploma. I have had to hire extra help. I am independent in my own business." D. P. Cressey, Stockton, Cal.

Works on Color-TV
"NRI changed my whole life. If I had not taken the course, probably would still be a fireman, struggling along. Now Control Supervisor at WRCA - TV." J. F. Meline, NewYork, N Y.

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how long would it take you to solve this service problem?

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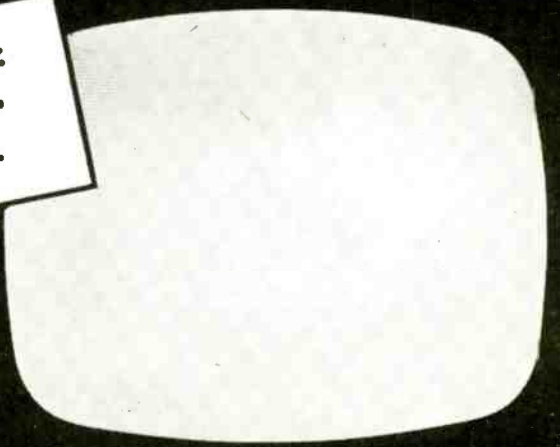
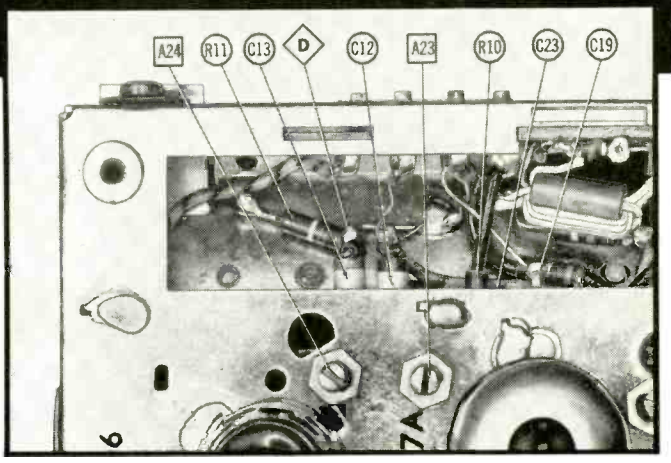


PHOTOFACT

helps you lick problems like this in just minutes for only *2½¢ per model!



(Based on an actual case history taken from the Howard W. Sams book "TV Servicing Guide")

Let's take a look at this problem: A condition such as this can exist only when there is no signal reaching the picture tube or the audio output stage. Using the Tuner Service data (found in every PHOTOFACT TV Folder), first isolate the trouble by connecting an amplitude-modulated signal to the mixer-grid test point "D." The appearance of one or more black bars on the face of the tube would indicate that the trouble is probably in the tuner. So look for the following possible causes:

1. Defective oscillator-mixer tube
2. Defective RF amplifier tube
3. Open plate-load resistor in the oscillator stage
4. Failure of the feedback capacitor in the oscillator stage
5. Open decoupling resistor
6. Dirty or faulty contacts
7. Cold solder joint

Using the applicable PHOTOFACT Folder you can trouble-shoot and solve this problem in minutes. Here's how:

Check the oscillator-mixer and RF amplifier tubes. Tubes okay?—then: Check voltages on the tube pins (they're right on the schematic) for open oscillator plate-load resistor, open RF decoupling resistor, faulty feedback capacitor, dirty switch contacts or cold solder joints.

Every PHOTOFACT Television Folder contains complete detailed information on Tuners, including separate Schematics, separate Keyed Chassis Photographs, Parts Lists, Alignment Points, Test Points, and Field Service Adjustments that will help you quickly locate the proper parts to replace and tell you how to do a touchup or thorough alignment job after making the necessary repairs. These features are a *plus* exclusive in PHOTOFACT.

Whatever your problem or favorite servicing procedure may be—you will always find all of the information you need at your fingertips in PHOTOFACT. For only *2½c per model, PHOTOFACT helps you solve your service problems in just minutes—helps you service more sets and earn more daily!

*Based on the average number of models covered in a single set of PHOTOFACT Folders.

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Got a tough repair? Try this—at Howard W. Sams' own risk: see your Parts Distributor and buy the proper PHOTOFACT Folder Set covering the receiver. Then use it on the actual repair. If PHOTOFACT doesn't save you time, doesn't make the job easier and more profitable for you, Howard W. Sams wants you to return the complete Folder Set direct to him and he'll refund your purchase price promptly. GET THE PROOF FOR YOURSELF—TRY PHOTOFACT NOW!

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You'll save yourself trouble if you standardize on Raytheon "All-Set" Tubes for replacement work.

Here's why:

Raytheon "All-Set" Tubes are designed to give perfect service in many makes and models of receivers because Raytheon sells Tubes to almost every set manufacturer. To satisfy the many and varying needs of so many manufacturers, these tubes must combine top quality performance and dependability. This successful combination makes Raytheon "All-Set" Tubes tops for replacement.

Always use Raytheon "All-Set" Tubes to satisfy your "all-set" customers.

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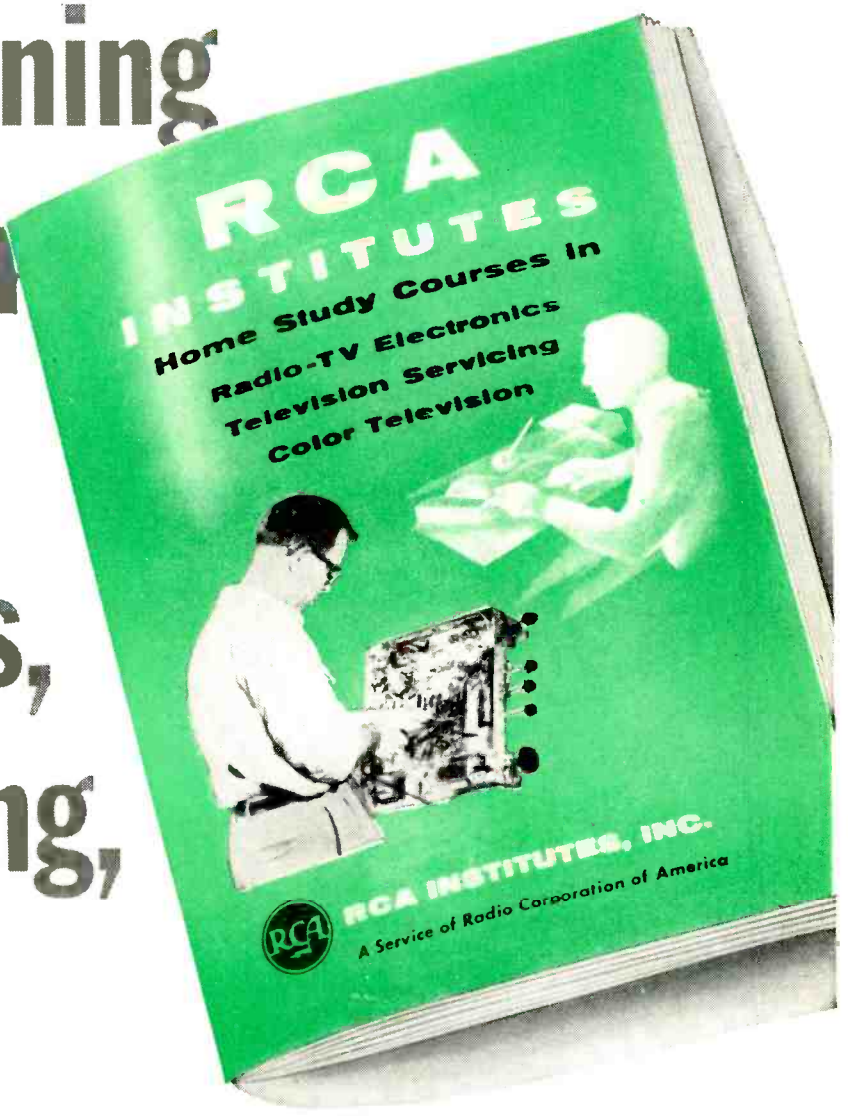

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Shown at Bell Laboratories, Murray Hill, N. J., are, left to right, F. J. Herr, S. T. Brewer, L. R. Snoke, E. E. Zajac and F. W. Kinsman.

They're wiring the seas for sound

These five Bell Labs scientists and engineers may never "go down to the sea in ships." Yet, they're part of one of the most exciting sea adventures of modern times. Along with many other specialists, they are developing the deep-sea telephone cable systems of the future.

Here's how they join many phases of communications science and engineering—to bring people who are oceans apart within speaking distance.

F. J. Herr, M.S., Stevens Institute, is concerned with systems design and analysis. He studies the feasibility of new approaches and carries out analysis programs to select optimum parameters for a proposed system design.

S. T. Brewer, M.S. in E.E., Purdue, communications and electronics engineer, explores new designs for sea-bottom amplifiers needed to step up power of hundreds of simultaneous telephone conversations.

L. R. Snoke, B.S. in Forestry, Penn State, is the team biologist. He investigates the resistance of materials to chemical and microbiological attack in sea water. Materials are evaluated both in the laboratory and in the ocean.

E. E. Zajac, Ph.D. in Engineering Mechanics, Stanford, is a mathematician. He studies the kinematics of cable laying and recovery. Cable's dynamic characteristics, ship's motion, the mountains and valleys in the ocean bottom—all must be taken into account.

F. W. Kinsman, Ph.D. in Engineering, Cornell, solves the shipboard problems of storage, handling and "overboarding" of cable. New machinery for laying cable is being developed.

Deep-sea cables once were limited to transmitting telegraph signals. Bell Labs research gave the long underseas cable a voice. New research and development at the Labs will make this voice even more useful.

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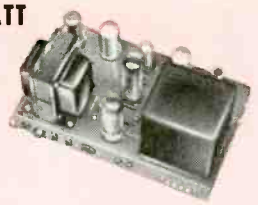
NEW! 12-WATT Williamson-type HIGH FIDELITY INTEGRATED AMPLIFIER HF12

with Preamplifier, Equalizer & Control Section

KIT $34.95 WIRED $57.95

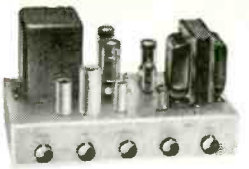
Compact, beautifully packaged & styled. Provides complete "front-end" facilities and true high fidelity performance. Direct tape head & magnetic phono inputs with NARTB (tape) & RIAA (phono) feedback equalizations. 6-tube circuit, dual triode for variable turnover bass & treble feedback-type tone controls. **Output Power:** 12 w cont., 25 w pk. **IM Dist.** (60 & 6000 cps @ 4:1): 1.5% @ 12 w; 0.55% @ 6 w; 0.3% @ 4 w. **Freq. Resp.:** 1 w: ±0.5 db 12 cps – 50 kc; 12 w: ±0.5 db 25 cps – 20 kc. **Harmonic Dist:** 20 cps: 2% @ 4.2 w; ½% @ 2.5 w; 30 cps: 2% @ 11 w; ½% @ 6.3 w; 40 cps: 1% @ 12 w; ½% @ 9.3 w; 2000 cps: ½% @ 12 w; 10 kc: 1% @ 10 w; ½% @ 6 w. **Transient Resp:** excellent square wave reproduction (4 usec rise-time); negligible ringing, rapid settling on 10 kc square wave. **Inverse Feedback:** 20 db. **Stability Margin:** 12 db. **Damping Factor:** above 8, 20 cps – 15 kc. **Speaker Connections:** 4, 8, 16 ohms. **Tone Control Range:** @ 10 kc, ±13 db; @ 50 cps, ±16 db. **Tubes:** 2-ECC83/12AX7, 1-ECC82/12AU7, 2-EL84, 1-EZ81. Size: HWD: 3⅜" x 12" x 8¼". 13 lbs. Mounts in or out of cabinet.

NEW! 50-WATT Ultra-Linear HIGH FIDELITY POWER AMPLIFIER



HF50 KIT $57.95 WIRED $87.95

Like the HF60 shown below, the HF50 features **virtually absolute stability, flawless transient response** under either resistive or reactive (speaker) load, & **no bounce or flutter** under pulsed conditions. **Extremely high quality output transformer** with extensively interleaved windings, 4, 8, & 16 ohm speaker connections, grain-oriented steel, & fully potted in seamless steel case. Otherwise identical to HF60. **Output Power:** 50 w cont., 100 w pk. **IM Distortion** (60 & 6000 cps @ 4:1): below 1% at 50 w; 0.5% @ 45 w. **Harmonic Dist.:** below 0.5% between 20 cps & 20 kc within 1 db of rated power. **Freq. Resp.** at 1 w: ±0.5 db 6 cps –60 kc; ±0.1 db 15 cps –30 kc at any level from 1 mw to rated power; no peaking or raggedness outside audio range. **All other specs identical to HF60 below.** Matching cover **Model E-2, $4.50.**



NEW! 50-WATT Ultra-Linear HIGH-FIDELITY INTEGRATED POWER AMPLIFIER HF52

with Preamplifier, Equalizer & Control Section

KIT $69.95 WIRED $109.95

Combines a power amplifier section **essentially identical to the HF50 power amplifier** with a **preamp-equalizer control section similar to HF20 below.** Provision for use with electronic crossover network & additional amplifier(s). See HF50 for response & distortion specs; HF60 for square wave response, rise-time, inverse feedback, stability margin, damping factor, speaker connections; HF20 for preamplifier, equalizer & control section description. Hum & noise 60 db below rated output on magnetic phono input (8 mv input for rated output), & 75 db below rated output on high level inputs (0.6 v input for rated output). Matching cover **Model E-1, $4.50.**

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HIGH FIDELITY PREAMPLIFIER

#HF61A KIT $24.95, WIRED $37.95

With Power Supply: #HF61 KIT $29.95, WIRED $44.95

Will not add distortion or detract from the wide-band or transient response of the finest power amplifiers at any control settings. High quality feedback circuitry throughout plus the most complete control & switching facilities. Heavy-gauge solid brushed brass panel, concentric controls, one-piece brown enamel steel cabinet for lasting attractive appearance. **Feedback-type, sharp cut-off (12 db/octave) scratch & rumble filters. Low-distortion feedback equalization:** 5 most common recording curves for LPs & 78s including RIAA. **Low-distortion feedback tone controls:** provide large boost or cut in bass or treble with mid-freqs & volume unaffected. **Centralab printed-circuit Senior "Compentrol" loudness control with concentric level control. 4 hi-level switched inputs** (tuner, tv, tape, aux.) & **3 low-level inputs** (separate **front panel low-level input selector** permits concurrent use of changer & turntable). **Proper pick-up loading & atenuation** provided for all quality cartridges. **Hum bal. control.** DC superimposed on filament supply. 4 convenience outlets. **Extremely flat wideband freq. resp.:** ±1 db 8-100,000 cps; ±0.3 db 12-50,000 cps. **Extremely sensitive. Negligible** hum, noise, harmonic or IM distortion. Size: 4-7/8" x 12-5/16" x 4-7/8". 8 lbs.

NEW

60-WATT Ultra-Linear HIGH FIDELITY POWER AMPLIFIER #HF60 with ACRO TO-330 OUTPUT TRANSFORMER

KIT $72.95 WIRED $99.95

Superlative performance, obtained through finest components & circuitry. EF86 low-noise voltage amplifier direct-coupled to 6SN7GTB cathode coupled phase inverter driving a pair of Ultra-Linear connected push-pull EL34 output tubes operated with fixed bias. **Rated power output:** 60 w (130 w peak). **IM Distortion** (60 & 6000 cps at 4:1): less than 1% at 60 w; less than 0.5% at 50 w. **Harmonic Distortion:** less than 0.5% at any freq. between 20 cps & 20 kc within 1 db of 60 w. **Sinusoidal Freq. Resp.:** at 1 w: 35 kc at any level from 1 mw to rated power; no peaking or raggedness outside audio range. **Square Wave Resp.:** excellent from 20 cps to 25 kc, 3 usec rise-time. **Sensitivity:** 0.55 v for 60 w. **Damping Factor:** 17. **Inverse Feedback:** 21 db. **Stability Margin:** 16 db. **Hum:** 90 db below rated output. **ACRO TO-330 Output Transformer** (fully potted). **Speaker Taps:** 4, 8, 16 ohms. **GZ34 extra-rugged rectifier** (indirectly-heated cathode eliminates high starting voltage on electrolytics & delays B+ until amplifier tubes warm up). **Input level control.** Panel mount fuse holder. **Both bias and DC — balance** adjustments. Std octal socket provided for pre-amplifier power take-off. Size: 7" x 14" x 8". 30 lbs. Matching cover **Model E-2 $4.50.**

NEW

COMPLETE with Preamplifier, Equalizer & Control Section 20-WATT Ultra-Linear Williamson-Type HIGH FIDELITY AMPLIFIER #HF-20

KIT $49.95 WIRED $79.95

A low-cost, complete-facility amplifier of the highest quality that sets a new standard of performance at the price, kit or wired. **Rated Power Output:** 20 w (34 w peak). **IM Distortion (60 & 6000 cps/4:1) at rated power:** 1.3%. **Max. Harmonic Distortion between 20 & 20,000 cps at 1 db under rated power:** approx. 1%. **Mid-band Harmonic Distortion at rated power:** 0.3%. **Power Response (20 w):** ±0.5 db 20-20,000 cps; ±1.5 db 10-40,000 cps. **Freq. Resp.** (¼ w): ±0.5 db 13-35,000 cps; ±1.5 db 7-50,000 cps. **5 feedback equalizations** for LPs & 78s. **Low-distortion feedback tone controls:** large boosts or cuts in bass or treble with mid-freqs. & volume unaffected. Loudness control & separate level set control on front panel. Low Z output to tape recorder. **4 hi-level switched inputs:** tuner, tv, tape, aux: **2 low-level inputs** for proper loading with **all** cartridges. **Hum bal. control.** DC superimposed on filament supply. **Extremely fine output transformer:** interleaved windings, tight coupling, careful balancing, grain-oriented steel. 8½" x 15" x 10". 24 lbs.
Matching cover **Model E-1, $4.50**

NEW COMPLETE with FACTORY-BUILT CABINET— 2-WAY HI-FI SPEAKER SYSTEM #HFS1 $39.95

Genuine 2-way book-shelf size speaker system. **Jensen** heavy duty 8" woofer (6.8 oz. magnet) & matching **Jensen** compression-driver exponential horn tweeter with level control. Smooth clean bass & crisp extended highs free of coloration or artificial brilliance. **Factory-built** tuned bass reflex birch hardwood cabinet (**not** a kit) constructed to high quality standards. Neutral acoustical grille cloth framed by a smooth-sanded solid birch molding. **Freq. Resp.** measured 2 ft. away on principal axis in anechoic chamber with 1 watt input – **Woofer:** ±4 db 80-1800 cps; **Tweeter:** ±2 db 2800-10,000 cps; **Crossover Region:** 1800-2800 cps, shift in level over this region depends on tweeter level control setting. Power-handling capacity: 25 watts. Size: 23"x11"x9". 25 lbs. **Wiring Time:** 15 min.

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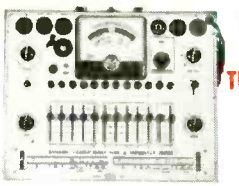
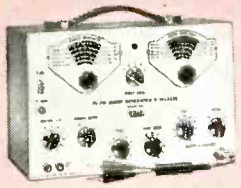


NEW! DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666

KIT $69.95 WIRED $109.95

COMPLETE with steel cover and handle.

SPEED, ease, unexcelled accuracy & thoroughness. **Tests all receiving tubes** (and picture tubes with adapter). **Composite indication** of Gm, Gp & peak emission. **Simultaneous sel** of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot). **New series-string voltages:** for 600, 450, 300 ma types. **Sensitive** 200 ua meter. **5 ranges meter sensitivity** (1% shunts & 5% pot). **10 SIX-position lever switches:** freepoint connection of each tube pin. **10 pushbuttons: rapid** insert of any tube element in leakage test circuit & speedy sel. of individual sections of multi-section tubes in merit tests. **Direct-reading** of inter-element leakage **in ohms. New gear-driven rollchart. Checks n-p-n & p-n-p transistors:** separate meter readings of **collector leakage current & Beta** using internal dc power supply. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet. **CRA Adapter $4.50**



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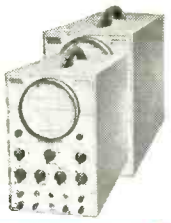

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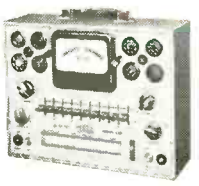

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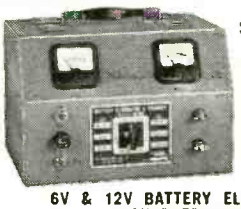

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KIT $29.95
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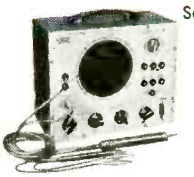

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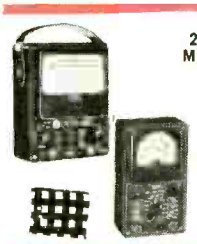

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Radio-Electronics
Hugo Gernsback, Editor

HIGH-FIDELITY SOUND

. . . *A New Approach to Higher Fidelity* . . .

THE basic principles of sound reproducers in use today for audio high-fidelity acoustics are comparatively ancient, as viewed by modern audio engineering. Only two fundamental principles are used in loudspeakers common today. The first is Dr. Alexander Graham Bell's electromagnetic telephone of 1876, now adapted into a loudspeaker. Bell's old vibrating 2-inch-diameter iron diaphragm has been expanded into a large vibrating cone (the latter is attached to a voice coil which floats in the magnetic field.) Roughly the same principle, however, remains. The second is Prof. Amos Emerson Dolbear's 1879 condenser (capacitance) telephone which worked on the "static" principle. It had two 2-inch iron or steel diaphragms separated about ⅛ inch. One diaphragm was fixed, the other left free so it could vibrate. The transmitting line was connected to the two diaphragms. This astonishingly simple telephone worked exceedingly well. The same principle is used in our electrostatic loudspeakers today in a highly refined form.

As we all know, our modern loudspeaker reproducers—good as they are—leave much to be desired. They do not *reproduce* with complete fidelity—they only *approximate* in fact. The sound reproduction is a compromise. Indeed, if we wish the best reproduction possible with present-day means, we must use *several* reproducers simultaneously, one (or more) for the lower notes plus one (or more) for the higher register.

The main reason for this deficiency is that up to now we have no *inertialess* loudspeakers, with the possible exception of Siegfried Klein's *Ionophone*, which works on a combination of molecular motion and thermo effects. Unfortunately, it requires a very large horn, if it is to cover the full range.*

As we see it, we should dissociate ourselves from the fixed idea prevalent for over 80 years that we must move large masses of air in order to hear. Hence our present-day loudspeaker cones which we fashion to "grip" the surrounding atmosphere.

Have you ever placed your ear tightly to a solid wood telegraph or telephone pole and listened to the loud "singing" wires 40 feet above your head? This is sound conduction (often molecular) through a solid. Several decades ago, the same interesting phenomenon occurred when boys, living on the prairie, placed their ears against a rail on the ground to listen to an invisible oncoming (or receding) train many miles away. And the sound often was very loud, too. (Today's modern railroad signalling requires insulated joint bars between the rails. This cuts down long-distance sound reception.)

The writer made use of this principle when he patented the *Osophone*, in 1923, the first bone-conduction speaker, which near-deaf people held between their teeth. They could hear speech or music well, entirely through the osseous part of the cranium.

Another interesting example can be cited. Many years ago, we visited an experimenter friend of ours on Long Island. He was living in an old house supported in the cellar by several large round wooden beams, each about 8 inches in diameter. To the center post he had attached a large loudspeaker in such a manner that the speaker's armature was fixed solidly into the wooden pole. The loudspeaker itself was supported by the cement floor. The result: music and sound were propagated clearly through the entire house. The sound—and radio—could be switched off or on from any room on all floors.

These examples are given merely to illustrate how sound can be propagated in the absence of air. What we are trying to say is that the orthodox "grip" on the air by means of large vibrating "driver" surfaces is not necessarily a future requirement of high-fidelity loudspeakers.

At the same time, it is true that humans, immersed in ambient air, normally hear best when sound vibrations impinge via air columns of their ears onto their tympanums. But it makes no difference *how* the sound waves are propagated, or by what means, so long as the end result—high-fidelity sound reproduction—is perfect, or at least near perfect.

It would appear that inertialess molecular speakers would stand the best chance of succeeding in the end. The reasons seem obvious. Today's ideal audio reproducer is called upon to re-create faithfully tens of thousands of different sounds in every imaginable combination, with all sorts of overtones, resonances, timbres and intensities, in frequencies from 2 to 20,000 cycles. This seems an impossible task for a single vibrating or oscillating surface or set of surfaces. They cannot faithfully reproduce at the same time an entire orchestra with all its various instruments, plus a large singing chorus. At best we get an approximation, but a large percentage of *true* tones are lost.

An oscillating cone or surface swings to and fro. *It has inertia.* This requires time. During the long swing, on a low note, the cone must also vibrate at a higher rate to reproduce higher notes that may have to be reproduced simultaneously. They are thus out of phase, hence are not fully rendered. The molecular speaker on the other hand has no parts that move. It is inertialess, hence it cannot be out of phase.

This brings to mind a very early molecular type of inertialess telephone. Th. Du Moncel, in the magazine *Le Téléphone* (Paris, 1882) reported the invention as follows: "To convince himself whether the telephone effect of his instrument was based upon molecular or transverse vibrations, in the 1880's, Dr. Clément Ader, the French inventor, constructed a telephone without diaphragm or membrane; with it he could reproduce only articulated sounds, but not the human voice. Soon, however, by changing his central magnetic rod to various dimensions, he noticed that the intensity of the reproduction increased as the diameter of the magnetic rod was reduced. Finally, he used an iron wire only 1 millimeter in diameter. By rigidly fixing the wire in his instrument, reproduction of the voice and words became audible. The effect was even better when he fixed the iron wire rigidly at the top and weighted the free end with a large and heavy metal mass. The iron wire itself was surrounded along its middle by an induction coil which did not touch the iron wire."

Du Moncel explained the action as follows: "The molecular oscillations of the iron wire are principally effective along its longitudinal axis. They propagate themselves faster than normal (transverse) oscillations which are communicated to the inert metal mass; this action results in minute shocks which amplify the mechanical effect of the oscillations in the iron wire. The resulting total effect of the suspended metal mass then communicates itself along the iron wire to the upper fixed suspension of the wire, which is a solid block of copper. From here on, audio oscillations result which are now transmitted to the surrounding air by the instrument. There is of course no horn but instead a small wooden saucer-like surface."

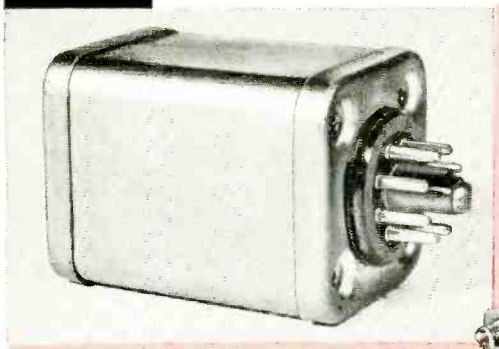
It is to be hoped that future audio loudspeaker research will be in the molecular direction. It holds great hope for high fidelity. —*H.G.*

*See also the editorial "Wanted—Inertialess Speakers," RADIO-ELECTRONICS, October, 1953.

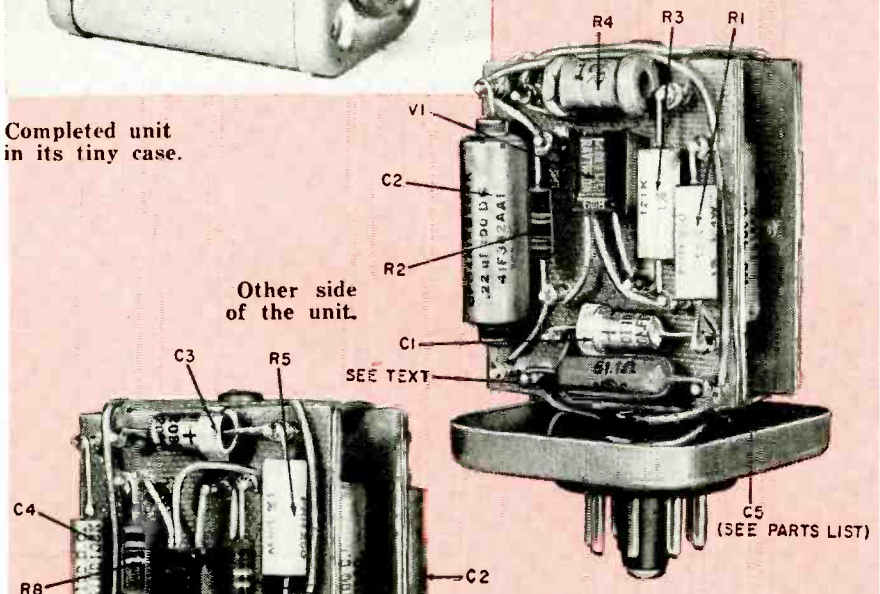
All Transistor Tape-Head Preamp

Miniature two-stage preamp plugs into an octal socket

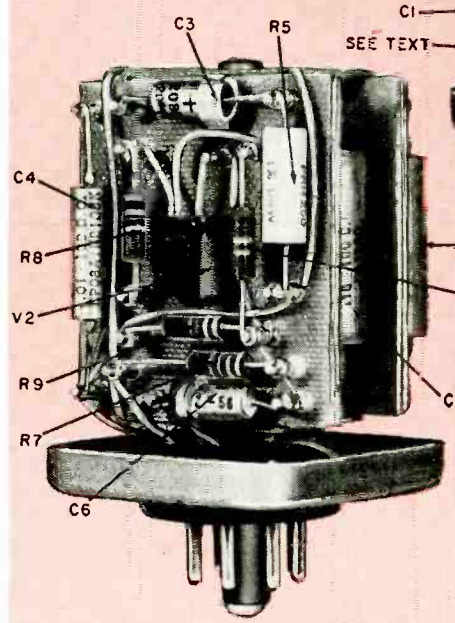
By FRANCIS A. GICCA *



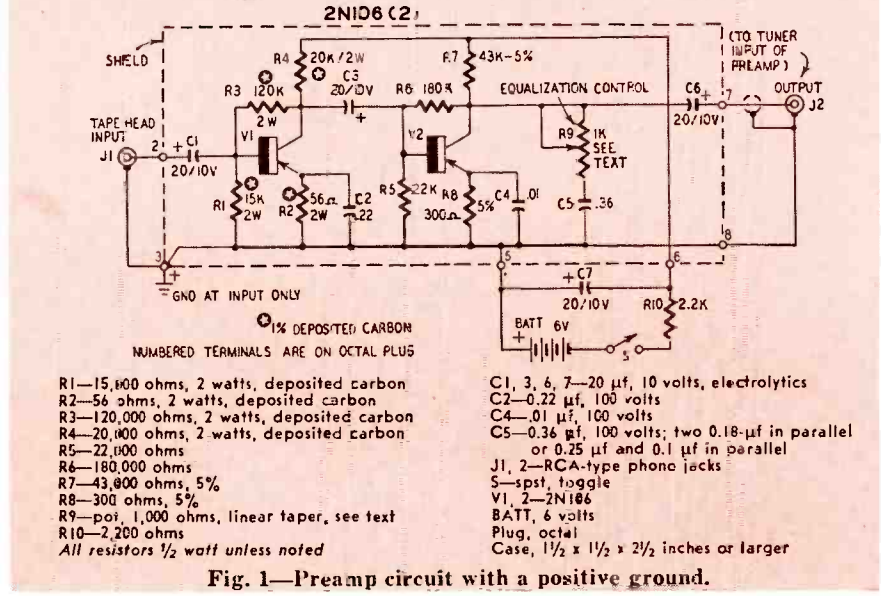
Completed unit in its tiny case.



Other side of the unit.



Sandwich construction aids compact layout.



R1—15,000 ohms, 2 watts, deposited carbon
R2—56 ohms, 2 watts, deposited carbon
R3—120,000 ohms, 2 watts, deposited carbon
R4—20,000 ohms, 2 watts, deposited carbon
R5—22,000 ohms
R6—180,000 ohms
R7—43,000 ohms, 5%
R8—300 ohms, 5%
R9—pot, 1,000 ohms, linear taper, see text
R10—2,200 ohms
All resistors ½ watt unless noted

C1, 3, 6, 7—20 μf, 10 volts, electrolytics
C2—0.22 μf, 100 volts
C4—.01 μf, 100 volts
C5—0.36 μf, 100 volts; two 0.18-μf in parallel or 0.25 μf and 0.1 μf in parallel
J1, 2—RCA-type phono jacks
S—spst, toggle
V1, 2—2N186
BATT, 6 volts
Plug, octal
Case, 1½ x 1½ x 2½ inches or larger

Fig. 1—Preamp circuit with a positive ground.

AN ideal use for the transistor, in the audio field, is in a tape recorder preamp. Let's look at some requirements of a good tape preamp and we'll quickly see why a transistor unit can outperform its vacuum-tube cousin.

A tape head is a low-impedance device—usually about 500 ohms. For optimum performance it's important for a preamp to have a similar input impedance. High-frequency response of the head suffers seriously unless it is matched to a low-impedance preamp input.

Generally, it is not the mechanical gap width of the head that limits the high-frequency response, but the stray capacitance across the head's windings. For example, a typical tape head has a mechanical gap width of .0002 inch, a resistance of 500 ohms and a stray capacitance across the windings of 20 $\mu\mu$f. This head at 7½ ips has a mechanical gap cutoff frequency of 37,500 cycles ($f_{co} = \frac{7.5}{\text{gap-width}}$.) With a preamp that has an input impedance of 1 megohm, the head's stray capacitance will cause the half-power point (3 db down) to be about 8,000 cycles. But, if our preamp has an input impedence of 500 ohms, the half-power point becomes about 16 mc. This allows the head's mechanical gap width to be the dominant high-frequency limitation.

For a vacuum-tube preamp to have an input impedance of 500 ohms we must use an input transformer. A good, wide-range input transformer is expensive. It easily picks up stray hum fields and we may lose high-frequency response in the transformer's secondary due to its stray capacitance. On the other hand, a grounded-emitter transistor stage has, by its very nature, a low input impedance.

Noise and hum are two other important problems. The NARTB tape-playback characteristic helps to minimize noise by calling for a 10-db gain reduction at 10,000 cycles. Vacuum tubes are noisiest at these higher frequencies—the thermal-noise region. A 10-db gain reduction at 10,000 cycles reduces the effect of this noise.

Transistors have about the same noise problems as vacuum tubes. It is true that transistors generally have more noise at low frequencies than

* Electronics development engineer, Raytheon Manufacturing Co.

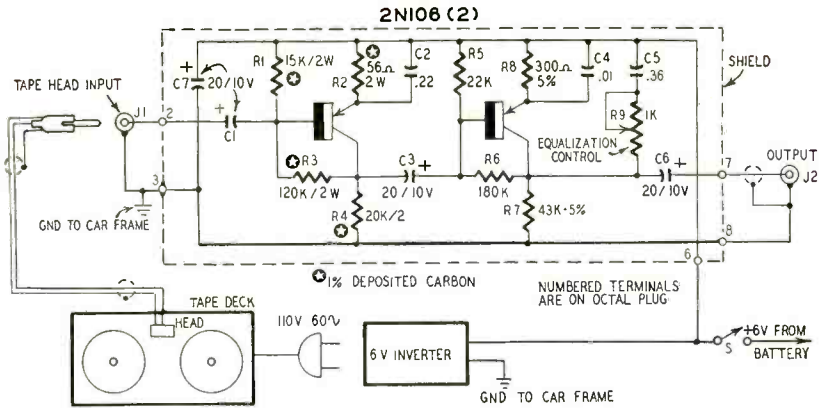


Fig. 2—Negative-ground circuit hooked to tape deck and inverter for auto use.

tubes, but the most noticeable noise also occurs at high frequencies. The Raytheon type 2N106 transistor is a new low-noise type developed especially for high-fidelity audio applications. When used with the NARTB tape-playback curve, it will have a signal-to-noise ratio of about 55 db, which is quite acceptable for a tape preamp.

Hum is much more of a problem, for the NARTB characteristic calls for 23 db of bass boost at 60 cycles. Unless a vacuum-tube preamp is very carefully wired or dc used for the heater, hum will be objectionable. The hum signal-to-noise ratio for a tube preamp can be as bad as 30 db. If we're willing to use a battery supply for a transistor preamp and shield the unit from stray hum fields, there will be no hum due to the preamp. This is extremely desirable—another victory for transistors.

Design features

A transistor preamp should be designed so that it can drive high-level inputs of audio control units, since most high-fidelity installations use such a control unit as the master control center for the system. Since the average tape head has about a 5-mv output at 1,000 cycles, preamp gain of 32 db at this frequency would provide 0.2 volt of signal to the control unit. This is adequate for all control units.

The NARTB tape characteristic calls for a maximum bass boost 26 db above the 1,000-cycle reference level, so our preamp must have a maximum gain of 58 db at extremely low frequencies to give an output of 0.2 volt. With careful design two 2N106 transistors supply this gain.

The grounded-emitter configuration was chosen as it has a low input impedance, high gain and is relatively stable. Bias current for the transistor base is obtained by using a resistive divider from the collector to ground. This type of biasing circuit also applies both dc and ac stabilizing negative feedback around the stage, helping to minimize transistor drift and individual variations. The use of emitter feedback in the form of a series emitter resistor also adds stability and allows us to adjust each stage for maximum flat frequency response by properly bypassing the emitter resistor.

To obtain the NARTB tape-playback characteristic we use a simple R-C shaping circuit between V2's collector and ground. Since the NARTB curve folows the ideal 6-db-per-octave curve of an R-C network such an equalization circuit is simple and very effective for achieving the right response.

The circuit is shown in Fig. 1. Its overall simplicity is evident and its performance leaves nothing to be desired. It follows the NARTB characteristic within 1 db from 20 to 20,000 cycles, has an overall signal-to-noise ratio of better than 55 db which includes *no hum* and provides the necessary 0.2 volt at 1,000 cycles to drive an audio control unit. No gain control is used since the audio control unit already has one.

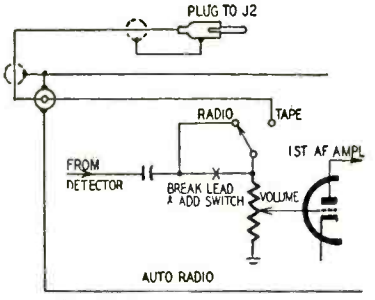


Fig. 3—Switching arrangement using car radio as tape recording amplifier.

An interesting application for this tape preamp is as part of a hi-fi tape player for your car. Since only 6 volts are required for the supply voltage, the car battery can power the preamp. Due to the unit's simplicity, it can be built into a tape deck. Then all you need do is power the tape deck's transport motor with an inverter and install a switch in your car radio to connect the preamp to your radio's power amplifier.

The preamp will have to be modified slightly to operate with a negative ground. Fig. 2 shows this circuit. (For cars with a positive ground, the Fig. 1 circuit can be used.—*Editor*)

To modify your car radio for a tape player system, merely break the lead from your radio's volume control, and add a switch between this lead and the detector stage to allow you to switch from the radio to the preamp. This wiring change is shown in Fig. 3.

If your car has a 12-volt battery, insert a 15,000-ohm 2-watt resistor between the battery and the preamp power input and use a 12-volt inverter.

Construction details

There are many ways in which the transistor preamp can be built. I constructed my model using two phenolic boards with spacers glued between them. (Perforated bakelite boards can be used.—*Editor*) This allowed me to mount the entire preamp in a 1½ x 1½ x 2½-inch Mumetal case. This was a junkbox item. A small Bud Minibox is just as good. Input, output and power leads are brought into the preamp through an octal plug.

A conventional chassis will do just as well. The finished size is larger than the phenolic-sandwich type of construction, but a lot easier to build. It is wise to plan your layout so that the finished chassis will fit into a miniature case. The shielding from stray hum pickup, obtained by enclosing the preamp in a case is well worth the small cost.

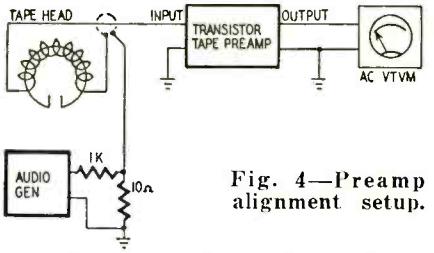
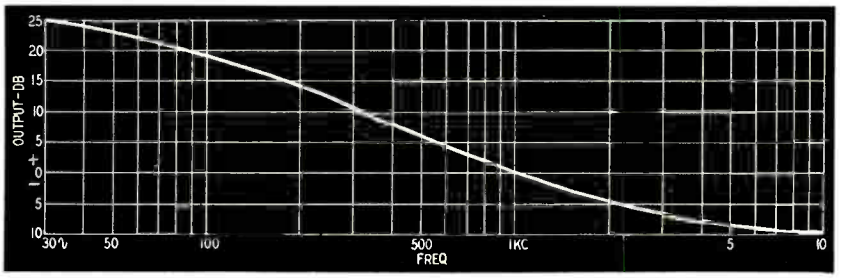


Fig. 4—Preamp alignment setup.

To keep the input transistor noise low, use 1% deposited-carbon resistors for R1, R2, R3 and R4.

Be sure to use a single wire as a ground bus. Connect all grounds to this wire which should be connected to the chassis only at pin 3 of the octal plug. This eliminates hum from the



Frequency (cps)	Output Voltage (rms)	Frequency (cps)	Output Voltage (rms)
10.0	0.2	500.0	0.02
50.0	0.14	1,000	0.01
100.0	0.09	5,000	.0038
		10,000	.0032

Fig. 5—NARTB curve followed for proper alignment.

ground loops.

The EQUALIZATION CONTROL (R9) can be replaced by a nominal resistance. In the unit constructed an equalization control was not used. Instead, space was provided for a conventional resistor, and the proper value was soldered in to yield the standard NARTB tape curve.

If you use a resistor for R9, it must be chosen for the proper NARTB playback curve. To do this, insert a 10-ohm resistor in the ground lead from the playback head, as shown in Fig. 4. Connect an audio generator to this resistor through a 1,000-ohm resistor. Connect an ac vtvm to the preamp's output. The vtvm should have a flat response to at least 10,000 cycles. Set the audio generator to 1 kc and adjust its output control so that the vtvm reads .01 volt rms.

Temporarily, use a 1,000-ohm potentiometer for R9 and set the audio generator to the frequencies listed on the chart in Fig. 5. Adjust the potentiometer to obtain the output voltages listed. If the output at 100 cycles is greater than .09 volt rms, there is not enough resistance. If the output is less than .09, there is too much resistance. Continue adjusting the resistor until you get readings closest to those listed on the chart, or read on the curve. Each time you change R9, be sure to return the generator to 1 kc and readjust its output for a reading of .01 volt rms on the vtvm. When the proper setting is found, measure the pot and replace it with a 1% fixed resistor of equal value. The preamp now follows the NARTB characteristic.

If your audio control unit has tone controls, then it is a good idea to remove the equalization control to avoid interaction between tone and equalization controls. If the preamp is used as part of an automobile tape player, the equalization control is handy for adjusting tone to suit noise conditions.

To avoid ground loops between the head and the preamp use two-conductor shielded cable between them. Connect the hot lead from the head to one wire of the two-conductor cable, and the ground lead from the head to the other wire of the cable. The shield and ground lead should be soldered to the input's ground, but do not connect the shield to the recorder chassis.

The preamp's output impedance is fairly low and a relatively long lead can be used from the unit to an audio control unit or car radio. Up to 10 feet of shielded cable can be used without any loss of high-frequency response.

The 51-ohm resistor across the preamp input in the photos is a terminating resistor and is unnecessary. It was placed across the input to allow response runs with an audio oscillator.

Now all that's left is the listening. You have a tape preamplifier that is superior to vacuum-tube types in all respects. The preamp draws little current and the 6-volt battery lasts about a year under normal usage. END

Bass Reproduction in Loudspeakers

By EDGAR VILLCHUR*

One view on the relationship between cone excursion and bass reproduction

THE Correspondence column of the May, 1957, issue of this magazine contained a letter from Paul W. Klipsch which I read with considerable interest. The issues raised are both important and fundamental and deserve treatment at some length. I subscribe entirely to the accuracy of the data quoted, but cannot agree with Mr. Klipsch's conclusions.

It has been known for a long time that a speaker cone must move increasingly greater distances as the frequency enters the bass regions. This relationship (among others) was pinned down in 1942 by Frank Massa in his classic book *Acoustic Design Charts*.

Chart No. 61 of Massa's book shows the relationship between the acoustic output of a vibrating diaphragm, in watts, to the distance of travel at various frequencies. Mr. Klipsch specifically points out in his letter, on the basis of the above, that the excursion required of a directly radiating 12-inch speaker cone, for 1 acoustic watt at 30 cycles, is 2.8 inches.

These figures are as accurate today as when they were published 15 years ago, but they must be interpreted with the same rigor that was used in their original formulation. They do *not* mean that a 12-inch loudspeaker cone has to vibrate over the impractical distance of almost 3 inches to reproduce 30-cycle energy at concert level in the home. If this were so, direct-radiator speakers would be incapable of reproducing the pedal line of a pipe organ or the explosive thud of a bass drum.

Bass power

The amount of bass power created by a speaker cone depends upon three things: (1) the cone travel, or excursion, relative to the frequency, (2) the size of the cone and (3) the solid angle in which the speaker is mounted. The significance of the first two factors is fairly obvious since the larger the cone, and the farther it moves, the more air will be pumped back and forth. The third factor is equally significant but the reasons for it being so are not as obvious.

Consider the hypothetical situation in which a loudspeaker system (including

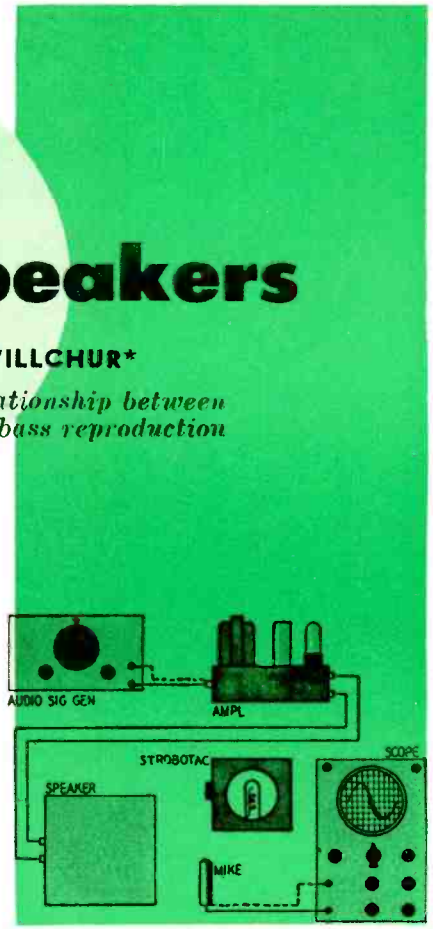


Fig. 1—Test setup for checking linearity of speaker sound output in relation to cone excursion.

enclosure) is suspended on a rope, in the center of the universe. There will be a tendency for energy at higher frequencies to be concentrated in the area directly ahead of the speaker, but bass frequencies will be radiated equally in all directions. Bass sound levels in front of the speaker are thus watered down relative to the treble by their better dispersion and are weaker in comparison.

Now let us place the speaker system behind an infinite baffle so that the speaker looks out on only half the universe. The treble portion of the signal will not be concentrated any more than it would be by the natural directive characteristics of the speaker but the bass, which was formerly radiated in all directions, is now restricted. The cone gets a better bite of the air that it engages at low frequencies and the area in front of the speaker receives a double concentration of bass.

Following the same analysis, halving the solid angle of radiation once more doubles the bass power again.

Translated into practical terms, this means that, when a speaker is mounted in a two-sided corner (such as at the junction of the floor and wall), the bass power radiated into the room, with given excursions, will be doubled compared to that produced by a speaker mounted in the center of a flat wall. If

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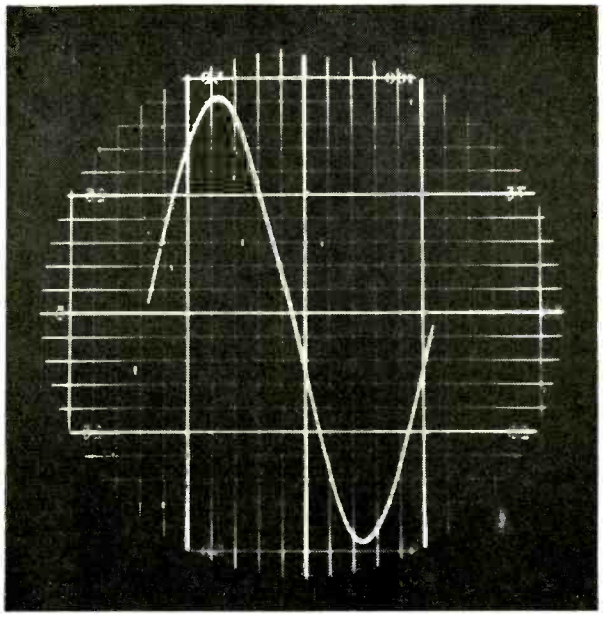


Fig. 2—Waveform of speaker output using test setup shown in Fig. 1. Speaker mounted in 45° corner. Cone excursions are ½ inch. Input power is 39 watts to rated impedance.

the speaker is mounted in a three-sided corner—the junction of two walls and the floor, for example—the bass power will be quadrupled.*

Massa is very explicit about the solid angle seen by his radiating diaphragm, as he must be for his data to be meaningful. The figures he gives us are for diaphragms radiating into 180° or, as he puts it, into semi-infinite space. His figures can thus only be applied to practical speakers in the mid-wall position. If we place our speaker in a corner on the floor, the same 2.8 inches of cone excursion will radiate an effective 4 watts of acoustic power at 30 cycles, rather than 1 watt.

The order of magnitude of acoustic power that we are discussing here is tremendous and, for a living room of even large size, literally ear-shattering. Massa's book also contains data on the number of acoustic watts required for musical reproduction at concert-hall level, in rooms of various sizes and reverberation periods (Chart No. 72). For a typical living room of, say 3,000 cubic feet, we would require about 0.4 acoustic watt *total* sound power.

Required cone excursion

It is highly unlikely that all of the sound would ever appear at 30 cycles. Assuming, however, that it did, we would require cone excursions of 0.8 inch peak to peak with the speaker mounted in a corner. If we used a more reasonable assumption, that no more than half of the total power would appear at 30 cycles, we find that ½-inch excursions will give us just a bit less than the 0.2 acoustic watt required.

The $64,000 question then becomes: Is a direct-radiator 12-inch loudspeaker capable of linear ½-inch excursions? Or, to put it another way, can such a speaker radiate clean 30-cycle energy when its cone has to vibrate over a distance of ½ inch?

The answer must be given in terms of practical demonstration rather than theory. At least one commercial direct-radiator speaker system is capable of such linear excursions and demonstrations of this capability have been made before professional groups—an AES meeting at the New York Trades Show Building in September, 1956, and an IRE meeting at MIT in May, 1957.

The test setup that was used is shown in Fig. 1. The speaker is fed by a high-powered amplifier, driven from a signal generator tuned to 30 cycles. The resulting sound output of the speaker is picked up by a microphone and the waveform is displayed on an oscilloscope screen so that deviations from the sine-wave pattern may be observed. A *Strobotac* light, tuned a few cycles off frequency, is played on the speaker cone, visually converting the vibrations to a slow, clearly observable breathing.

Viewing moving parts under a Strobotac light is a common industrial technique. The speaker cone, of course, is still vibrating at 30 cycles, but the apparent velocity of each repeated vibration is slowed down to the point where each motion can be seen and the distance easily gauged.

Fig. 2 is a photograph of the scope trace produced by the output of the microphone in front of the speaker. This waveform represents actual sound output from the speaker when the cone is undergoing ½-inch excursions at 30 cycles, the speaker in a 45° corner. The amount of electrical power that had to be used to produce this sound is not really relevant to the discussion here but it happened to be 39 watts to the rated speaker impedance.

An analysis of the sound power capabilities of a 12-inch direct-radiator speaker must be put into the context of the current loudspeaker state of the art for final evaluation. In comparing this power capability with that of a horn, for example, we will find that a properly designed horn system can produce a much higher sound level at low distortion—and with far less amplifier power — than the direct-radiator, down to the former's cutoff frequency. If, however, we explore response below the horn cutoff frequency (which is indirectly a function of horn size), we will discover that the horn rapidly ceases to load the driver and that there is a sharp falloff of response. This falloff is increased by the fact that the usual horn driver—unlike the direct-radiator speaker mechanism—does not have to be and is not designed for very large excursions.

30-cycle performance

Mr. Klipsch, in speaking of performance at 30 cycles, chose a frequency region particularly favorable to the direct-radiator speaker system. I believe that the absolute 30-cycle power capability of a really good direct radiator, at low distortion levels, is greater than that of any commercial horn small enough to be used in the home. A ½ octave higher, however, the power capability of a good horn would swamp that of the direct radiator.

As for Mr. Klipsch's joshing about a "miniature 32-foot wavelength," I have always appreciated his keen and often biting humor. I am sure, however, that Mr. Klipsch does not mean to infer that a speaker system must have physical dimensions comparable to the wavelength of the low-frequency sound it is designed to produce. There is no direct relationship between wavelength and the size of a direct-radiator speaker structure since enclosure resonance is not employed as a design element and horn-mouth reflections do not have to be considered. In the acoustic suspension system there is no such relationship whatsoever, direct or indirect. Massa's data clearly show that our 0.2 watt of 30-cycle acoustic energy can be radiated from a diaphragm of any size (1 inch, let us say) provided that the diaphragm can move far enough in a linear manner.

There has been a running battle in hi-fi circles between self-styled "horn men" and "long-throw infinite-baffle men," each type of combatant serving with devotion. The truth is that both of the design approaches represented are valid and each presents advantages over the other in particular applications. The point made in this article is that, when the problem is clean reproduction of 30-cycle energy (admittedly not too great in importance compared to other problems), a linear direct-radiator speaker system always has the advantage over a reasonably sized horn. END

This article—as the author points out—presents one view on the subject of bass reproduction. Another view is presented on page 44 by no less doughty a champion than Paul Klipsch himself.

* Leo L. Beranek, "Acoustics," McGraw-Hill Book Co., 1954, page 320.

Record Tracking

Improper tracking can hurt the quality of a hi-fi system. Learn why it does and how to check for it

By NORMAN H. CROWHURST

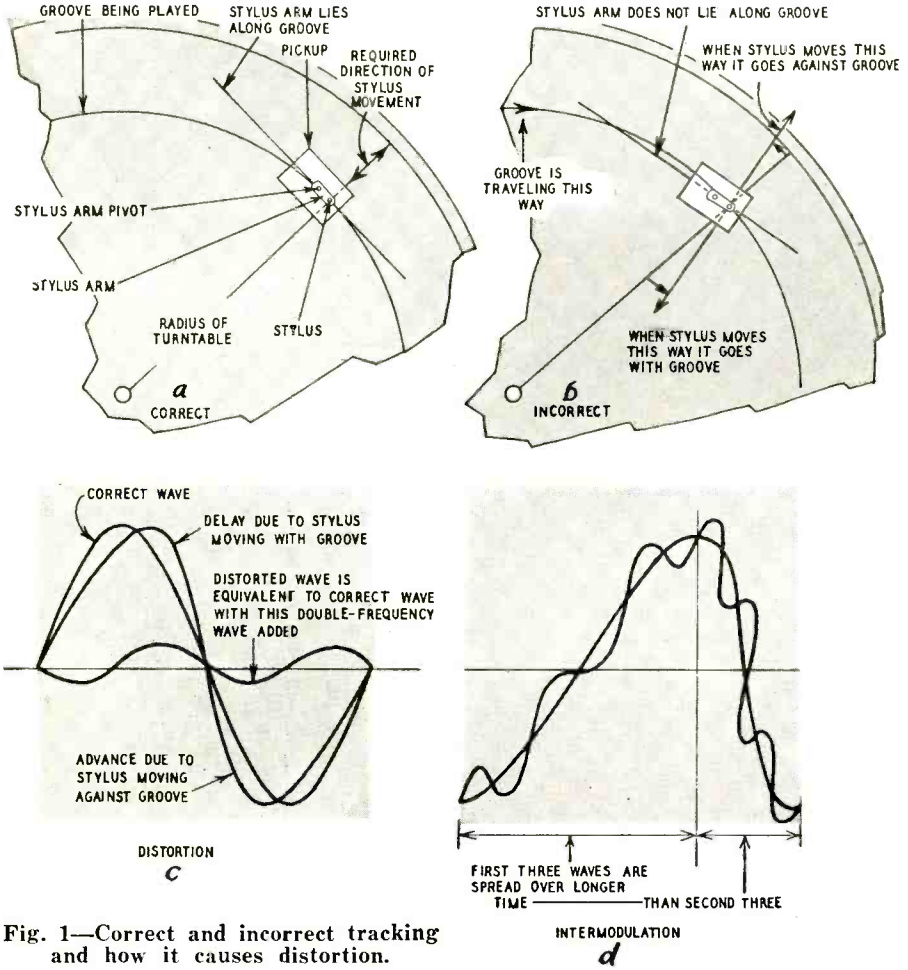


Fig. 1—Correct and incorrect tracking and how it causes distortion.

JUDGING from correspondence on the subject of mounting tone arms, there is some confusion about tracking — why records mistrack and how different constructions of tone arms and the method of mounting them obviate or minimize mistracking.

The record groove carries lateral vibrations that should move the stylus back and forth at right angles to the groove. As the groove is a very slight spiral and thus almost a perfect circle, with its center corresponding with the center of the disc, the stylus should move back and forth along a radius from the record's center.

All modern pickups carry the stylus on a stylus arm, pivoted so the arm moves over a relatively small arc. When the stylus arm is in line with the groove, the stylus moves at right angles to the groove. This relationship is illustrated in Fig. 1-a.

If the stylus arm gets out of line, the stylus movement is not at right angles to the direction of the groove. Then, as the modulation in the groove moves the stylus from side to side, it also moves it a little back and forth along the groove. At one point it will move with the disc and half a cycle later it will move against it (see Fig. 1-b).

This will distort sine-wave modulation in the groove so it has a slope as shown in Fig. 1-c. This is equivalent to adding a second-harmonic component to the groove modulation.

A small amount of second harmonic added to a sine wave is not very important. It is not audibly different from a pure sine wave. Because of the natural octave relationship, the ear identifies the two tones and cannot discriminate the second-harmonic component. The more important effect is due to what happens to other frequencies that may

be present with the same low-frequency sine wave.

Supospe the groove also contains a frequency six times as high as this low-frequency sine wave. This means there will be three waves going up the low-frequency wave and three waves coming down. The second harmonic, added by failure to track properly, results in frequency modulation of this higher frequency. The part of the low-frequency wave which is stretched out in time, due to the stylus tending to follow the groove round with the turntable, will take longer tracing its three cycles and thus momentarily produce a *lower* frequency than during the period when the stylus comes back again and momentarily makes the effective frequency *higher* (Fig. 1-d).

All the program, except the low-frequency tone which is causing it, gets frequency-modulated. This form of IM distortion produces a dithery effect in the reproduction, much like any other kind of IM distortion. This is why it is important that the stylus arm in the pickup should be in line with the groove, as nearly as possible, at all points across the record, so the stylus moves truly at right angles to the groove.

Producing good tracking

Now that we know what is wanted, let's examine different ways of doing it. The first thing to try is a straight arm with the pickup in line with the arm. This means the stylus moves at right angles to the end of the arm, as shown at Fig. 2. Variation of the mounting point will find different places across the groove at which the tracking is correct. At all other positions across the record (different radii of playing) the tracking will be incorrect.

By picking one radius and then moving the arm across the record, we can see which way the angle of stylus movement is in error. Note that the stylus arm or pickup head at a radius smaller than the correct one requires to be offset outward; while at a larger radius than the correct one it requires to be offset inward. The error is approximately proportional to the deviation from correct radius (Fig. 3).

The first step toward improving this situation uses an offset. The pickup is mounted at an angle to the end of the arm (and the mounting point for the arm has to be altered). If we put a considerable offset on, we can see why the *right* offset corrects matters very considerably.

Using too much offset, as shown in Fig. 4, there will again be only one radius of correct tracking for any particular mounting position of the arm. But this time, when the pickup is playing at a smaller radius the offset has to be more inward than that actually used. At a radius larger than the correct one the offset has to be more outward. We have reversed the situation that prevailed with the straight arm.

Somewhere in between these two extremes the offset will be much nearer to correct all the way across the record. This is what determines the correct offset, as shown by Fig. 5. This time we set the arm mounting to give perfect tracking at one radius near the middle of the playing area of the record. Then the deviation is very much smaller and also it is in the *same* direction, whether you go inside or outside the correct radius. Both ways the angle of offset should be a little bit more inward. But the deviation from correct has become extremely slight.

An even closer approximation to correct tracking can be achieved by slightly moving the mounting point for the arm, putting it a small fraction of an inch further from the turntable's center, the offset slightly incorrect at the center of the playing band. Now there will be two points across the record where the offset is correct and it will be incorrect at the inside, the center and the outside of the playing band. The direction of deviation will be the same at the inside and outside and in the opposite direction of the center of the playing area.

This reduces the maximum angle of tracking error to a very small amount —about 1° or less, depending upon the dimensions of the arm and the record.

At this point it should be mentioned that it is immaterial, as far as tracking is concerned, whether the pickup is mounted at an angle, on a straight arm or in line with the end of a curved arm, provided the basic geometry is the same (Fig. 6).

When the arm is correctly mounted, distortion due to tracking error is extremely small; in fact it will be smaller than distortions due to other causes at present—that in the record due to recording equipment, in many instances, and also in the pickup due to nonlinearity of damping material and other factors. However, high-fidelity enthusiasts are perfectionists so they seek to eliminate all possible causes of distortion however small.

One method is to use a radial arm, which theoretically gives perfect tracking all the way. In this case the pickup is mounted on a slide rather than on a hinged arm (see Fig. 7). This needs a short pickup arm from the slide to the stylus point, which is not necessarily a serious disadvantage.

The difficult thing in this design is to get a sufficiently free sliding action because a good pickup should require no more than 1 gram vertical force on the stylus to keep it in the groove. It requires a very free sliding action to get the friction down to a very small fraction of a gram, which is necessary if we are to avoid displacement of the stylus due to friction.

The trapezoid arm

Another approach uses the double-hinge arm. The B-J is an example of this construction. This is based on the information shown in Figs. 3 and 5 for the straight and offset arms. If we use, basically, a straight arm and then change the angle of offset as the pickup moves across the record, we can make a first-degree correction for track-

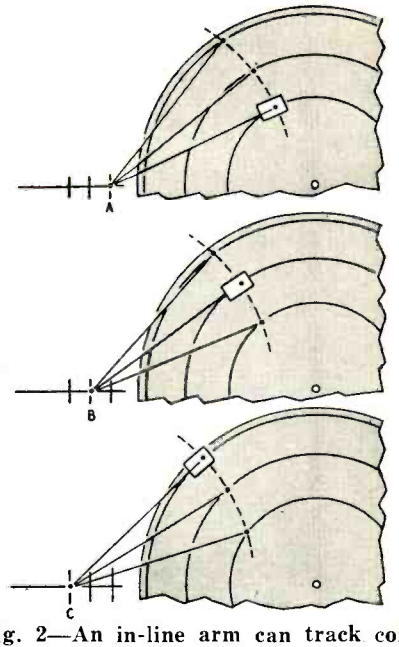


Fig. 2—An in-line arm can track correctly at only one point.

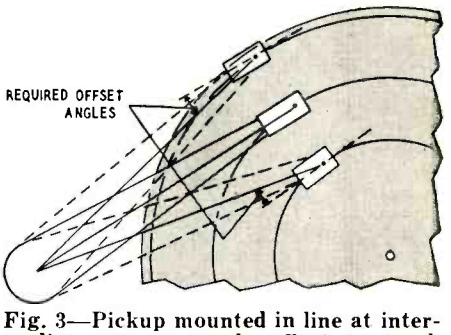


Fig. 3—Pickup mounted in line at intermediate groove needs offset to track correctly at inside of outside grooves.

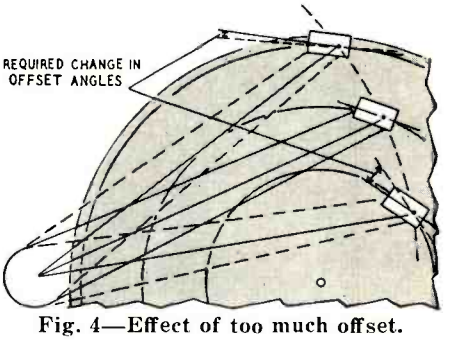


Fig. 4—Effect of too much offset.

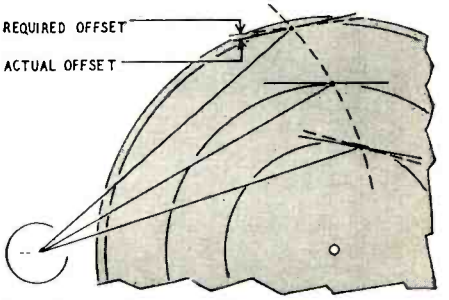


Fig. 5—Optimum offset reduces deviation to a minimum.

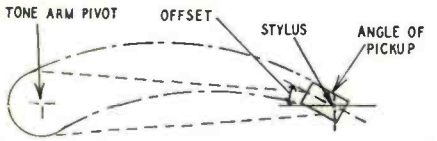


Fig. 6—It makes no difference if the arm is straight or curved, if the length from tone-arm pivot to stylus and the offset angle remain the same in each case.

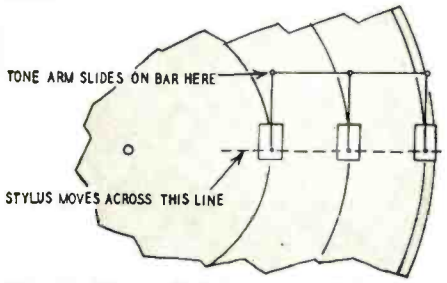


Fig. 7—The radial tone-arm slides on a bar and the stylus moves along the turntable's radius.

ing error. Using a double arm with a trapezoid action (a slightly offset parallelogram effect), the angle of offset changes due to the difference in the two short arms of the trapezium. This is shown in Fig. 8.

The link motion of the pickup arm changes the angle as the pickup moves across the record. Now, correct tracking is achieved at more points across the record and the deviation *between* the points of correct tracking is even smaller.

The first-degree step in this direction is based on a modification of the straight arm. This makes both of the long links of the movement equal. The number of correct points across the record is increased to three.

However, by making the two long links slightly different, which makes the arm more equivalent to an offset arm with correction for offset at different points across the record, the number of correct points can be increased to five. This means, of course, *provided the arm is accurately mounted*, the tracking is virtually correct all the way because the angle of deviation between five correct points must be extremely small.

The problem with this kind of arm is that, instead of having one tone-arm pivot, you have four. This leads to the possibility of four times as much friction in the movement. Also there is four times the possibility of play or slack, developing looseness in action. Extremely good pivots must be used, without any play whatever and with extreme freedom of movement to prevent introduction of any friction that may oppose the movement of the stylus across the record.

The principal reason the straightforward simple arm with an offset continues to be preferred is because it has only one pivot in a horizontal direction at the mounting point of the tone arm.

Using just the simple arm with an offset, the length of the arm determines the amount of deviation. Doubling the arm's length reduces the amount of deviation across the record by about 50%.

Conversely, using a smaller recorded area, as occurs on the 45-rpm record, a shorter arm can be used with a smaller deviation, provided the offset angle is correct for this particular *range* of radii. This was the reasoning behind the development of the original 45-rpm records: to produce a more compact unit with a shorter tone arm while still maintaining the same degree of accuracy in tracking available with the larger recordings and using a much longer tone arm. This is illustrated in Fig. 9.

The right offset

The correct offset for a tone arm (which is not usually adjustable so, if your tone arm is not correct, there is little you can do about it) is determined by the range of playing radii encountered in the record. The following table gives the average range of playing radii for different types of records, together with the design radius on which correct offset for this type should be based.

Type of Record	Radii (inches) Inside	Outside	Design
45-rpm	2.1	3.3	2.65
78-rpm, 10-inch	1.75	4.75	3.07
78-rpm, 12-inch	2.	5.75	3.65
33-rpm, 10-inch	2.5	4.75	3.55
33-rpm, 12-inch	2.5	5.75	4

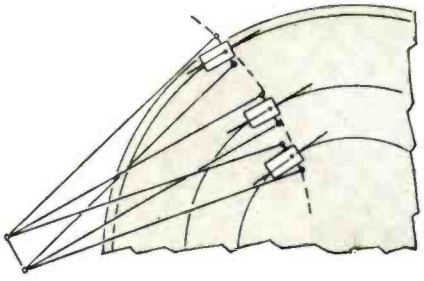


Fig. 8—Simplified construction shows action link-movement (trapezoid) arm.

The old 78-rpm records go down to a smaller inside radius than do the modern LP's. If we take the whole range of recordings including both LP's and 78's as a basis, we should come up with a slightly different answer for offset angle from that using only LP's. If you want to play 45's as well, this further complicates your choice. I prefer to use an offset and mounting position to suit 12-inch LP's and allow a little more tracking distortion at the inside of 78's and 45's. As the distortion on 78's usually starts out larger than on LP's, this seems to be the best balance of arrangement.

The offset should be such that the correct playing position, when only one correct playing position is selected, is a little inside of the mean radius of playing, as shown in Fig. 10. Then the tone-arm mount is moved a small fraction of an inch farther away from the turntable so as to have two correct radii, near the inside and outside of the playing band.

How to set up

Finally we come to the question of how to set up the arm correctly to produce the best approximation to correct tracking across the record. In the case of a straight arm the best compromise is to have the tracking correct about one-third of the distance from the inside radius to the outside radius. This will then minimize the error at both inside and outside radius —both will be about equal.

For the offset arm there are a number of procedures. Most manufacturers specify either an overhang, by which is meant the distance between the stylus point and the turntable center when the arm is swung so as to cross the center of the turntable, shown as A in Fig. 11, or the spacing between the turntable center and the tonearm mounting point, shown as B in Fig. 11.

Gauges of different construction have also been described for measuring the overhang with a certain degree of precision. I have found another approach quite useful and use an ordinary transparent protractor. This method has the advantage of giving a much better visual idea of just what you are trying to do and not requiring a specially made tool.

It consists of laying the protractor

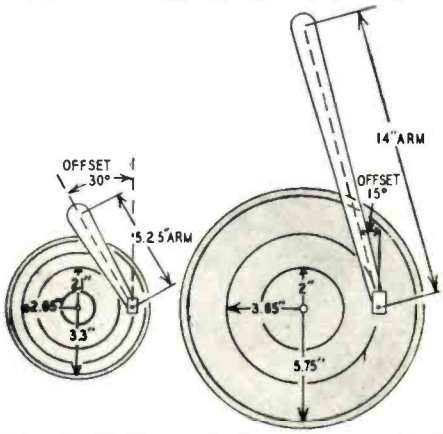


Fig. 9—A narrower band of recording makes a shorter tone arm possible without increasing tracking error.

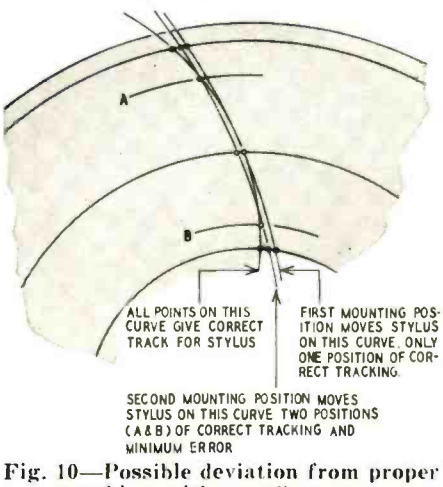


Fig. 10—Possible deviation from proper tracking with an offset arm.

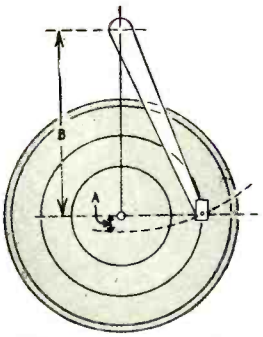


Fig. 11—Offset-arm mounting is specified in overhang (A) or distance from tone-arm mount to turntable center (B).

across the disc so the straight line between 0° and 180° lies along the radius of the record or turntable. Then the 90° line will be a tangent to the radius or should lie along the groove at this point. The stylus is rested upon the intersection or center point of the transparent protractor. If you now look along the 90° line between the pickup

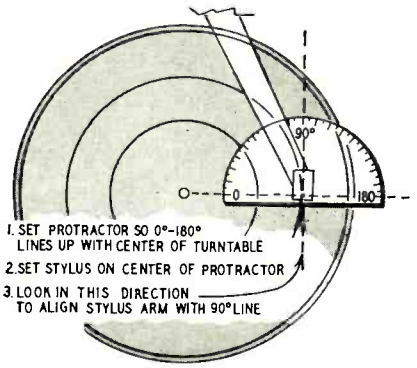
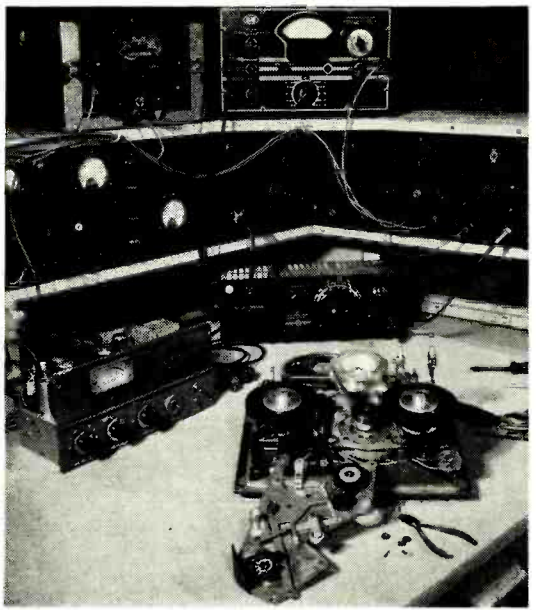


Fig. 12—Checking tracking visually.

arm and the protractor, you will be able to see whether the stylus arm of the pickup is in line with the 90° line on the protractor (see Fig. 12). If it is and the position you have chosen for the stylus point to rest represents the medium radius of playing, you are pretty close to the correct mounting point for the tone arm. If not, the tone arm, turntable and protractor can be moved to find a suitable mounting point.

Technically, when you get these two in line you should move the tone-arm mounting point from 1/16 to 1/10 inch farther away from the turntable's center. This will then get the correct position where there are two points of correct tracking and a minimum deviation across the record. Using this method, however, you will find it is extremely difficult to tell when you are exactly right, within 1/10 inch, especially if you are using a tone arm with a length of 9 inches or more.

You can also use this method to check accuracy of tracking through the record from inside to outside and if you need to, choose a better compromise for the mounting position. It may also give you some idea of how academic are the claims that the offset arm does not achieve *perfect* tracking. The degree by which it misses is really so small as to be inconsequential compared to other causes of distortion. END



Another view of the service bench featured on our cover.

AUDIO SPECIALISTS

THE photograph on our front cover shows a corner service bench used by service technicians of the Sigma Electric Co., New York City, to do special audio service work. On the upper shelf is a D & R flutter meter and a Barker & Williamson distortion meter, necessities for checking quality high-fidelity record players, tape recorders, tuners and amplifiers.

On the lower shelf, at the left, part of a voltage-regulated power supply is seen. To its right, in the corner, is a Variac, into which the Ampex 601 undergoing servicing is plugged. The Ampex tape unit, already partially stripped down for inspection and repair, is in the foreground. The right side of the lower shelf is occupied by an audio amplifier, specially designed to accommodate a very wide variety of inputs and outputs so that any preamp, tuner or record changer can be thoroughly checked. At the extreme rear, on the bench, a General Radio oscillator, for determining frequency response of high-fidelity equipment, can be seen.

Sigma Electric is now completely an audio service company. All types of high-fidelity equipment are repaired. Amplifiers, preamps, tuners, tape recorders and record changers, from an inexpensive home unit to precision broadcast equipment passes through their repair shop. An official service station for nine brands of tape recorders and an even larger number of tuners and amplifiers, Sigma employs 21 persons, including 5 doing clerical, counter and shipping work. The other 16 are technicians or assistants.

Although general service work, including radio and television, was once handled (see photo on page 37, RADIO-ELECTRONICS for June, 1954), at present the only deviation from high-fidelity audio units is the servicing of electronic-flash equipment. For this specialized work they hold franchises from four manufacturers of electronic-flash equipment.

The firm is owned by Arthur Peikes and Wilfred Goldstick, both of whom hold Bachelor of Science degrees from the University of Toronto Engineering School. Sigma Electric was started when these two men formed a partnership in 1949 to construct audio accessories on a contract basis and to service Brush tape recorders. END

Loudspeakers and acoustic fundamentals

By PAUL W. KLIPSCH*

MY letter in the May issue (reprinted here) has stirred a response from an unexpected quarter. It was far from my mind to offend one of the internationally respected pioneers — elder statesmen — in the audio art. I was pointing at some of the "new and marvelous inventions" which violate the principles of physics.

The response by Mr. H. A. Hartley (July, 1957) points out quite accurately that 1 acoustic watt in a living room would produce painful sound pressures. The response also accuses me of abandoning the scientific attitude and becoming dogmatic and inaccurate. I regret provoking this response because I have no desire to trap or provoke anybody into an inadvertent misstatement.

The facts behind my letter are:

As for the amount of motion to produce distortion, I refer to G. L. Beers and H. Belar "Frequency-Modulation Distortion in Loudspeakers," *Proceedings of the IRE*, Volume 31, No. 4, pages 132-38, April, 1943. They showed that a cone performing an excursion of ⅛ inch (amplitude of 1/16 inch) produced 10% distortion by frequency modulation of a 5,000-cycle tone, expressing distortion as sideband amplitude. They mentioned that as low as 3% distortion causes perceptible change in quality. Probably listeners were less discerning in 1943 than now.

In good tape machines a total wow and flutter of 0.1% is just barely tolerable. Taking this to be true for the frequency-modulation distortion of a loudspeaker, then the cone must move less than 1/1,000 the velocity of sound or less than 34.4 centimeters per second. The amplitude of motion is expressed by the equation:

$$A = A_o \sin \omega t$$

where A is the displacement at instant t, A_o is the maximum displacement (in each direction) and ω is 2π times frequency, the equation for velocity of movement is found by differentiating:

$$V = \frac{dA}{dt} = A_o \omega \cos \omega t$$

The maximum velocity occurs when $\cos \omega t = 1$, or $V = A_o \omega$.

Thus, at a frequency of 50 cycles per second, $\omega = 2\pi \times 50 = 314$, and we have decided that V must not be more than 34.4 cm/sec. So the maximum permissible value of A_o is

$$A_o = V/\omega = 34.4/314$$
$$= 0.11 \text{ centimeter or } .043 \text{ inch maximum amplitude or } .086 \text{ inch maximum excursion.}$$

This "just tolerable" distortion excursion of .086 inch is a little larger than the .06 inch used in my original "fundamentals"; the difference is not an error, but a rather close agreement.

Experience indicates the factual significance of fluttering frequency shifts even as small as 0.1%. The higher the modulated frequency the greater the audible distortion, usually, up to about 6,000 cycles.

These facts pertain whether the cone is driven by a voice coil or a broom handle, is hung on a high-compliance suspension or low, or is high or low efficiency. Actually the "fault" would exist with a "perfect" speaker. *Modulation distortion is not a fault but a property of a vibrating surface or air boundary layer; it is minimized by reducing excursion.*

Far from abandoning the scientific attitude and becoming dogmatic and inaccurate, I would point to the vast supporting literature behind my statements, and the simple mathematics above. Kellogg used many speaker units to limit excursion to .06 inch in a year when intermodulation distortion had not yet been mentioned. (E. W. Kellogg, "Means for Radiating Large Amounts of Low-Frequency Sound," *Journal Acoustic Society of America*, Volume 3, No. 1, Part 1, pages 94–110, July, 1931. Mr. Kellogg was co-inventor of the Rice-Kellogg speaker. See *Transcript AIEE*, 1925.) (The name Kellogg was unfortunately misspelled "Keller" in my original letter.)

This is not to deny that many speaker drive mechanisms can disdainfully handle ¼ inch or larger excursion, with relatively low *harmonic* distortion. But

THE MAY LETTER

Dear Editor:

Much air must be moved to radiate appreciable power at low frequencies. The following table shows the excursion necessary to produce one acoustic watt output and the acoustic power output capability of a 10-inch piston (equivalent to a 12-inch speaker) executing an excursion of .06 inch (peak amplitude of .03 inch) which is regarded as about the maximum limit for tolerable distortion.[1]

Frequency	Excursion Needed To Radiate 1 Acoustic Watt	Power Radiated At .06-Inch Excursion Acoustic Watt
60	0.7	.0072
50	1.0	.0036
40	1.5	.0016
35	2.0	.00085
30	2.8	.00045

These figures are independent of box shape, suspension compliance or amplifier power supplied.

The facts of life in acoustics are simply that the undistorted output of a small cone at low frequencies would be too small to hear, regardless of the "response curve".

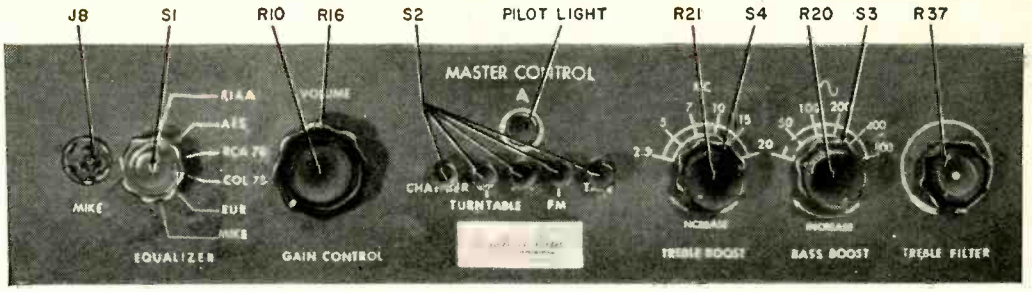
In 1931 E. W. Kellogg proposed the use of 54 cones of 8-inch diameter to radiate 1 watt at 30 cycles, and the use of a corner horn. Structural designs have improved in the following 25 years but acoustical fundamentals have not changed.

There have been little speakers with big claims since the Edison phonograph of 1901, but nobody has devised a miniature 32-foot wavelength.

PAUL W. KLIPSCH
Klipsch & Associates
Hope, Ark.

[1]Frank Massa, *Acoustic Design Charts*, Blakiston Co., Philadelphia.

*Klipsch & Associates, Hope, Ark.



Front panel of the completed unit.

HI-FI MASTER CONTROL UNIT

Easily built 6-tube circuit is more versatile than most commercial control units

By JOSEPH MARSHALL

A SIX-TUBE control unit needs justifying. Even the crankiest hi-fi crank is likely to be taken aback by such extravagance, although several commercial units use five or six tubes. My justification is that it produces a versatility beyond that of commercial control units and approaches that of equipment used by broadcast stations and recording companies. The complete circuit is in Fig. 1.

The principal feature is the tone control circuit. Any two octaves from 20–20,000 cycles can be boosted 20 or 25 db with an insignificant increase in distortion. The bass and treble channels have six peaking points about an octave apart which are selected by switching.

This is highly useful to the record collector. Anyone who has tried playing ancient recordings on a modern hi-fi system knows that they usually sound pretty horrible. With this equalizer the majority of them produce a satisfying sound.

Its versatility is also useful to the amateur recorder who makes off-the-air, off-the-record or live recordings.

A rolloff or high-frequency filter provides a way to minimize noise, beatnote interference, phase distortion in FM and similar distractions with little loss of musical quality.

The biggest problem of hi fi is to provide at a level tolerable in the home a tonal balance with some resemblance to that in the concert hall. Both people and rooms require different listening levels and the rooms themselves require compensation. No single loudness curve, slope, crossover or single combination of them can possibly suit anything but a fraction of the needs. This control unit will provide just about any conceivable tonal balance to take care of almost any acoustic condition, playback level or any listener's personal taste.

Finally it provides a way for many hard-of-hearing persons to enjoy high fidelity. Loss of hearing involves, not only a loss in hearing acuity, but usually a serious modification of the hearing curve too. Most of the hard-of-hearing have holes in their hearing curves and unfortunately these holes do not always appear at the ends of the spectrum where they can be compensated by ordinary tone controls.

The tone control circuit of this unit fills any two such holes with 20–25 db of boost. The network is that used in most audiometers to measure and test hearing. Not everyone will find perfect compensation, but the control unit will do a good job for many.* Each individual can adjust the controls for the

*Note, however, that authorities have found that flat hearing aids are most acceptable to the hard-of-hearing.—*Editor*

Loudspeakers and Acoustic Fundamentals (Continued)

music is not just one single tone or frequency at a time; it is a terrifically complex mixture of high and low tones. Even if the bass speaker is crossed over to a tweeter or mid-range at 500 cycles, a mixture of 40 and 400 can produce unpleasant distortions when the diaphragm amplitude becomes large. Again, intermodulation is not a fault but a property of sound radiators performing large excursions.

The remedy to limit distortion is adequate radiating area and reduced excursion. As Kellogg proposed in 1931, a group of 8-inch cones can be used to produce large amounts of power.

Mr. Hartley states in his reply, "If we accept the Massa data . . . which I, for one do not . . ." The reference is to *Acoustic Design Charts*, Frank Massa, Blakiston, 1942. Granting that any particular piece of data in any publication might be in error, due perhaps to a misprint, I checked the particular data by computation from earlier and more basic information and as far as I could tell the data were accurate. Incidentally, the basis for the information goes back to 1877 when a great British physicist derived the function of a piston vibrating in a hole in an infinite wall (Lord Rayleigh, *Theory of Sound*, MacMillan, 1877). The Massa data were not used without question, they were checked.

Mr. Hartley closed his remarks with an attack on the choice of driver units used in our speaker systems. No defense is needed here, for our bass driver is capable of nearly ¾ inch total excursion with very low *harmonic* distortion. And a ¾-inch motion of a 15-inch speaker cone can really pump a lot of air. But this when used in a horn develops large pressures at almost invisible amplitudes, due to the way the acoustic matching of the horn provides an air load for the diaphragm. With these very small amplitudes, the doppler and amplitude distortions are extremely low, compared with what the same driver would produce as a direct radiator.

For my part, I would question by what measure a speaker is required to pass a test of ½-inch excursion without cross-modulation and by what measure a speaker of any size can be claimed to be flat to 0 cycles or to be nonresonant in spite of being a mass suspended on a compliance.

Hermeneutics, the art of not being fooled, could well be applied to this new high-fidelity art wherein hard well-established facts are disputed, wishful thinking is copy for ads and rave articles, and truth becomes a relative quantity. An especial premium should be placed on intellectual honesty, and the reader should school himself in hermeneutics and learn to distinguish fact from opinion and well-grounded opinion from mere wishing. I believe my own writings have been marked for the reader to distinguish between facts I present and my opinions. END

tonal balance that sounds best and most natural to him. The only change is that of adding a phone jack at the output. Headphones can be used across the output of the cathode follower.

Specifications

A choice of five input sources is provided through pushbutton switches. The phono equalizer (Fig. 2-a) uses a cascode amplifier and provides a choice of five playback curves: two for LP discs (RIAA and AES) and three for 78 rpm (one with a 500-cycle crossover and a 6-db drop at 10,000 cycles, another with a 350-cycle crossover and a slightly greater drop and the third with a 250-cycle crossover and no treble slope). Specifications for additional equalizers are shown in Fig. 2-b.

The tone control circuit uses three parallel channels: the flat, bass and treble. Tone control networks are the Wien-bridge type and provide a broadly peaked curve. Each channel gives a choice of six peaking points about an octave apart. The extreme positions in each channel have the effect of changing the crossover and slope.

In normal use these positions may be used to increase the presence of some favored instrument. You can also improve the quality of old acoustic records. An output jack is provided for a recorder—this output is unaffected by the tone control.

Concentric controls are used for both volume (loudness) and gain (level). The volume control varies the gain of the flat channel. Relative boost of both bass and treble channels will vary with the setting of this control. At maximum the bass and treble channels cannot produce more than 6 db of boost, while at minimum 20 or 25 db is possible. Therefore, the volume control provides an automatic increase or decrease of boost with volume level to take care of the Fletcher-Munson effect and is actually a loudness control.

The volume control adjustment is exactly opposite to that generally used. Usually the tonal balance is adjusted at maximum output levels. When the volume is reduced, the loudness control curve is supposed to provide compensation which produces a good balance at the desired level. This is the wrong way of getting the desired end and is not used in this unit. The control is

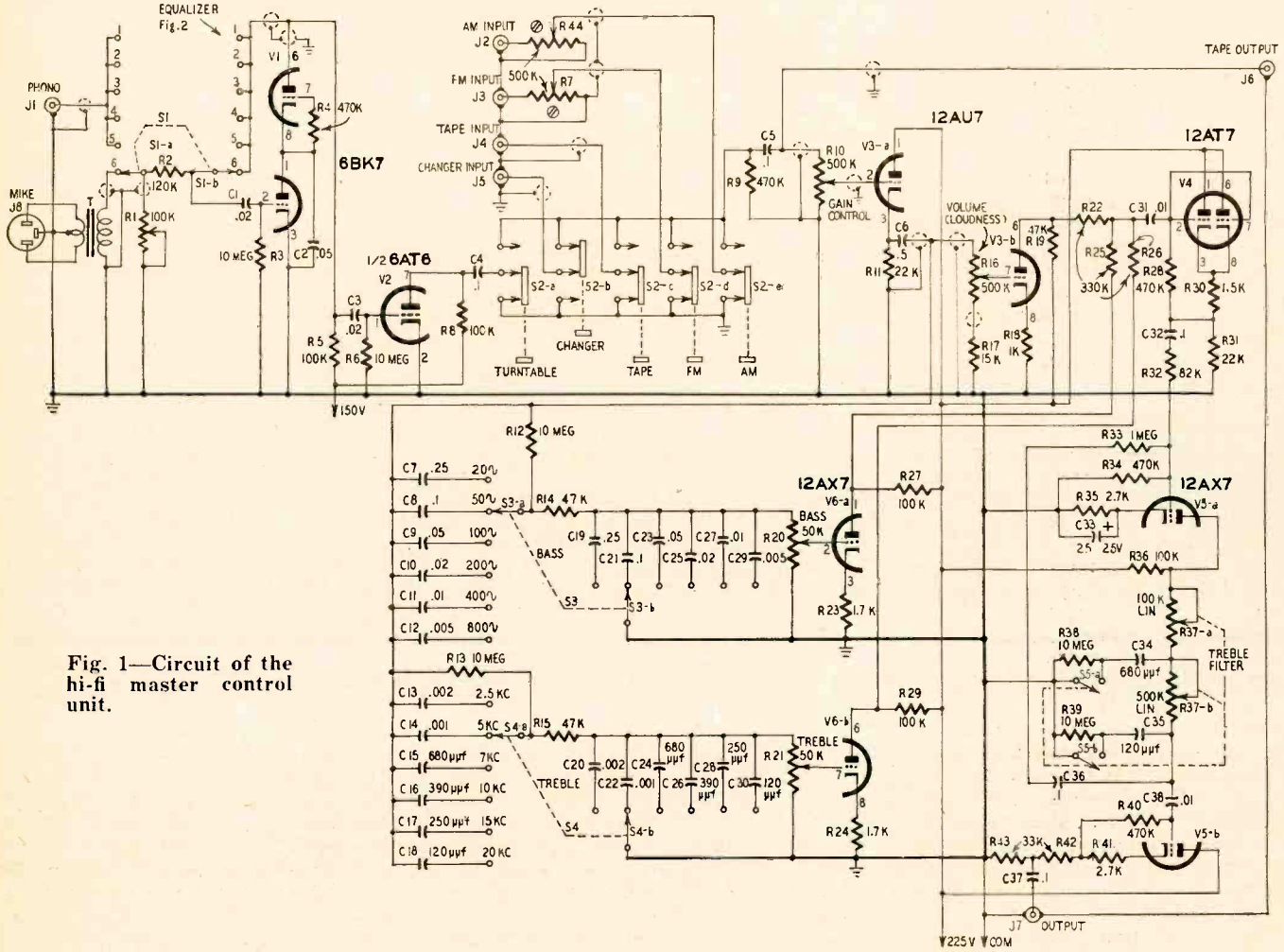


Fig. 1—Circuit of the hi-fi master control unit.

R1—pot, 100,000 ohms, linear
R2—120,000 ohms
R3, 6, 12, 13, 38, 39—10 megohms
R4, 9, 28, 34, 40—470,000 ohms
R5, 8, 27, 29, 36—100,000 ohms
R7, 44—pot, 500,000 ohms, audio screwdriver-adjust concentric (Centralab AB-60)
R10, 16—pot, 5000,000 ohms (Centralab F141+R2-42)
R11, 31—22,000 ohms
R14, 15, 19—47,000 ohms
R17—15,000 ohms
R18—1,000 ohms
R20, 21—pot, 50,000 ohms, audio (Centralab B-32)
R22, 25, 26—330,000 ohms
R23, 24—1,700 ohms
R30—1,500 ohms
R32—82,000 ohms
R33—1 megohm
R35, 41—2,700 ohms
R37—pot, 100,000—500,000 ohms, linear (Centralab F1-31+F14, Solder shafts together and add KB-2 dpst)
R42, 43—33,000 ohms
All resistors ½ watt, see text for type
C1, 3—.02 µf, 200 volts
C2—.05 µf, 200 volts
C4, 5, 32, 37—0.1 µf, 200 volts
C6—0.5 µf, 200 volts
C7, 19—0.25-µf disk
C8, 21—0.1-µf disk
C9, 23—.05-µf disk
C10, 25—.02-µf disk
C11, 27—.01-µf disk
C12, 29—.005-µf disk
C13, 20—.002-µf disk
C14, 22—.001-µf disk
C15, 24, 34—680-µµf ceramic
C16, 26—390-µµf ceramic
C17, 28—250-µµf ceramic
C18, 30, 35—120-µµf ceramic
C31, 38—.01 µf, 400 volts
C33—25 µf 25-volt electrolytic
C36—0.1 µf, 400 volts
J1—7—phono jacks
J8—microphone jack
S1, 3, 4—2-pole 6-position rotary
S2—single-pole 5-position pushbutton or rotary
S5—dpst Centralab type KB2 on R37
T—hi-fi mike-to-grid transformer
V1—6BK7
V2—6AT6
V3—12AU7
V4—12AT7
V5, 6—12AX7
See-Zak Chassis: (see text) 2—R28; 2—R216; 1—P816; 1—P616
Vector No. 8NN-7A5-4 (see text) (2)
Vector No. 10-3N-11A7-4
Miscellaneous hardware

turned to minimum and GAIN CONTROL is set for a desired loudness of mid-frequencies. Now the bass and treble controls are adjusted for the desired balance. Then when volume is increased with the volume control, bass and treble boosts are reduced until at maximum volume you have just about a flat response. For broadcasting and similar uses the volume is regulated with the GAIN CONTROL, which has no effect on the compensation.

The unit has enough gain to provide at least 2 volts of output, either with 20-db boosts at any two points or flat.

The tone controls provide only boost and no means for attenuation. There is a treble filter with a 12-db-per-octave slope and a continuously adjustable crossover between 4,000 and 15,000 cycles.

The total IM distortion at a 2-volt output ranges between 0.3 and 0.7%. At lower levels it is insignificant.

A simple filter is included to attenuate transients due to warped or eccentric records, FM squelches, shortwave fading, beatnotes of stations on the same broadcast channel but whose frequencies differ by 1–20 cycles, etc. The filter does little good on rumble whose frequency is usually between 20–30 cycles. If you are troubled by rumble, considerable relief can be obtained by reducing the value of the output capacitors of the phono preamp and the following input capacitor to .05 or .03 μf.

Power supply

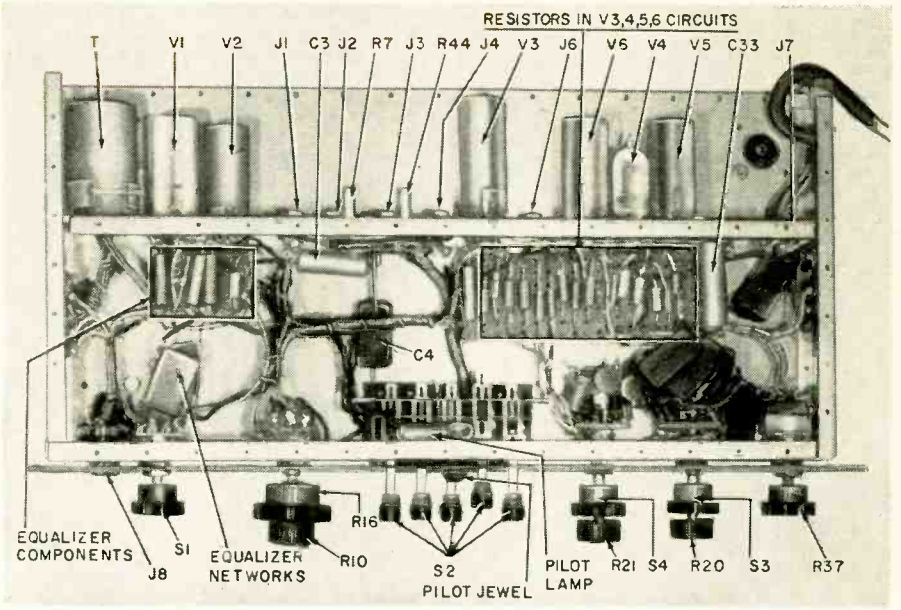
An *independent* well filtered power supply with dc for the heaters is essential. Any attempt to feed this preamp from the power amplifier's power supply is almost certain to result in motorboating or instability. The supply diagrammed (Fig. 3) uses two regulator tubes to supply 255 volts to the tone control stages and 150 volts to the phono channel. The .05-μf capacitors in shunt with the regulators minimize hash. If the preamp shows any tendency to oscillate at mid or high frequencies, try removing this capacitor before making any other checks. Dc for the heaters is necessary to keep hum down. Even 1 or 2 μv of hum applied to the first phono tube will produce an output of several hundred millivolts.

Building the unit

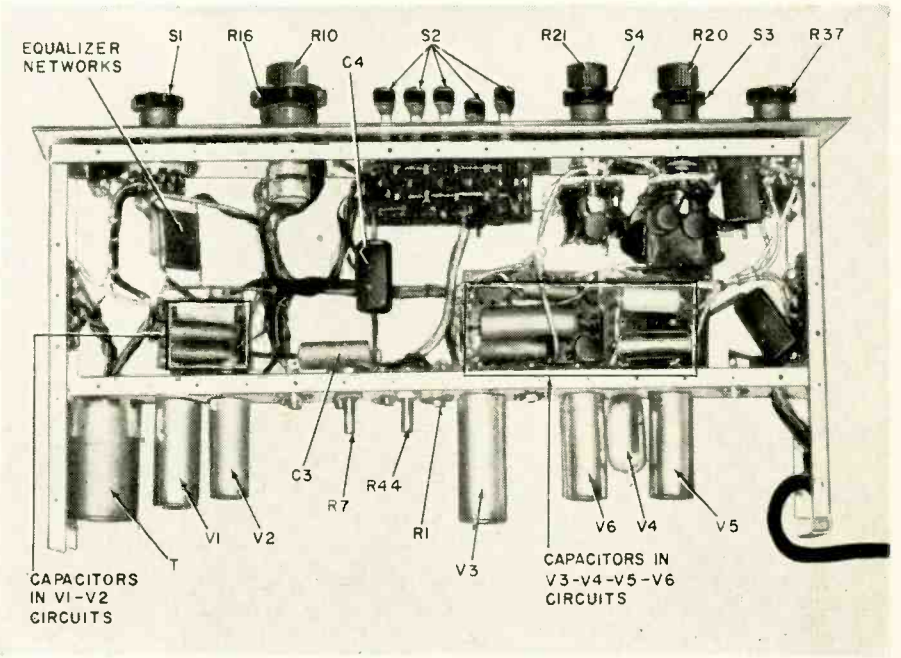
The construction uses See-Zak chassis components and Vector turret walls. The chassis comes in pieces like an Erector set. I used two 16-inch rails for the front and back, two 8-inch rails for sides, one 8-inch bottom plate and a 6-inch top plate. The rear rail is set in 6 inches from the front. Don't worry about fastening it to the side rails since the top and bottom plates will tie the whole works together. (These chassis are available at many radio parts distributors or can be obtained from U M & F Manufacturing Co., 10929 Vanowen St., N. Hollywood, Calif.)

The Vector turret walls are combinations of terminal strips and tube sockets and are available in almost any combination. Here we use one two-tube wall for the equalizer, a three-tube wall with one socket removed and a two-tube wall for the rest of the stages. If you cannot obtain these, the more easily available Vector turret sockets may be used instead.

The turret walls are mounted on the rear rail along with the mike transformer, input and output plugs and level controls. Resistors are mounted on one side of the walls, capacitors (and a few resistors) on the other side. Connections from tube sockets to components are short. Connections between components are made on the wall. A common ground bus of heavy wire is run along the edge of the turret walls under the last series of holes.



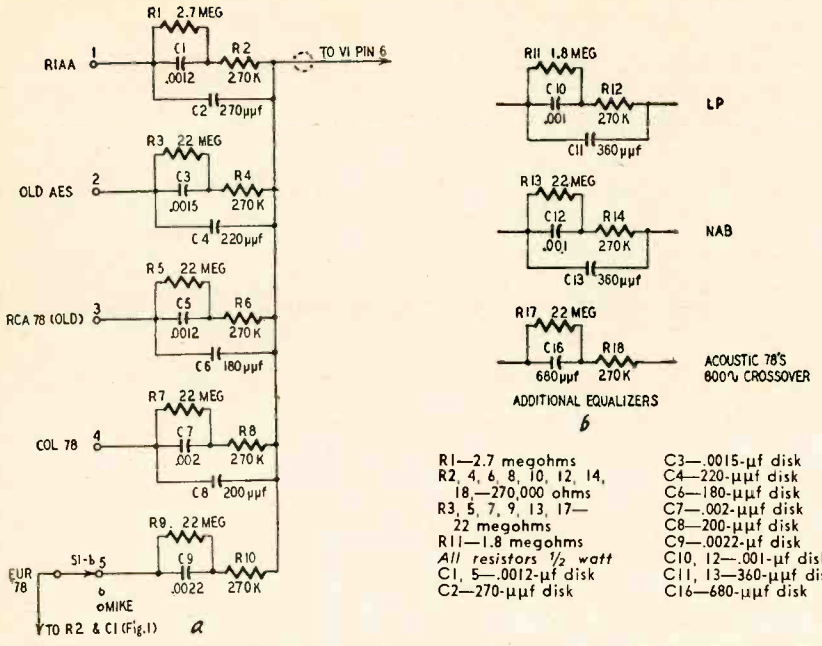
Internal layout as seen from the top.



Bottom view of the control unit.

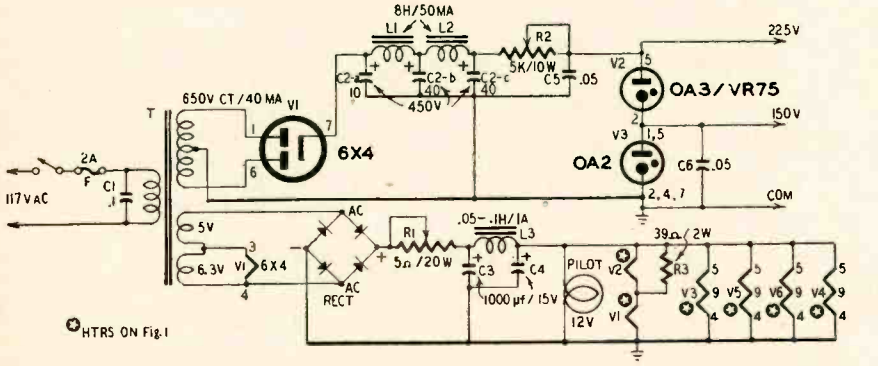
Components which are grounded are mounted so that the tinned lead of the grounded end can be put through the hole, wrapped around the ground bus and soldered. The terminals at the bottom of the walls are used for voltage supply and any interconnections which may be required.

The controls are mounted on the front rail. A couple of these R21-S4 and R20-S3 are not commercially available: the combination of double-pole six-position rotary switch and a concentric potentiometer. If a standard 3-inch chassis is used, there will be room for independent switches and potentiometers. Replacing the push-button switch with a rotary unit will also give more room. Capacitors in the tone control channels are grouped at the switches.



R1—2.7 megohms
R2, 4, 6, 8, 10, 12, 14, 18,—270,000 ohms
R3, 5, 7, 9, 13, 17—22 megohms
R11—1.8 megohms
All resistors ½ watt
C1, 5—.0012-µf disk
C2—270-µµf disk
C3—.0015-µf disk
C4—220-µµf disk
C6—180-µµf disk
C7—.002-µµf disk
C8—200-µµf disk
C9—.0022-µf disk
C10, 12—.001-µf disk
C11, 13—360-µµf disk
C16—680-µµf disk

Fig. 2-a.—Equalization circuit for the control unit; b—additional equalization networks.



R1—5 ohms, 20 watts, adjustable slider
R2—pot, 5,000 ohms, 10 watts
R3—39 ohms, 2 watts
C1—0.1 µf, 600 volts
C2—10-40-40-µf 450-volt electrolytic
C3, 4—1,000 µf 15-25 15-volt electrolytics
C5, 6—.05 µf, 600 volts
F—2 amps
L1, 2—8-h 50-ma chokes
L3—.05-0.1-h 1-amp choke
T—Power transformer, primary 117 volts; secondary 650-volt center tap, 40-ma; 5 volts, 2 amps; 6.3 volts, 2 amps (Stancor PC8406 or equivalent)
V1—6X4
V2—OA3/VR75
V3—OA2
Rectifier—TAB 18/14-volt 2-amp bridge

Fig. 3—Power supply for control unit. Note dc filament supply.

When the front and rear rails are wired as far as they can be, the side rails are attached to the front and the 6-inch plate is temporarily fastened with three or four screws. Now start interwiring. I used fine shielded and insulated phono input leads for the leads from the input jacks to various portions of the circuit. *This shielding is necessary.*

Except where a short direct connection was possible, I ran these interconnecting leads along the ground bus and then cabled the works with twine. Except for shielding the indicated leads, there is nothing critical about the wiring. Duplicate the layout as closely as possible for highest insurance, but if a similar but not exactly identical layout is used, no trouble should arise. I used deposited-carbon resistors in all stages preceding the rolloff stage, but believe that if deposited-carbon types are used only for the plate loads and wirewound resistors for cathode loads, the others can well be good quality carbons.

Power supply construction

The power supply is separate. In my case it is mounted on the same chassis which supplies power to two amplifiers. There is nothing critical about it, especially if the two regulator tubes are used to establish voltages. The 12-volt ac can be obtained either from a 12-volt filament winding or 6.3- and 5-volt windings wired in series. (If you do not get about 12-volt ac, reverse one winding.) You can use the 5-volt winding for a rectifier with a separate cathode, or use a 6-volt rectifier with cathode (6W4 or 6X4) on the 6-volt winding (see Fig. 3).

Please note that there is a series parallel connection of the 6BK7, 6AT6 and 39-ohm resistor. This value is critical if you want a reasonable life from these tubes. Adjust the potentiometer in the heater supply to provide no more than 12 volts. Remember, the voltage will rise if you remove a tube. The total heater drain of the dc string, wired as indicated, is 1.05 amps.

No other adjustment is necessary. I had no trouble with oscillation or motorboating. If any occurs, the chances are 9 to 1 you have one of the two feedback loops (one in the phone equalizer and the other in the cutoff filter) wired wrong, have accidentally used the wrong value resistor or capacitor or the regulator tubes are not operating properly.

You should have no trouble with hum if you shield the leads indicated and follow the layout. Excessive noise, especially hash and crackling, may be the result of a bad tube or of badly soldered joints which might rectify the hum field which exists in any house.

You are quite likely to have some trouble with microphonic tubes, especially the 12AU7. It can be replaced with the taller 12BH7 which seems to be free of microphonism. The newer 12AU7-A is even less microphonic.

If you want to use a high-impedance mike without the transformer, connect the mike input to the phono–equalizer switch the same way the transformer now is. Incidentally, the transformer of a Ferranti, Electro-Sonic, Fairchild, etc. pickup can be connected directly across the 100,000-ohm input load. Any load up to 100,000 ohms can be provided by varying the load potentiometer. Calibrate with an ohmeter.

The panel is a piece of 1/16-inch aluminum 4 inches wide. Drill it at the same time you drill the front chassis rail by clamping the two together. It was sprayed with Spray-O-Namel in a dark gray glossy finish. Wrinkle, crackle and other finishes are also available in spray cans. (A paint spray that dries to a hammertone finish is available and can be used.—*Editor*) *Do your spraying outside.* The fine mist is likely to spread all over the house and cause domestic havoc. It's tough on the lungs, too. When dry, apply decals for the controls.

Because of the complications in the circuit and construction and in use, I recommend this unit only for special requirements. For most home listening the control unit for Golden Ears (March, 1954, RADIO-ELECTRONICS) will be fully satisfactory. But those who need and can use the versatility will find this control unit like nothing they ever used or heard before. END

Did you make any of these errors in your R-C-coupled amplifier design?

design calculations for R-C COUPLED AMPLIFIERS

By HERBERT RAVENSWOOD

HAVE you ever found a circuit that didn't perform according to the calculations for it? This too common occurrence is often dismissed as being an inherent discrepancy between theory and practice—the idea being that calculations cannot be that accurate or else the measurements may be wrong, so let's just make some adjustments and try to get it right experimentally.

This procedure takes time. Sometimes it completely fails to give us the desired results. It is much better to put theory and practice together and make them both work for us. It has been said that theory is the guide to practice and practice the ratification of theory. Applying this principle to our work on audio-coupling circuits can save considerable time in making calculations and experiments.

Let's start with a simple coupling arrangement (see Fig. 1). The tube may be a triode or pentode, with an ac resistance designated R_a. Plate current is fed from B plus through coupling resistor R_c and signal voltages are coupled to the grid resistor of the next stage (R_g) through capacitor C. We will leave complications, like the cathode-bias resistor, its decoupling and any plate decoupling, for the moment to get the simple circuit straight. Then we can take these factors one at a time.

Gain calculation

The first common mistake, even found in some textbooks, is in stage gain calculations. The accepted method is to take the quoted amplification factor of the tube (μ) and then use the formula:

$$A = \mu \frac{R_L}{R_L + R_a}$$

where R_L is the plate load resistance and R_a the tube ac resistance. When using R_L, don't forget to include the effect of the grid resistance of the following stage. The usual error consists of taking R_L to be just the plate coupling resistor, while the true value for calculating mid-band gain requires using the resistance of R_c and R_g in parallel.

Even this leaves us liable to some error because we are taking for the amplification factor of the tube a quoted value which may not be realized under the operating condition we are using. However, for a good approximate gain figure, take the amplification factor of the tube and use the above formula. Use a corrected value for R_L, taking into account the effect of R_g. This will give us results as close as it is possible to obtain without referring to a complete set of tube characteristics.

To see what the error could amount to, let's take values from a typical triode circuit. Let μ be 100 and R_a 77,000, R_c 220,000 and R_g 470,000 ohms. If we assume R_L is just R_c:

$$A = \mu \frac{R_L}{R_L + R_a}$$

$$A = 100 \times \frac{220{,}000}{220{,}000 + 77{,}000}$$

$$A = 74$$

If we use the correct value of R_L which consists of 220,000 and 470,000 ohms in parallel or 150,000 ohms:

$$A = \mu \frac{R_L}{R_L + R_a}$$

$$A = 100 \times \frac{150{,}000}{150{,}000 + 77{,}000}$$

$$A = 66$$

The difference, as you can see, is appreciable.

The corresponding formula usually used for pentode stages is $A = g_m R_L$. Here we assume that g_m is a mutual conductance of 2 ma per volt (.002 mho or 2,000 μmhos) and we use the same values of R_c and R_g, 220,000 and 470,000 ohms, respectively. The gain, making an incorrect assumption that R_L is 220,000 ohms, is:

$$A = g_m R_L$$
$$A = .002 \times 220{,}000$$
$$A = 440$$

On the other hand, using the correct value of 150,000 ohms for R_L, the gain is:

$$A = g_m R_L$$
$$A = .002 \times 150{,}000$$
$$A = 300$$

This is a difference of more than 3 db.

Calculating the gain of a stage tells us what it will contribute to overall amplifier gain and, if we make similar mistakes in several stages of an amplifier, we may end up 10 or 20 db short.

We also want to know the frequency response, first of individual stages and then for the whole amplifier. Where feedback is used, this is especially important because accurate prediction of the response for individual stages is necessary to determine whether the amplifier will be stable or why it gets into a region of instability.

Low-frequency response

First, let's take the low frequencies. A common but erroneous statement says: The low-frequency response is obtained by comparing the reactance of coupling capacitor C with the resistance of R_g. When the reactance is equal to the resistance, the frequency response is 3 db below maximum at the low-frequency end.

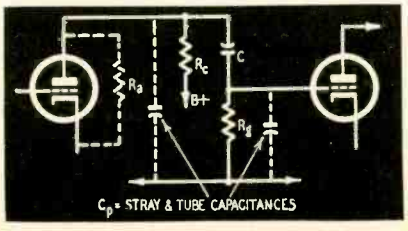


Fig. 1—Simple R-C-coupled stage; C_p is total of stray capacitances shown.

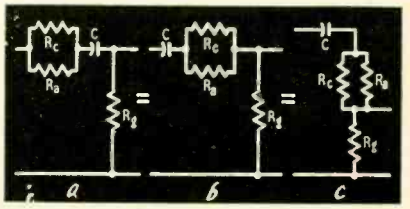


Fig. 2—Step-by-step deduction of how circuit elements contribute to low-frequency response.

This statement fails to take into account the ac resistance of the tube and coupling resistor, both of which enter into the correct formula for predicting low-frequency response. Fig. 2 shows a step-by-step derivation of the correct low-frequency network.

We start by redrawing the circuit to take into account all the impedances. As series elements we have the parallel combination of R_a and R_b in series with C feeding grid resistor R_g. In considering response it makes no difference if we switch the positions of C and the parallel combination of R_c and R_a. Then, by redrawing this arrangement, so the resistors appear as a simple fixed potentiometer with coupling capacitor C feeding, it becomes evident that the correct frequency response is determined by comparing the reactance of C with the combined resistance of R_g in series with the parallel combination of R_a and R_c.

How will this adjustment affect our calculation? Let's take the same example as for the gain calculations and assume a .02-μf coupling capacitor is used. With the triode arrangement the .02-μf capacitor will have a reactance of 470,000 ohms at 17 cycles. To obtain the correct value we should add to 470,000 ohms the equivalent of 220,000 and 77,000 ohms in parallel, or 57,000 ohms. The capacitor will have a reactance of 527,000 ohms at 15 cycles. This is not too serious an error.

Now let's turn to the pentode. This time we will assume that a grid resistor of 220,000 ohms is used and that the pentode plate resistance R_a is 1 megohm. The parallel combination of 1 megohm and the plate coupling resistor's 220,000 ohms is 180,000 ohms. The usual statement which compares the capacitive reactance with the grid resistance would set the 3-db point at the frequency where the reactance of C is 220,000 ohms. This is 36 cycles. Using the correct value of 400,000 ohms obtained by adding 180,000 and 220,000 ohms, the 3-db point is 20 cycles, a large difference.

High-frequency response

Here, too, we find a number of common errors. The correct solution is found by taking all the circuit resistances effectively in parallel. This can be seen in Fig. 3 which shows the equivalent circuit for high-frequency loss. The accepted way of proving that this reduces to an equivalent of three resistors in parallel involves Thevenin's theorem. A little simple reasoning may be better.

Let's take the effect of C_p with each part separately. If R_g is removed, the output voltage will differ from the input voltage due to the current C_p draws through the parallel combination of R_a and R_c. Now suppose that R_a and R_c are replaced with a high resistance approaching infinity to produce a constant current feed through C_p and R_g in parallel. Under this condition there will be a 3-db drop when the reactance of C_p is equal to the resistance R_g.

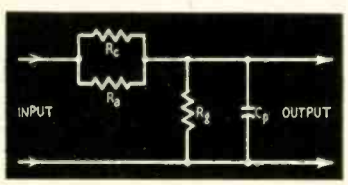


Fig. 3—Basic circuit for high-frequency response. All resistance shown must be taken into account.

Now combine these two ideas to see the effect of C_p when R_a and R_c are effective as well as R_g. We see that first the output voltage is reduced due to the current C_p draws through the parallel combination of R_a and R_c. It is also reduced due to the current which C_p bypasses from R_g. But there is only one value of current in C_p. So the voltage drop must be due to the combined current that C_p draws from the equivalent parallel circuit of R_a, R_c and R_g.

Omission of R_a, R_c or R_g from this calculation will throw the result into error. In the example given, a combination of 77,000, 220,000 and 470,000 ohms works out to 52,000 ohms. The combination of 1 megohm with two 220,000-ohm resistors in parallel produces a total value of 100,000 ohms. The degree of error will depend upon which value gets overlooked.

The biggest error occurs in the case of the triode circuit if the ac resistance is overlooked. The equivalent value of 220,000 and 470,000 ohms in parallel is 150,000 ohms instead of 52,000 ohms. This represents a change in the turnover point of approximately 3 to 1.

The value of C_p is a little difficult to estimate. It is made up of the combination of the plate-to-ground capacitance of the previous tube, the effective grid-to-ground capacitance of the following tube (including any that may be due to Miller effect) and stray capacitance of the wiring. Under the last heading should be included stray capacitance due to the coupling capacitor itself. Often a large coupling capacitor will have as much stray capacitance to ground as all the rest of the circuit put together, and often gets overlooked. Metallized capacitors are particularly susceptible to producing a large stray ground capacitance.

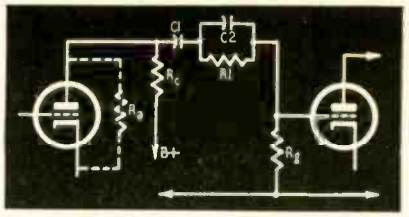


Fig. 4—Treble boost added to an interstage coupling.

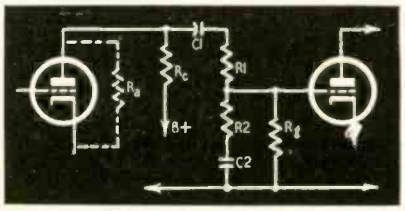
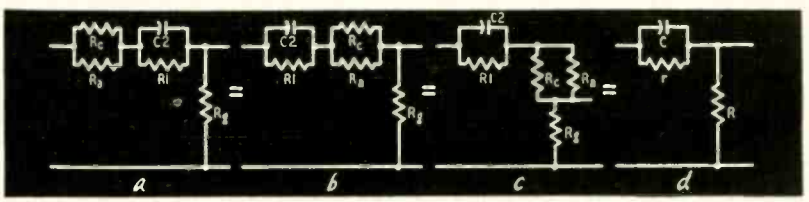


Fig. 5—Adding bass boost—practical circuit.

Interstage equalizers

Before going on to consider the effect of decoupling components, we turn to interstage equalizers because each of the decoupling arrangements can be converted into the equivalent of an equalizer circuit. The same kind of error already mentioned with respect to simple coupling circuits can also occur in the calculation of response of compensating networks, particularly for treble or bass boost, using the arrangements shown in Figs. 4 and 5.

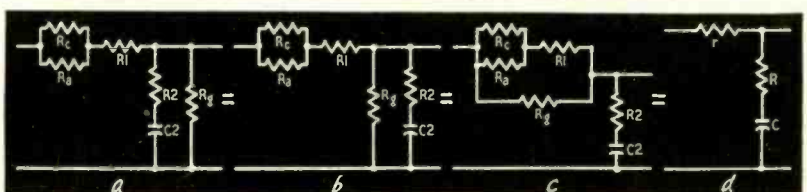
What often happens in calculating the response of these arrangements is that only the obvious components are taken into account. The plate resistance of the preceding stage is often forgotten in both circuits, and in the bass boost circuit a grid resistor is necessary to insure correct bias voltage on the following stage. This also can get left unconsidered sometimes. Using a step-by-step method of transposition to



Inverted rolloff frequency given by $X_c = r$ $\qquad r = R_1$

Final rolloff frequency given by: $X_c = \dfrac{rR}{r+R}$ $\qquad R = R_g + \dfrac{R_a R_c}{R_a + R_c}$

Fig. 6—Reduction of circuit in Fig. 4 to its basic form.



Inverted rolloff frequency given by: $X_c = R$

Final rolloff frequency given by: $X_c = \dfrac{rR}{r+R}$ $\qquad r = \dfrac{R_g\left(R_1 + \dfrac{R_a R_c}{R_a + R_c}\right)}{R_g + R_1 + \dfrac{R_a R_c}{R_a + R_c}}$

Fig. 7—Reduction of actual circuit of Fig. 5 to its basic form.

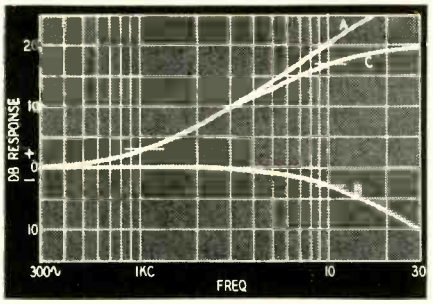


Fig. 8—Graphic construction for frequency response Fig. 6 circuit: curve A, inverted rolloff; curve B, direct rolloff; curve C, resultant response. Design frequencies shown by short horizontal lines cutting curves.

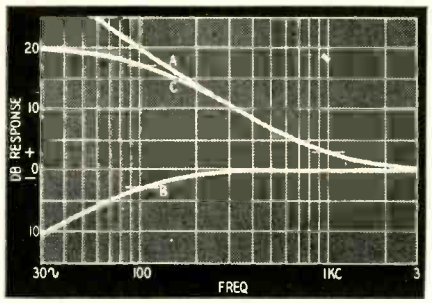
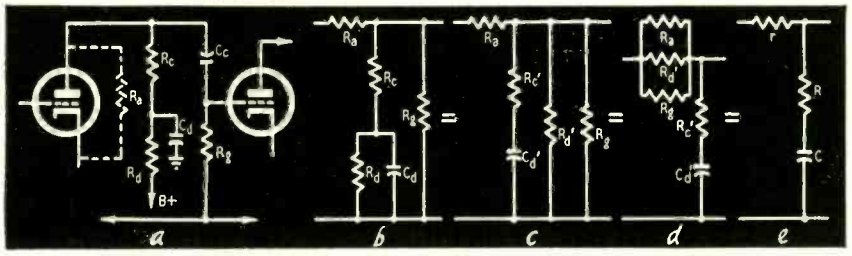


Fig. 9—Construction for frequency response of circuit in Fig. 7: curve A, inverted rolloff; curve B, direct rolloff; curve C, resultant response.



Conversions: $R_c' = R_c\left(1+\frac{R_c}{R_d}\right)$ $C = C_d' = C\left(1+\frac{R_c}{R_d}\right)$ $r = \frac{R_aR_gR_d'}{R_aR_g + R_gR_d' + R_aR_d'}$

$R_d' = R_c + R_g$ $R = R_c'$

Fig. 10—Practical plate decoupling circuit and stage-by-stage reduction to basic form. Note conversion between b and c of R_c, R_d and C_d, to a new configuration, using different values, R_c', R_d' and C_d', making simple conversion from c to d to e possible.

see how the equivalent boils down to the simple basic circuits. Figs. 6 and 7 show how the hidden circuit resistances are taken into account in each case.

In Fig. 6-a the basic equivalent circuit is developed from the practical treble boost circuit of Fig. 4. This is rearranged following the method of Fig. 2, to get an arrangement in which the resistances appear as a straight fixed potentiometer in combination with a simple frequency-discriminative circuit involving a single capacitor and two resistances shown at 6-d. The equivalent values and derivation for the symbolic quantities r and R are shown at the bottom of the figure.

What often happens in this circuit is that R is taken to be just the value of R_g, which is not correct. To this must be added the parallel combination of R_a and R_c to get the equivalent value of R.

When the correct circuit values have been ascertained the treble-boost response can be predicted by the method shown in George Fletcher Cooper's articles on this kind of circuit (RADIO-ELECTRONICS, December, 1950; February, 1951), combining an inverted rolloff (A) with a direct rolloff (B) which becomes more of a *rollover* (C) because it neutralizes the effect of the inverted rolloff. This is shown in Fig. 8.

Following a similar method of step-by-step deduction, the actual bass-boost circuit shown in Fig. 5 can be reduced to the equivalent shown in Fig. 7 and the values are derived by the method shown and given in formula form at the bottom of the figure. This circuit gives a bass-boost response (C) which can be produced by combining an inverted rolloff (A) with a direct rolloff (B) in the manner shown in Fig. 9.

In this case the use of incorrect values results in taking r as just equal to R1, whereas in fact it is the complicated expression shown. The next common error is leaving out the parallel combination of R_a and R_c. Even when this is incorporated, sometimes grid resistor R_g is omitted.

An accurate prediction of the response requires that all these values be taken into account to find the effective value of the resistance r.

In this case omitting the resistors R_a and R_c from consideration will result in an effective value of r smaller than it should be. On the other hand, omission of R_g from consideration results in a value of r larger than it should be. Incomplete consideration in this case can result in an error either side of the correct value.

Decoupling circuits

The only kind of decoupling circuit that can be accurately predicted, without some reference to tube characteristics that are not usually available, is the plate decoupling. This prediction is illustrated in Fig. 10. Fig. 10-a is the actual circuit. The remaining figures show the derivation of the equivalent practical circuit. In this case a transformation effect is introduced to simplify the ultimate calculations.

C_d is tapped across a junction between R_c and R_d in Fig. 10-b. To get an equivalent that can be further reduced, the values of C_d, R_d and R_c are transformed from an equivalent Y into an equivalent delta network. The conversion for this is shown at the bottom of Fig. 10. From this point the network may further be reduced to a simple equivalent which can be used for design purposes.

Cathode and screen decoupling produce an effect opposite to that of plate decoupling. This cannot readily be reduced to an equivalent circuit because it depends on certain tube characteristics. However, it is not very difficult to calculate on the basis of empirical information.

In the case of cathode decoupling, the height of step introduced will depend upon the amount of feedback which the cathode resistor produces. This can easily be checked by removing the capacitor and checking the change of gain that it produces at a mid- frequency. This is usually about 6 db.

When the reactance of the capacitor is equal to the bias resistance, the feedback effect will be 3 db less than when the capacitor is completely removed. This means that the 3-db point on the inverted rolloff in Fig. 11 occurs at the frequency where the reactance of the decoupling capacitor is equal to the bias resistance. If the step is 6 db high, representing a 2-to-1 ratio, the rolloff point will be at twice the frequency of the inverted rolloff point.

The same procedure can be used for deducing the response due to screen decoupling. The screen decoupling capacitor is removed and the change of gain at a mid-frequency is noticed. The inverted rolloff point will then occur at a frequency where the reactance of the decoupling capacitor is equal to the screen feed resistor. The direct rolloff point will be higher than this by a ratio equal to the change in gain.

Suppose the change in gain was 12 db and the screen decoupling consists

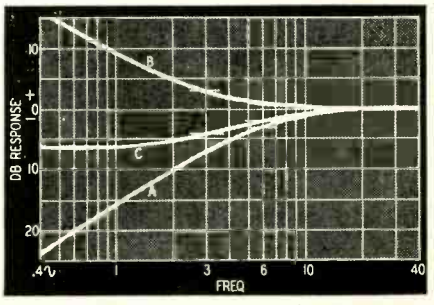
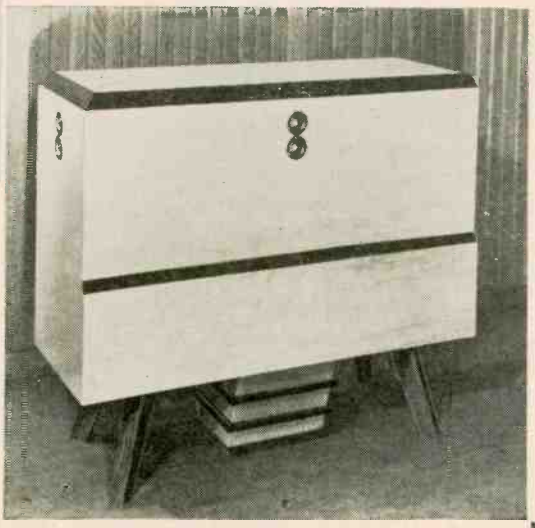


Fig. 11—Response curve of cathode decoupling, using 50 μf across 1,000-ohm resistor and assuming change of gain at mid-band when capacitor is removed to be 6 db. Rolloff points at 3 and 6 cycles are indicated.

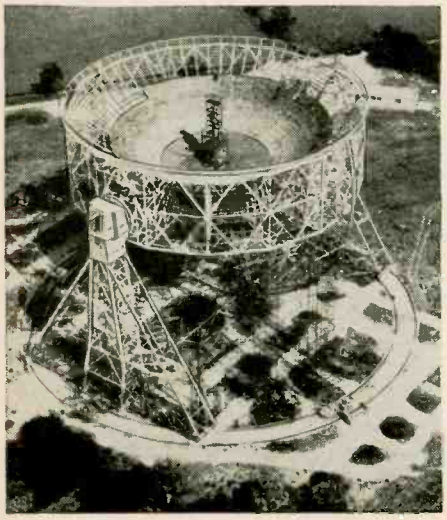
of a 0.1-μf capacitor with a 150,000-ohm resistor. The reactance is equal to this resistance at 10 cycles so the inverted rolloff will be at 10 cycles and the direct rolloff at 40. At the mid-point of 20 cycles the response will be 6 db down due to this screen decoupling.

As you have seen, a slight error can cause a lot of difficulty. The next time you calculate gain, response or boost for an R-C amplifier use all the values. They can save you a lot of work. END

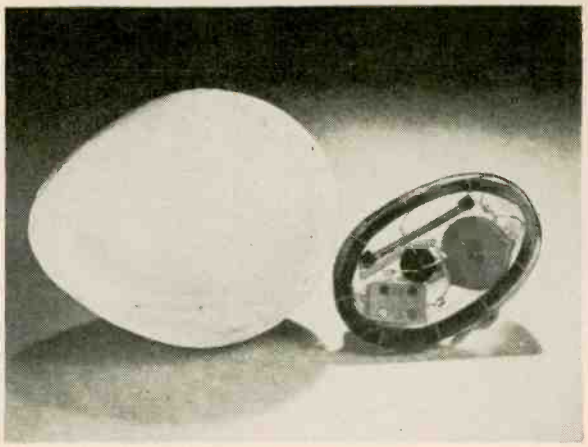
what's new?



SPEAKERS MOUNTED OUTSIDE the cabinet is the startling feature of the Periphonic Speaker System, by General Electric Co., Ltd. of England. Sound is radiated through a small slot into the cabinet from the peripheries of two metal-cone loudspeakers mounted as shown in a V-shaped enclosure on the outside of the cabinet. The air coupling of these speakers, which move in opposite directions, reduces the distortion which occurs with a single unit, particularly at bass frequencies. The complete system, with the speakers mounted below the cabinet, reproduces the lower frequencies from 2,000 cycles down to 30 cycles. Six tweeters, two mounted on the front and both sides of the cabinet cover the frequency range above 2,000 cycles.



GIANT RADIO TELESCOPE, Jodrell Bank, Cheshire, England, is to be 10 times more powerful than any other in existence. Built for Manchester University for the exploration of the skies by radio astronomy, the lensless telescope is expected to be able to reach out into space to a distance of 1 billion light years. It has a directable reflector 218 feet in diameter, and the completed structure weighs 2,000 tons.



THERMOMETER THAT TRANSMITS its indications by radio was developed to measure the temperature inside a penguin egg. Biologists wanted to know how cold the penguin embryo gets and, since the penguin carries its egg with it when it moves from place to place, it would have to work by radio. Object of the study is to find out how living things survive cold—possible application to human life includes research for enzymes that will aid man to adapt to cold or even make it possible to lower human body temperature during operations, etc.

The thermometer is inserted in an egg that has been emptied and filled with gelatin. A thermistor measures the temperature and a transistor is the heart of the transmitter. It is powered by three mercury cells that occupy less than ½ cubic inch and run 125 hours. The transmitter shown next to the king penguin egg has an operating range of 80 feet and is accurate to within 0.2°F.

NOISE RECEPTION is the sole purpose of this radio station. Called the dog house by scientists at Boulder Laboratories of the National Bureau of Standards, it is one of a world-wide chain of observation stations that, during the International Geophysical Year, are recording static and radio noise largely generated by thunderstorms. The wires radiating out from the 21.75-foot vertical-whip antenna, near the center of the building, are part of an elevated radial system used to stabilize reception.

automation

and the tube tester

The Hickok Cardmatic, model 123

Hickok Cardmatic requires no manual settings or roll chart

By HAROLD B. McKAY

AUTOMATION has reached the tube-tester field in the form of an instrument which checks all important aspects of a vacuum tube under actual service conditions and literally does it in one-two-three fashion.

Operation One consists of plugging a tube into a socket and placing a card in a slot. This immediately tests the tube for shorts, leakage and grid emission. Pushing a button marked 2 tests the transconductance, and button 3 tests the tube for gas.

The new device is Hickok's Cardmatic Tube Testing Machine (models 123 and 123A) and its construction permits anyone who can read the words GOOD and REPLACE to test tubes with laboratory accuracy.

The outstanding mechanical feature of the tester is a multiple-contact sandwich switch. This consists of an assembly of plastic panels about the size of a postcard. The bottom part of the unit contains over 170 specially designed switch-contact units.

These units are made up of plungers resembling copper nails, which, when pushed downward through copper sleeves, enter and make contact with other sleeves below. (See Fig. 1.)

In operation, a card corresponding to the tube type to be tested is put in a slot in the sandwich and pushed until it touches a snap-action switch at the rear of the unit (Fig. 2). This triggers an electromagnet inside the instrument case, which pulls the sandwich assembly down on the copper switch plungers.

If there is a hole in the card over any given switch plunger, it will not be pushed through to the bottom sleeve and the switch remains open. In positions where the card is not punched, it bears down on the switch plunger and closes the circuit.

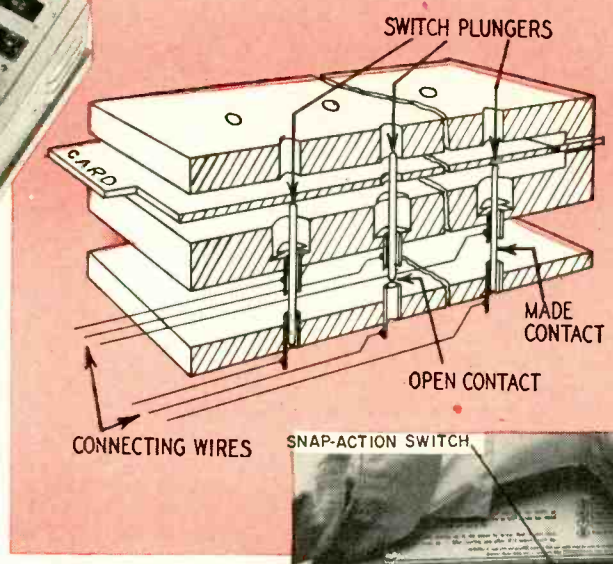


Fig. 1—The card switch, heart of the automatic tester.

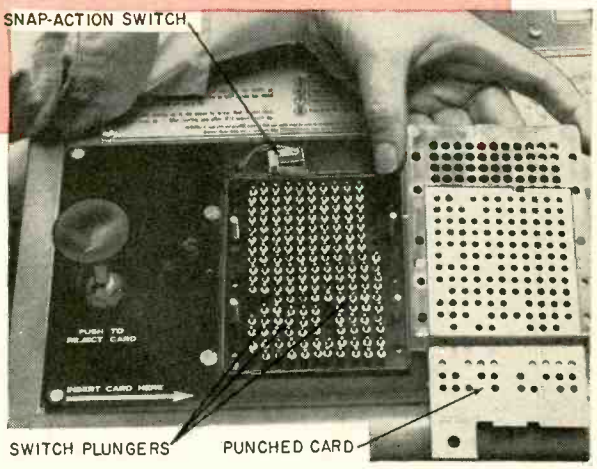


Fig. 2—Inside the switch housing. Each plunger is a separate switch.

A notch cut in the top of the card coincides with the plunger for the sensitive snap-action switch if the card is inserted upside down. This safeguard prevents the test from being made until the card is right side up.

When a test is completed, the card is released by pressing a large button which mechanically restores the sandwich assembly to normal, lifting it upward. This action releases the card so that it can be withdrawn. It also pulls upward on the switch plungers of all made contacts, causing them to withdraw from the bottom sleeve and again become open.

Short test

Once a card and tube have been placed in the machine, operation is almost completely automatic. The first operation, that of testing for interelectrode shorts, is done at once, without even pushing a button.

A voltage divider places a voltage gradient across all electrodes in the tube. The gradient is such that five neon indicators which peer out from under a tiny hood remain dark if no shorts exist. If a resistance path is present between tube elements, it upsets the voltage distribution. The lamps flash for a high- or glow steadily for a low-resistance path in the tube.

Grid emission, a highly objectionable defect not revealed by some tube testers, shows up on the short test because of the way the dc neon lamp supply is polarized when connected to the tube.

Heater–cathode leakage is indicated by the first of three scales on the meter. A definite reject point is indicated (by the words GOOD and REPLACE) but this point may be as low as 10 microamperes for some tubes. The holes in the card determine the test placed on the tube.

An aim in the instrument's design is to overcome the principal objection that many radiomen have to all tube testers, that "the best test of any tube

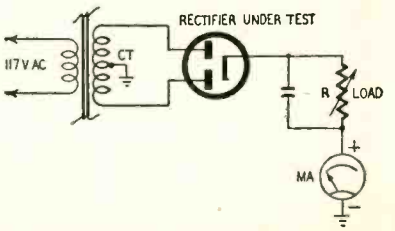


Fig. 3—Rectifier tubes deliver rated current to loads typical of circuits in which they would be used.

Fig. 4—Potentiometer adjustments are used in calibrating the instrument.

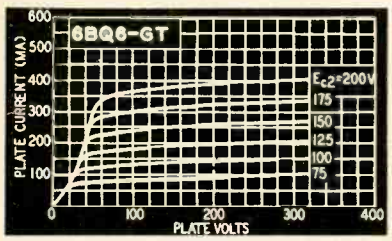
is how it acts in the circuit for which it was designed."

Military standards

A 6X4 is usable with a 150-μa leakage (at 100 volts) between heater and cathode, while an if amplifier such as the 6AU6 cannot tolerate a leakage of over 10 μa. TV damper diodes also are rejected if leakage exceeds this value. The reject points in all Cardmatic tests are determined by using standard military specifications as a guide.

In all cases, the tester automatically applies conditions which simulate those encountered in actual service. For instance, diodes may be classed as falling into at least six basic operational groups. These include full-wave high-voltage group (5U4); half-wave low-voltage group (35Z5); TV dampers (6W4); TV high-voltage diodes (1B3); high-perveance detectors (6AL5) and low-perveance diodes (6AV6).

Each of these groups is given tests common to the group as well as specific tests called for by the individual tube type. Thus, a 5U4 and a 6X4 will both



Graph of plate curves of a 6BQ6 TV deflection amplifier.

be tested in a circuit using a high-voltage center-tapped ac winding and a load resistance with filter capacitor. The 5U4 will be required to deliver its handbook rating of 200 mas and the 6×4, 70 ma or show as REPLACE (Fig. 3).

Television damper tubes such as the 6W4 must withstand high inverse voltages in service, therefore the Cardmatic applies a set of conditions which will test this feature. A low voltage applied to the plate of such a tube readily tests its emission characteristic, and this may be sufficient for some classes of service. For damper service, however, 1,200 inverse volts are applied because this is what the tube might be expected to withstand in actual service.

Sometimes, in testing diodes, gassy tubes may arc, causing the meter to slam beyond full-scale deflection. If this happens, a protective relay trips, turning the tester off before any harm can be done.

Actual laboratory tests with defective tubes have shown this machine balks and refuses to test gassy tubes.

Triodes

Pentodes and triodes may be operated in one of two basic modes—fixed bias and self-bias.

A fixed-bias test is a stringent one to apply if a tube is intended for self-bias operation. This is because self-bias provides a kind of self-regulating effect for the tube when in operation. Thus, a tube under self-bias conditions will show a mutual conductance rating closer to the published value, while fixed bias would indicate REPLACE long before the tube would fail otherwise.

The tester selects the correct mode before applying a mutual-conductance test to a tube. However, while mutual conductance is perhaps the most important measurement that can be made on most tubes, some tubes in certain applications require an additional test.

An example of this is television horizontal deflection amplifiers which must supply high current. Tubes of this type have plate-voltage current curves like those shown in the graph. These curves feature a knee where plate saturation is reached at about 60 volts, with a given screen voltage. In service this tube must sweep from near cutoff to full saturation at the knee of this curve. Therefore, the test applied to a tube like the 6BQ6-GT checks mutual conductance and makes an additional test for high emission at the knee of the curve.

Tubes which contain two units in one envelope, or extra elements such as the two control grids in the 6DT6, are tested with two or more cards—one for each tube functions.

The Cardmatic model 123A contains a couple of features not found on the 123. These include a cathode-activity or *Life Test* and a provision for testing regulator tubes.

Life test

The Life Test is an approximation, but it is one used with good results by large tube users such as the telephone company. This feature is operated by a spring-loaded switch which decreases the heater voltage by 10%. If a tube has considerable reserve life left, the mutual conductance does not change appreciably. Tubes in which emission drops as much as 25% for a 10% heater-voltage reduction may be considered as being near the end of their useful life.

The Hickok automatic tube testers do not use a calibration for line voltage. Instead the critical electrode voltages applied to the tube are obtained from regulated power supplies, making line-voltage calibration unnecessary.

But perhaps the most outstanding feature of the new machines is the means by which they can be made to test themselves. Normally a tube tester must be regarded as a sort of a standard; tubes are accepted or rejected on the basis of a reading obtained on the meter of such a tester. Yet the tester itself can lose its calibration or otherwise get out of order, and the user may be none the wiser until he has thrown away a lot of good tubes.

The conventional tube tester is checked by specially calibrated tubes—tubes which have been tested by a laboratory. These tubes are retested on a tube checker of doubtful accuracy to see if the same readings are obtained as were produced in the laboratory.

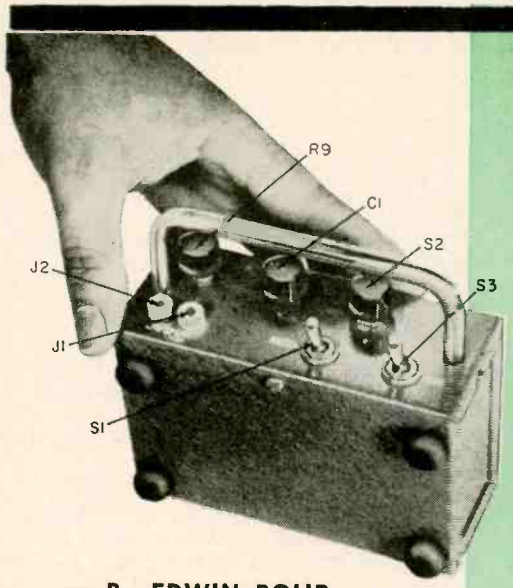
None of this is necessary with the Cardmatic. Each instrument comes supplied with a set of special test cards. To use them, you have only to remove a small panel on the side of the instrument, which exposes a set of potentiometer shafts (see Fig. 4). Each card is placed in the slot assembly and the corresponding potentiometer adjusted to a specified reading on the meter scale. The card itself tells the amount of deflection which should be obtained on the meter.

These adjustments compensate for aging of the tubes inside the tester and they are not dependent upon the use of standard or pretested tubes.

One of the principal ideas which governed the design of the tester was the creation of a foolproof instrument which could be operated by the customer himself. This is in line with the thinking which is placing tube testers in supermarkets and drugstores.

The Cardmatic is expected to have a profound appeal to this class of customer. This could be especially true in radio shops which are meeting the supermarket competition by allowing customers to do their own tube testing.

However, beyond this obvious application, the automatic tube-testing machine has a strong appeal to industry because of its foolproof operation. If the machine is used in special industrial applications where tubes are operated in something other than their normal manner, special cards can be supplied, which will be punched out to supply a test for any type of tube operation required. END



TV BAR GENERATOR for your service kit

Four-transistor miniature unit generates horizontal and vertical bars; is easily built

By EDWIN BOHR

THIS television bar generator occupies no more toolbox room than a couple of 5U4's. It is just the thing for either home-service calls or bench work. There are no vacuum tubes — transistors are used throughout — and the unit is entirely self-contained.

No dangling and tangling power cord is needed. A single 4-volt mercury battery supplies enough power for about 2 years of operation in a shop with plenty of work to get out.

The circuit contains three oscillators and uses four transistors. One oscillator generates a carrier signal in the 30-mc range. Harmonics from this oscillator fall within the TV channels, producing good signals even in the high end of the vhf band.

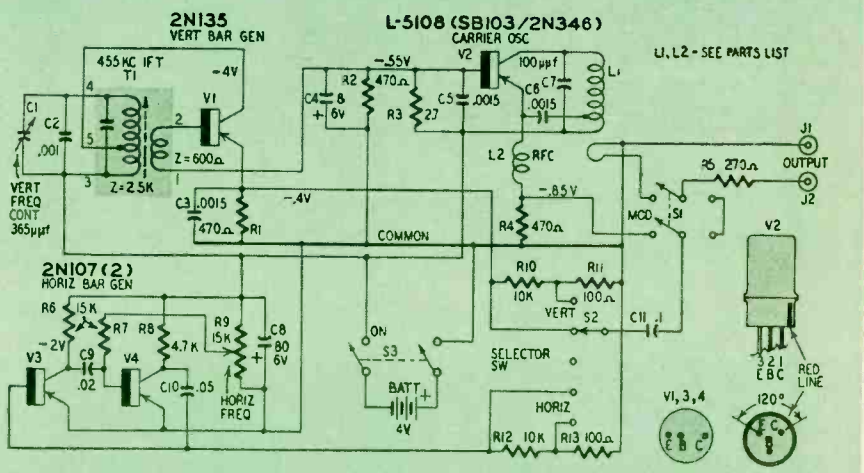
This 30-mc oscillator uses a surface-barrier transistor made by Philco. These transistors cost more than conventional junction varieties. But, if you really need a bar generator in your service work, this additional cost will not be prohibitive. The generator, including battery, can be assembled for around $32.

Other transistors used in the unit are two G-E type 2N107 and a G-E 2N135. The 2N107 transistors function in a multivibrator that generates the horizontal bar frequencies for modulating the carrier oscillator. This audio-frequency signal is also very handy for signal-injection checking of amplifiers and audio stages of radios and TV sets.

The vertical bar generator oscillates at 10 times the horizontal sweep frequency. This is well into the rf region and we found that an L-C tuned-circuit oscillator is necessary for adequate frequency stability. A miniature transistor type if transformer, with additional shunt tuning capacitance, serves this purpose.

Circuit details

Looking at the schematic (Fig. 1), you can see that the circuit is pretty simple and naturally divides itself into



R1, 2, 4—470 ohms
R3—2,700 ohms
R5—270 ohms
R6, 7—15,000 ohms
R8—4,700 ohms
R9—pot, 15,000 ohms, miniature (Lafayette VC-35 or equivalent)
R10, 12—10,000 ohms
R11, 13—100 ohms
All resistors ½ watt or less

C1—365 μμf, variable (Lafayette MS-274 or equivalent)
C2—.001 μf, tubular ceramic
C3, 5, 6—.0015 μf, disc ceramic
C4—8 μf, 6 volts, miniature electrolytic
C7—100 μμf, disc ceramic
C8—80 μf, 6 volts, miniature electrolytic
C9—.02 μf, 75 volts, ceramic
C10—.05 μf, 75 volts, ceramic
C11—0.1 μf, 75 volts, ceramic

J1, 2—tip jacks
L1—5 turns from Barker & Williamson No. 3003 Miniductor
L2—rf choke, approximately 30 turns No. 26 wire, ⅛-inch diameter
S1—dpdt, toggle
S2—1-pole 5-position rotary
S3—dpst, toggle
T1—transistor if transformer (Lafayette MS-268-A or equivalent) 455 kc; primary, 25,000 ohms; secondary, 600 ohms
V1—2N135
V2—L-5108 (SB103/2N346)
V3, 4—2N107
BATT—mercury, 4 volts (Mallory TR-233R or equivalent)
Case—5¼ x 3¼ x 2⅛ inches (ICA 3797 or equivalent)
Perforated, insulated chassis board
Handle
Knobs
Miscellaneous hardware

Fig. 1—Circuit of the miniature generator.

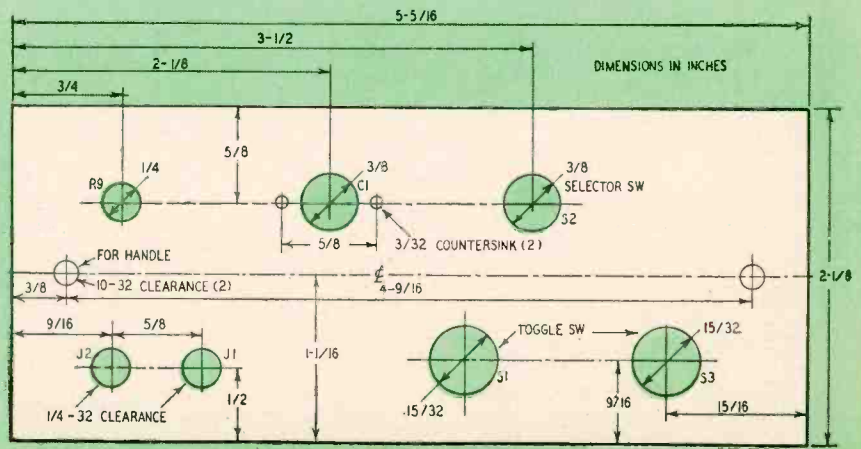
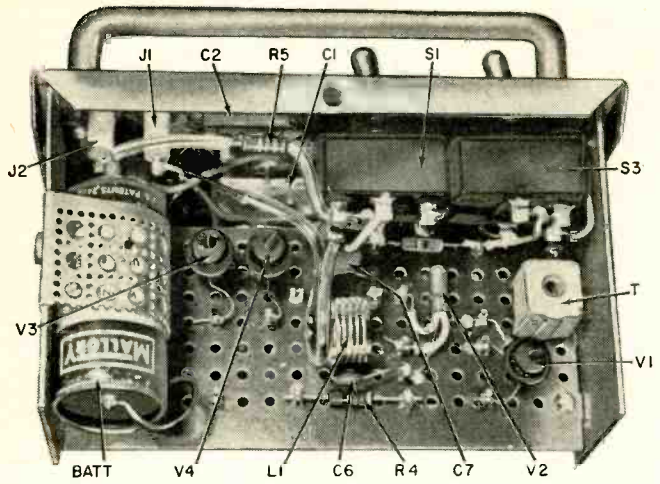
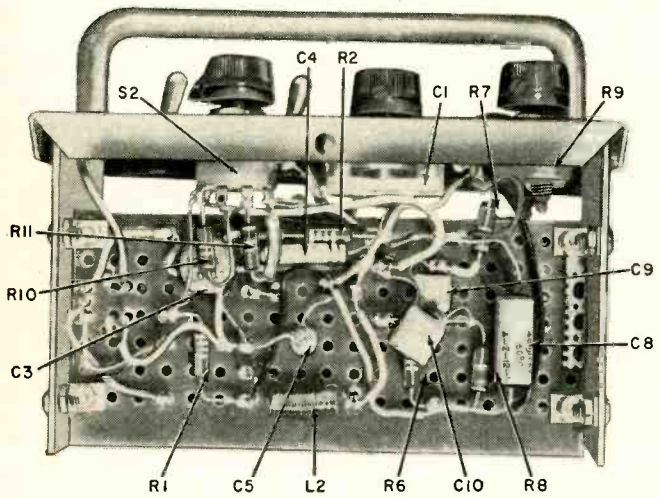


Fig. 2—This panel layout was found to be the best.



Top of the chassis board. Transistor sockets are not used.



The other side of the chassis board. Most small parts are mounted here.

three sections: carrier oscillator, vertical bar generator and horizontal bar generator. Of course, the carrier oscillator is the heart of this unit.

As you probably know, we must apply a bias to transistors to cause collector current to flow. Also, the bias circuit should be designed to maintain a constant collector current, despite temperature changes and varying transistor characteristics.

Resistors R2 and R3 connect across the battery supply and provide a constant bias voltage to both the L-5108 carrier oscillator transistor (V2) and the vertical bar 2N135 transistor (V1). This voltage is applied to the transistor base circuits. The emitter resistors of these transistors are chosen for the desired collector current.

Resistor R4 determines the nonoscillating current of V2. The assigned value of 470 ohms sets this current at about 1 ma. However, when the circuit begins to oscillate, rectification at the emitter–base junction changes this bias, automatically placing the operating point in the class-C region.

With V2 oscillating vigorously, the rectified signal may reach an average value of 0.3 volt. Notice the higher negative voltage of V2's emitter. Ordinarily, if this were an amplifier rather than an oscillator, the emitter potential would then be approximately 0.1 volt lower than the value of the base voltage.

Choke L2 is a simple coil of wire designed to keep the 30-mc carrier out of R4 and the bar-generating circuits. The exact wire size and turns are not too important.

A feedback tap for the emitter is placed approximately three-quarter turn from the −4-volt end of coil L1. This, we found, produced the strongest carrier. If you wish to experiment with this tap position, turn off all modulation, connect a low-range voltmeter across R4 and place the tap for maximum voltage reading.

Although the oscillator is fixed-tuned, it could easily be made variable by replacing fixed capacitor C7 with a variable unit. Coil L1 is a five-turn section from a prewound type 3003 Miniductor. This coil has a diameter of ½ inch and a pitch of 16 turns per inch. If you wish, you can wind your own coil from No. 20 wire. The exact wire size is noncritical, but the coil should be wound on a form and doped for rigidity.

Notice the oscillator coil is placed near the geometric center of the case (see photos). This reduces loading effects of the small steel cabinet.

A single loop of stiff wire, insulated with spaghetti, couples the oscillator carrier to the output jacks. A 270-ohm series resistor R5 is necessary to eliminate standing waves on the leads connecting the generator to the TV set.

Switch S1, in one position, connects the output of S2 to V2's emitter for modulation and also connects the pick-up loop to the output jack J2. This position of S1 is marked MOD on the panel. The other position of this switch connects S2 directly to the output jack J2. The outputs of either the horizontal or vertical bar generators are then available for direct injection into video amplifiers.

In our model of this generator, S2 is an eight-position switch, but only four positions are electrically active. One dead position is necessary to turn off modulation. Only a five-position switch is needed. I used the extra terminals of the eight-position unit for tie points.

There are two switch positions for both of the modulating oscillators. One provides a signal attenuated by 100 for signal injection into high-gain amplifiers without overloading them. For modulating the carrier, S3 must be in the unattenuated positions.

Vertical bar generator

The vertical bar generator uses a 455-kc if transformer, shunted with both a fixed capacitance of .001 μf and a variable tuning capacitor. These capacitances are in *addition* to the capacitance inside the transformer can. Capacitor C1 is variable. The one shown in the photographs is a two-gang superhet type. We used it *only* because it was on hand. This two-gang capacitor is a Lafayette MS-270 but, because of its lower cost, we recommend a single-gang MS-274 be used. They are very compact, solid-dielectric types.

The if transformer we used is a Lafayette MS-268-A. This type is desirable because it can be tuned from the top — in fact, from either end.

A vertical-bar modulating signal is taken from the emitter of V1. It might appear that C3 would bypass all this signal to ground. It does not. At the oscillator frequency, its reactance is roughly 700 ohms.

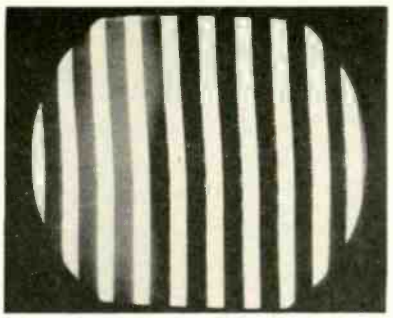
Two inexpensive G-E 2N107 transistors, operating in a multivibrator circuit, produce a horizontal-bar modulating frequency. Because of the nonlinear operating conditions for this type of circuit and variations in low-cost transistors, the values of C9 and C10 *may* have to be varied somewhat. This is a job that must, of course, be left until the generator is completed.

If the frequency-varying control R9 does not have enough range to produce the number of desired bars, lower the values of these capacitors to increase the number of bars and vice versa.

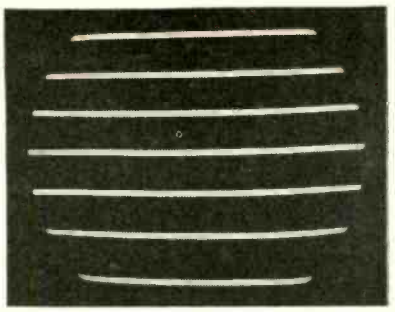
Despite the low internal impedance of the mercury battery, a bypass electrolytic C8 is placed across the horizontal bar generator supply voltage. This prevents feedback through the collector supply.

Construction

The cabinet is a control and switch



Vertical bars produced by the all-transistor unit.



Horizontal bars generated by the portable instrument.

case, fabricated from steel with welded end plates.

This is a small case but there is enough room to mount all parts with a generous margin of space and accessibility. The completed electronic package is strong enough to drop from a service truck without major damage.

A front-panel layout (Fig. 2) shows where to place the controls and switches. This is an optimum arrangement—the result of several hours' planning—and I suggest very strongly that it should be followed exactly.

The insulating-board chassis is supported by two aluminum brackets. In my model, these brackets are held to the front panel by the same screws that secure the chrome handle. If you do not want to use a handle, use the handle holes for ordinary screws. A 6-32 screw fastens the brackets.

Four small right-angle brackets hold the insulating-board chassis to the aluminum brackets.

A strap of perforated aluminum, cut from a large sheet sold at the local hardware store, holds the mercury cell in place. One end of the strap hooks around the insulating-board chassis and the other end wraps over the aluminum bracket and is held there by a self-tapping screw.

We attached rubber feet to the case with aluminum rivets. These are also sold in hardware stores. The rivet is pushed into the rubber bumper and through a hole in the case. Then a short spacer (a sawed-off piece of volume-control shaft works very well) is pushed against the rivet head inside the bumper and rested against the work bench. Then peen the rivet inside the case, using a punch if necessary.

Wiring the generator

I suggest wiring the horizontal bar generator first. When it is complete, it can be checked by connecting its output to headphones or into the video amplifier of a TV set. An audio growl with a rather high pitch should be heard in the phones. Horizontal bars should be seen on the screen.

Now, assemble the carrier oscillator. If it is oscillating, the emitter voltage should be greater than the base voltage. If it does not oscillate, and the voltages check OK at the base and collector, add more capacitance to C7 or try changing the tap on L1. The L-5108 (V2) is a hot little transistor and I have never had any trouble getting it to work, but I offer these suggestions as a safety measure.

Generous leads are left on all the transistors. This protects them from abusive soldering practices and breaking leads at the case.

Be sure of your wiring for the L-5108. If it is wired correctly, nothing should go wrong. But even a momentary wrong voltage can ruin its microscopic internal connecting leads.

With this much wired, you should be able to receive the carrier with horizontal bar modulation. If not, check your switches and wiring for possible errors.

Next, wire the vertical bar generator. This will produce vertical stripes on the TV screen, of course. If the generator works except for these bars, try reversing the leads numbered 1 and 2 on the if transformer or increase the value of C3. With variable capacitor C1 in mid-position, adjust the if transformer slug, with an insulated screwdriver (nonmetallic), until the desired number of vertical lines are obtained.

As you can see in the photographs, leads were soldered to the mercury battery. It is easy to solder to a mercury cell if you scrape the surface and quickly tin it with a hot iron. Then tack a pretinned wire in place with the iron.

Here is one last construction note. If it is anticipated that high voltages may accidentally ever be applied to J1 and J2, I recommend that a .01-μf capacitor, with a suitable voltage rating, be placed in series with resistor R5.

Using the unit

This is simple. Just flip S3 to the ON position, connect J1 and J2 to the set's antenna terminals and switch on the modulation. The number of bars and their sync are adjusted from the front panel. Receiver brightness and contrast are adjusted for the best pattern.

The tuned-circuit constants gave us a signal on channels 5, 8 and 13. For other channels, vary the value of C7.

This circuit shows that transistors are becoming more capable replacements for vacuum tubes, especially in high-frequency applications. In the not-too-distant future I hope to have a completely transistorized color bar and dot generator, both in the same size case. END

IMPACT NOISE METER USES 3 TRANSISTORS

A transistorized instrument to measure impact noise without an oscilloscope

By NATHANIEL RHITA

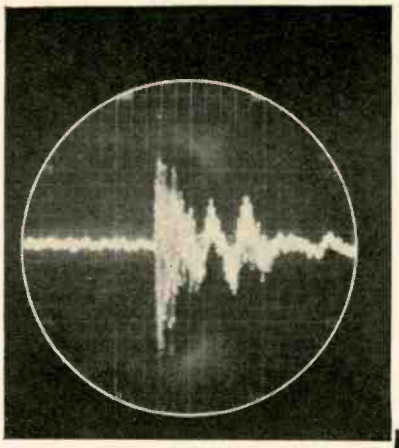
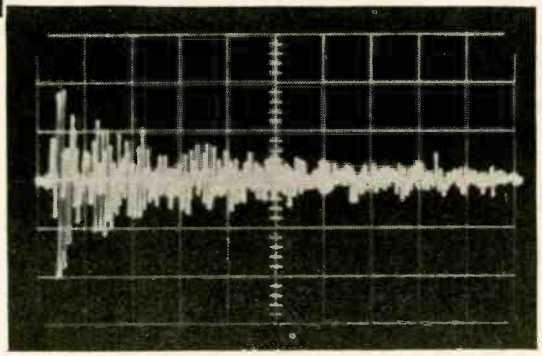


Fig. 1—Oscillogram of a handclap. Horizontal scale 2 msec per division.

Fig. 2—Oscillogram from a small drop hammer. Horizontal scale 10 msec per division.



IMPACT noise—the sound of drop hammers, typewriters and gas engines—is important to industrial technicians who must study it to be able to control and reduce it. These sounds generate complicated wavetrains that vary greatly from one instant to the next. Fig. 1 is a typical handclap wave and Fig. 2 that of a small drop hammer. In each case the peak pressure is approximately 118 db (above .0002 microbar). An ordinary sound-level meter alone is of little use in measuring impact noise which varies so much in so little time. The oscilloscope method is effective but very complicated and expensive. General Radio Co. has an instrument (No. 1556-A) designed to measure impact noise.

This meter uses three transistors and one tube. It is intended for use with a noise-level meter or analyzer.

Fig. 3 is a simplified diagram of the new instrument. The first transistor, V1, is a phase inverter so that either positive or negative noise pulses can be measured by means of S1. V2 and V3 form a highly stable amplifier with negative feedback. Output can be switched into separate networks.

With S2 in the QUASI-PEAK position the network has a rise time less than 1 millisecond and a slow decay, about 0.6 second. Therefore, the capacitor can follow *successive peaks* quite closely. This position is useful for measuring recurring noises like the explosions of a gas engine.

In the PEAK position, the attack time is only 100 microseconds, practically instantaneous. The *peak voltage* is stored on a capacitor which has no discharge path. This voltage is stored for several seconds without appreciable loss so it may be measured by the voltmeter tube V4 at a later time.

The TIME AVERAGE network provides seven different time constants (not shown) so its capacitor charges for a short or long interval as desired. This voltage also remains on a capacitor for subsequent measurement. This network indicates the *average* level of a noise as measured over a definite period of time.

Peak and *average* levels of an impact noise are important, but so is the *duration* of the noise. Most impact noises (Figs. 1, 2) begin with an initial peak that decays indefinitely. The wave duration may be defined by the time taken for its peak to fall 8.7 db. This is called the *time constant* of the impact decay. The time constant is determined from the peak and average levels of the noise as well as the charging time (averaging time) of the capacitor network. These relationships are shown in Fig. 4.

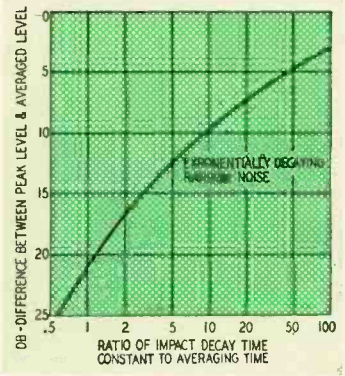


Fig. 4—Chart of relationship between the ratio of the peak-to-average value and the time constants of an impact (plus those of the circuit).

As an example, let the impact meter be set to an averaging time of .01 second. A noise is now measured as having a peak of 115 db and an averaged level of 98 db. This gives a difference of 17 db. The chart shows that the time constant is twice the averaging time. Therefore, the impact decay time is 2 × .01, or .02 second. END

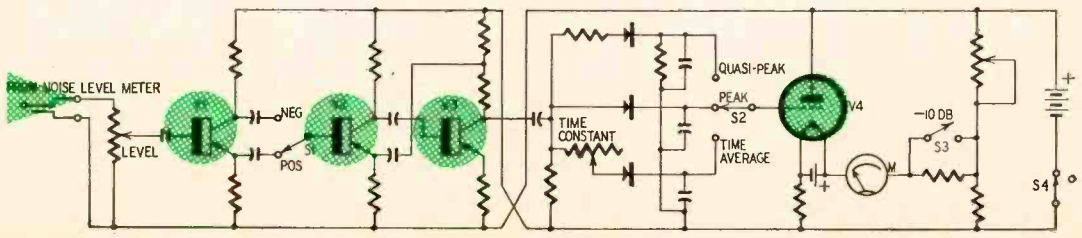


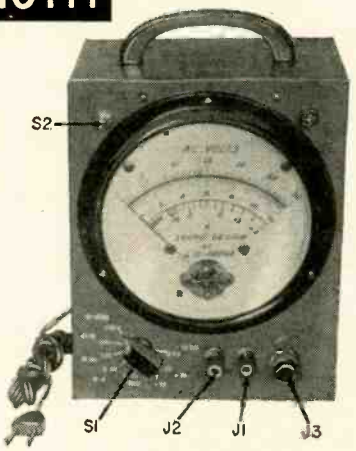
Fig. 3—Simplified circuit of the meter.

BUILD THIS...

Amplifier-Rectifier VTVM for Audio Testing

First of a series of articles on apparatus and techniques for testing hi-fi equipment

By L. B. HEDGE



Finished meter in its portable case.

THE serious worker in the audio field — professional or amateur, engineer or hi-fi enthusiast — is constantly faced with the problem of testing the equipment on which he works. The simplest and ultimate test of sound equipment is the listening test which, in practice, is simple only in concept. Evaluation of sound by listening depends on subjective reactions of the listener. These reactions vary greatly between any two persons.

Practical tests of audio systems which permit evaluation of specific system performance characteristics and their correlation with pertinent characteristics of the system's components have been evolved. Amplifiers, which are basic units in all electronic sound systems, are evaluated by tests which determine: amplification (voltage and power gain); frequency response (amplitude distortion); harmonic and intermodulation distortion, and phase-shift characteristics.

Each of these characteristics can be determined by tests using a variety of instruments and accessories. An audio oscillator and a high-impedance ac voltmeter alternately connected across the input and the output of the amplifier under test, provide basic gain, frequency response and output power checks (see Fig. 1). An oscilloscope connected across the voltmeter simplifies detection of amplifier oscillation and permits identifying serious distortions (changes in waveform between input and output).

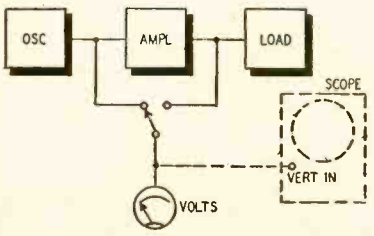
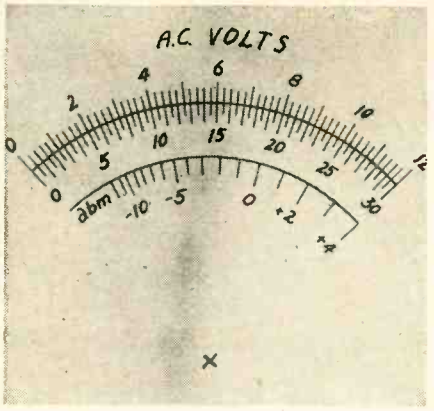


Fig. 1—Basic test setup for gain, frequency response and output power checks.



Scales for meter. Drawn for 90° movement.

Adding an electronic switch to the test setup makes visual comparison of input and output waveforms much easier. It also allows recognition of distortion of a much lower order than that identifiable with a scope alone. Phase-shift measurements can be made with a scope with or without an electronic switch, although the switch and scope method is generally more accurate and less involved (see Fig. 2).

Including a narrow-band filter (analyzer) in the setup — an instrument which suppresses any selected frequency in the audio range, while giving negligible attenuation to the higher harmonics of the selected frequency — permits measuring total harmonic distortion (Fig. 3). (See "Measuring Distortion" and "Distortion Totalizer" in the December, 1951, and August, 1954, issues, respectively.) Adding a mixing network (See "Build an IM Analyzer," December, 1953) to supply a mixture of a 60-cycle signal with the output of an audio oscillator to the amplifier input permits determining intermodulation distortion by measurements made with the scope and analyzer (Fig. 4).

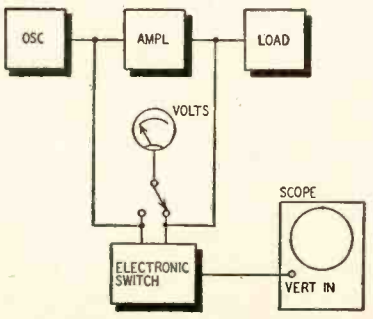


Fig. 2—Electronic switch and scope added to basic setup.

Except for certain readings made directly from the scope in the intermodulation and phase-shift tests, all measurements are af voltage measurements. Because of this basic function of voltage measurements in testing procedures and because af voltage measurements are also necessary for adjusting oscillators and other af test equipment, the logical unit with which to start an af test setup is an audio voltmeter.

Why an A-R vtvm

Since audio tests require voltage measurements over a range from a few millivolts (inputs to preamps) to over 100 volts (output signal across the primary of a power output transformer), over a wide frequency range (30 to 15,000 cycles at least; 15 to 50,000 cycles for special tests and analysis), and with a minimum loading of the test circuit by the meter, an amplifier–rectifier (A–R) type vtvm is indicated for the job. Although the A-R type vtvm responds to the mean (average) voltage rather than the root-mean-square (effective) voltage for pure sine-wave inputs, the errors resulting from using meter readings for effective voltage values will be less than 4% for waves containing up to 10% in harmonics and much smaller for waves with smaller harmonic content. No more accurate instruments of high input impedance, wide frequency range and extended voltage range are available as simple and economical units. The A–R vtvm's accuracy is quite adequate for tests in which the decibel is the significant unit and basic scale for reference standards.

The meter is quite conventional in general concept and form. It differs from more conventional instruments of this type, however, in two significant features:

1. The indicating meter used is not

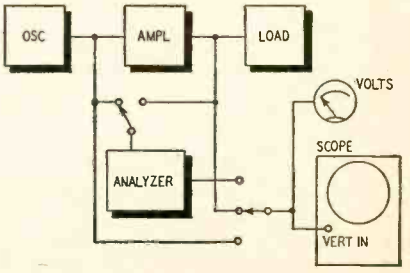
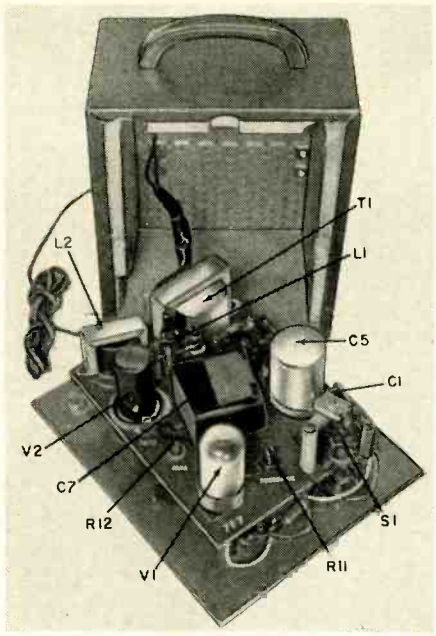


Fig. 3—Analyzer provides accurate harmonic-distortion measurements.

a supersensitive unit — a 5-ma meter is used instead of the conventional 200-μa meter.

2. The two voltage scales (each of which is used with successive multipliers of successive powers of 10) differ from each other by a factor of 2.5 (0.4) instead of the more conventional $\sqrt{10}$ ($\sqrt{0.10}$), with db intervals of 12 and 8 instead of 10 and 10.

The first of these differences makes possible the use of cheaper, more readily available and less delicate meter movements. To provide the additional current in the meter circuit, a "power" output stage is required, but the actual power requirements are sufficiently low that no essential complication results therefrom. The second feature permits the use of even values of precision resistors in the voltage range multiplier and considerably simplifies the meter scales, both in layout and for reading, since the same scale divisions are used on each range scale.



Inside the meter's case.

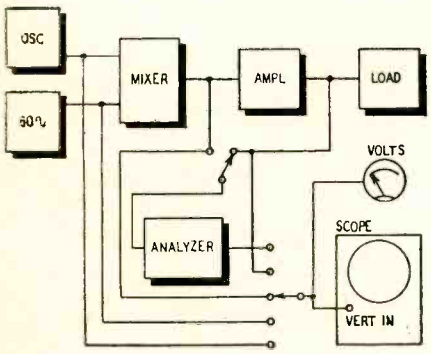


Fig. 4—Adding a 60-cycle source and mixer prepares for IM distortion tests.

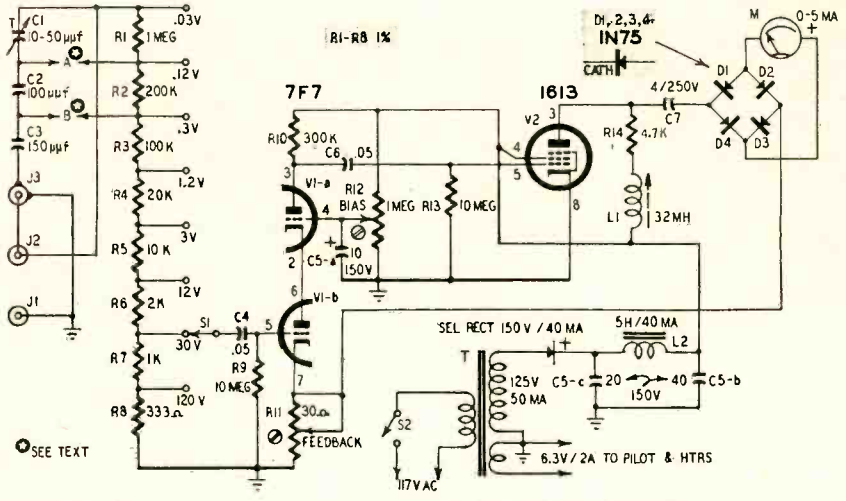
Layout and construction of the meter system are critical in only a few aspects. Since the input stage of the amplifier is a high-gain stage with high input impedance and operating at a low input signal level, complete shielding of the unit is necessary to prevent inaccuracies due to stray signal pickup. The unit shown in the photos is built into a wooden frame with a light sheet-copper shield attached to the outside and with a metal front panel and perforated rear cover plate. If a metal cabinet is used, ventilation should be provided for the tubes and transformer. Heater supply wiring should be twisted to minimize hum pickup. The masonite subpanel is attached to the meter by the two meter terminals. The insulated panel reduces stray capacitances in the circuit wiring. These capacitances tend to reduce the high-frequency response of the amplifier and consequently of the meter itself.

Capacitors C1, C2 and C3 (See Fig. 5) provide high-frequency compensation for the range attenuator network. With these capacitors omitted, the meter unit provides readings that are accurate to within a fraction of a decibel from 15 to more than 20,000 cycles. Including the compensating capacitors extends the accurate range beyond 50,000 cycles. If the extended frequency range is required, connections A and B should be left open on assembly and completed as part of the calibration procedure described later. The inductance L1 consists of two TV width controls in series and set at maximum inductance (16 mh each).

Meter scales

Layout of the meter scales is indicated at head of article. Voltage scales can be drawn using the diagram as a template for 90° meter movement scales. Scales for meter movements other than 90° can be drawn with ruler, compass and protractor without difficulty. Scale markings for the dbm (0 = 0.7746 volts — .001 watt at 600 ohms) are shown in the table in terms of the 0 – 1.2-volt scale.

On completion of the vtvm assembly, the cascode bias potentiometer (R12) should be set at approximately mid-position, and the feedback potentiometer R11 (calibration control) set at maxi-



R1—1 megohm, 1%
R2—200,000 ohms, 1%
R3—100,000 ohms, 1%
R4—20,000 ohms, 1%
R5—10,000 ohms, 1%
R6—2,000 ohms, 1%
R7—1,000 ohms, 1%
R8—333 ohms, 1% (1,000 and 500 ohms in parallel)
R9, 13—10 megohms
R10—300,000 ohms, 5%
R11—pot, 30 ohms
R12—pot, 1 megohm
R14—4,700 ohms, 2 watt

All resistors ½ watt unless noted

C1—10-50 μμf, trimmer
C2—100 μμf, ceramic
C3—150 μμf, ceramic
C4, 6—.05 μf, mica
C5—10–20–40 μf, 150 volt, electrolytic
C7—4 μf, 250 volt, electrolytic
D1, 2, 3, 4—IN75 diodes or IN65
L1—32 mh, choke (two 16-mh width controls in series, RCA 212R1 or equivalent) see text
L2—5 h, 40 ma, choke
M—0–5 ma, meter
RECT—150 volts, 40 ma, selenium
S1—1-pole 8-position rotary switch
S2—spst toggle switch
J1, 2—Binding posts
J3—shielded cable connector (Amphenol No. 75 PC1M or equivalent)
T—Power transformer; primary, 117 volts; secondary, 125 volts, 50 ma, 6.3 volts, 2 amp (Stancor PA-8421 or equivalent)
V1—7F7
V2—1613
Pilot light assembly
Case, 7 x 9 x 5 inches
Bakelite subchassis

Fig. 5—Circuit of the A–R vtvm.

mum resistance. After a warmup period of a few minutes, the range switch should be set to the 0 – 12-volt range and a 6.3-volt 60-cycle signal connected across the meter input. This check signal can be provided by a temporary connection between the ungrounded heater supply and the ungrounded input terminal. With the 6.3-volt signal applied, R12 should be adjusted for maximum meter reading. When the correct (maximum output) setting for R12 has been established, R11 is adjusted to give a meter reading corresponding to the input signal voltage. If a reference meter is available for checking this voltage, this adjustment will provide the required calibration for the meter. If a variable voltage source and reference meter are available, mid-range checks in each voltage range should be made and R11 adjusted to give the smallest average errors in all ranges (the errors should all be small if the multiplier resistors are accurate, but some deviation can be expected).

TABLE I—Dbm Voltages into 600-ohm load—1.2 Volt scale, and additive factors for other scales.

Dbm	Volts	Voltage Range	Dbm
−14	.155	0— .03	−32
−13	.173	0— .12	−20
−12	.195	0— .30	−12
−11	.218	0— 1.2	0
−10	.245	0— 3.0	+8
−9	.275	0— 12.0	+20
−8	.308	0— 30.0	+28
−7	.346	0—120	+40
−6	.388		
−5	.436		
−4	.489		
−3	.548		
−2	.617		
−1	.690		
0	.775		
+1	.869		
+2	.975		
+3	1.094		
+4	1.228		

The compensator capacitor network can be adjusted with a signal of about 10,000 cycles and 0.1-volt amplitude. The signal should be sufficiently stable to maintain its voltage amplitude over an extended period during which the meter is disconnected from it. Check the voltage reading with the meter range switch set to the 0 – 0.12-volt range. Complete the connections A and B and adjust C1 to give the same reading that it gave on the same signal with A and B open. The compensation thus provided is adequate for the extended audio range of 15 – 50,000 cycles.

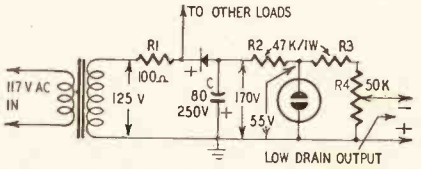
Tubes used in this unit (7F7 for V1 and 1613 for V2) were selected on the basis of performance and low-priced availability. The 7F7 can be replaced by a 6SL7 without changes in the circuit (a different socket is required, however). The 1613 can be replaced by a 6F6, a 6V6 or a 1621 with no changes at all, but calibration and other adjustments may require changes, due to differences in characteristics—the 6V6, for example, — will require somewhat greater feedback due to its higher transconductance. END

Regulating Bias and Polarizing Voltages

Use neon bulbs as voltage regulators

By RONALD L. IVES

REGULATION of bias and polarizing voltages used in many types of electronic equipment, test instrument power supplies, etc., is quite costly power-wise when standard regulator tubes are used. Each tube uses 1½ to 3 watts, which is radiated as heat. The regulator circuit uses and radiates as heat an additional wattage determined by the I^2R loss in the dropping resistor. This power loss is particularly annoying because the current consumed by the bias or polarizing circuit is usually less than 1 ma, and in some instances is actually much less than 1 μa. Therefore the power needed to control the bias or polarizing voltage is several thousand times that used in the regulated circuit.



R1—100 ohms, 1 watt
R2, 3—47,000 ohms, 1 watt
R4—pot, 50,000 ohms
C—80-μf 250-volt electrolytic
NE-32 neon bulb
Half-wave power transformer, primary, 117 volts, secondary 125 volts, power rating to suit load current

Fig. 1—Neon-regulated bias rectifier circuit.

This power waste can be reduced by a factor of 5 or more in many low-voltage low-current regulated supplies by using neon bulbs as regulators. Experiments show that many neon bulbs, drawing from 1/25 to 1 watt, have a constant voltage drop of about 55 through a very wide range of current consumptions, and hence make ideal voltage regulators.

A typical bias rectifier circuit and regulator, using neon-bulb regulation, is shown in Fig. 1. Output voltage, at various ac inputs, is plotted in Fig. 2, output being set at 3 volts when line voltage was 117. Some shifting of the end points of the plateau of the curve is possible by changing the value of the series resistor. The length of this plateau can be extended by using a higher-wattage neon bulb and shortened with a bulb of lower wattage. In general, the very small neon bulbs such as the NE-2 and NE-51 are not very satisfactory as regulators, but all resistorless neon bulbs of higher wattage seem to work very well. Bulbs with a symmetrical arrangement of the electrodes are completely nonpolar and work equally well on either socket connection. Bulbs with asymmetrical electrode arrangement tend to be polar and may work better if the connections are reversed.

When operated about midway between the "will-fire" current and the catalog rating, the life of standard neon bulbs is measured in tens of thousands of hours.

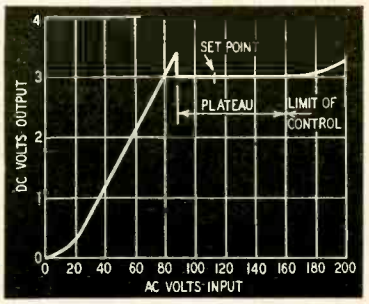


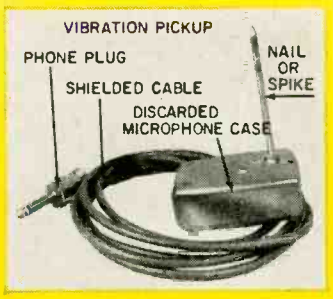
Fig. 2—Regulation characteristics of neon-regulated bias supply.

One limitation on the use of neon bulbs as regulators should be kept in mind—they do not work well as regulators in total darkness. This difficulty can be eliminated very effectively and cheaply by putting a drop of luminous paint on each bulb before installation in a dark location. If ambient light exceeding 0.1 foot-candle reaches the tube location, this precaution is not necessary. After an initial "triggering" by something less than 0.1 foot-candle, the bulbs perform satisfactorily as regulators until the ambient light level exceeds 1,000 foot-candles. END

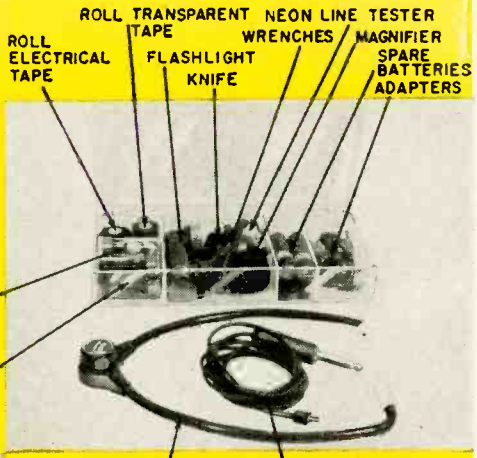
ELECTRONIC SURVEILLANCE KIT

Part II—More pickups and accessories to make your kit more versatile

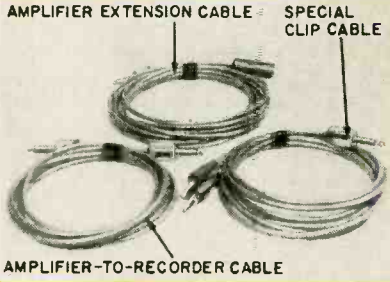
By LOUIS E. GARNER, JR.



The vibration pickup. The spike is solidly fastened to the case.



Spare-parts kit and Telex headset.



Accessory cables include: amplifier to recorder, amplifier extension and special clip cable.

Telephone pickup and remote microphone. Thin cable for the microphone makes its concealment easy.

Tool kit. Small tools are wrapped in convenient plastic case.

LAST month we described the main components that make up an electronic surveillance kit. You now have the amplifier, an rf pickup and an induction pickup. To extend the versatility of your kit, a variety of other pickups, listening devices, cables, spare parts and tools are needed. These are the items described here.

Vibration pickup

Few of the accessories included in an electronic surveillance kit are as versatile as a vibration pickup. The unit is used for such tasks as locating a suspected time bomb; listening through doors, windows and partitions; detecting hidden machinery or even opening combination locks and safes. Basically, it is an electromechanical transducer, converting physical vibrations into audio-signals. (See diagram.)

The pickup consists of a standard crystal or ceramic phonograph cartridge mounted in a thick-walled metal case. The model shown in the photographs was assembled from a discarded microphone. The original, defective cartridge was removed and the phono cartridge installed. A hardened nail or metal spike is mounted in one side of the case so that it bears against the cartridge's outer case. A 3- or 4-foot shielded output cable is provided, with the braid connected to one cartridge terminal and the metal housing, and the center lead to the cartridge's other terminal.

In operation, the point of the spike is held against the source of vibrations—a package, safe, door or wall partition. The vibrations travel along the spike to the phono cartridge's case and are transferred to it. The case tends to vibrate *around* the element, which in turn resists this vibration by virtue of its own inertia. A twisting action results, producing an electrical signal in the cartridge element. The signal is fed to the amplifier.

The telephone pickup is one of the standard flat inductive pickup coils stocked by many local and mail-order radio parts distributors and intended for use with high-gain tape recorders. A plug to match the amplifier's IN jack is added to the output cable. In use, the telephone pickup is simply placed under the base or next to the receiver of the telephone with which it is to be used. This unit has more sensitivity than the induction pickup, but it is not satisfactory for line pickup.

Intended for use as a plant in a suspect's room or office, a remote microphone permits the operative to overhear personal and business conversation. It consists of a thin crystal microphone cartridge attached to a 30- to 50-foot length of shielded cable and a plug to match the amplifier input. Small-diameter shielded cable is essential to permit concealment under rugs, behind baseboards, along moldings or behind furnishings. The kit may be equipped with several remote microphones since they must often be expendable.

A standard headset is the output de-

vice most commonly used. It is a high-impedance magnetic or crystal earphone equipped with a plug to match the amplifier's output jack. Any standard headset is suitable, but it is best to choose a unit that is comfortable to wear, compact and lightweight. Sturdy construction is another must since the headset may, on occasion, receive rough treatment in transportation and handling.

Essentially a high-impedance magnetic or crystal hearing-aid type earphone equipped with a plug to match the amplifier's OUT jack, a special earphone is used for undercover work where the operator may be seen by other people.

In a typical situation, the amplifier will be concealed in an inside coat pocket and the special earphone mounted so the operator appears to be an ordinary hard-of-hearing individual wearing a hearing aid. Actually, the operative may have the vibration or rf pickup concealed in the palm of one hand, with the connecting cable inside his coat sleeve.

Cable requirements

An assortment of properly terminated shielded cables is essential if the kit is to have maximum utility. These cables may be from 4 to 6 feet long, with one end terminated in a plug to match the IN and OUT amplifier jacks. The other end of each cable is terminated in another connector.

While the exact number and variety of accessory cables needed are largely a matter of individual preference, the following types may be considered as basic to any well-designed general-purpose kit:

1. Recorder Cable—terminated in a connector to fit a standard tape or wire recorder. It is used to connect the amplifier to a recorder when it is necessary or desirable to obtain a permanent record of monitored conversations.
2. Extension Cable—terminated in a female cable jack like those on the amplifier. It is used to extend the "reach" of other accessories.
3. Special Clip Cable—terminated in alligator clips and short lengths of flexible wire, is an all-purpose cable. It is used for tapping lines or connecting a special pickup or output device to the amplifier.

Spare parts

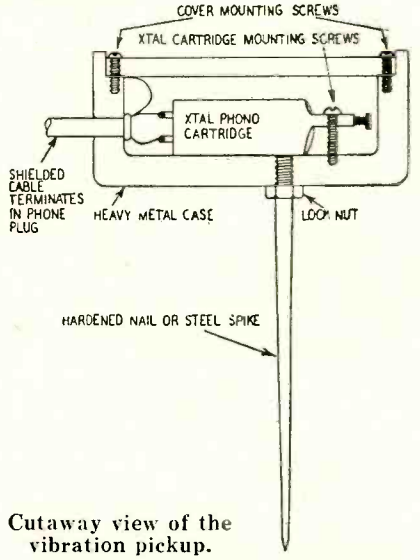
In making up the electronic surveillance kit, it must be remembered that an agent or operative using the kit in the field may not have ready access to a stockroom. Everything needed to keep the kit in operating condition or to facilitate the installation of the various accessories must be included in the kit.

A spare-parts kit may be assembled in a small multicompartment plastic box and should include: a supply of light and dark wiring nails; small rolls of transparent and black Scotch tape; a small magnifying glass; spare A and B batteries; a small penlight or flashlight; an electrician's pocket knife; a neon line-voltage tester; a set of tubes for the amplifier; and special-purpose adapters.

Where space permits and where the kit may be in the field for extended periods of time, a supply of hookup wire and shielded cable plus a small roll of rosin-core solder might be included with the spare parts.

Tool kit

Small hand tools are essential to the proper installation and use of many of the kit's components. An agent must be able to pry baseboards or moldings away from walls so he can hide microphone wires; reinstall moldings without leaving scratches or tell-tale marks; remove carpet and upholstery tacks to facilitate hiding a microphone or cable; cut small holes in walls or partitions for feeding a wire through or for use as a peephole; make minor repairs to the components in his kit and measure distances accurately in order to locate hidden wall compartments.



Cutaway view of the vibration pickup.

The following tools should be included as a minimum complement: small claw hammer; awl type drill saw; tape measure; small hacksaw; assortment of screwdrivers; a pair of long-nose pliers with a wire cutter or a separate diagonal cutter.

Optional tools, useful for some types of work but not absolutely essential, include a small soldering iron, a hand drill and assortment of bits, tweezers and a small set of wrenches.

Although not a functional part of the kit, the type of carrying case is extremely important. The case must be small, sturdy, lightweight and camouflage its contents.

A skate carrying case, with the various components held in place by small brackets and coil-spring straps, does a good job. A sturdy fiber case will serve as well; rubber, cloth or leather straps can be used to secure the components in position. Care should be taken in designing mounting brackets and straps—they must hold each item securely in position even when the kit is subjected to rough handling, and permit the ready removal and replacement of any component.

For camouflage purposes, many operatives prefer that the electronic surveillance kit be mounted in a small leather briefcase or a dispatch case. For maximum protection against accidental discovery, the entire kit might be concealed under a false bottom in an overnight bag or suitcase, or even hidden in concealed pockets in a large overcoat.

PARTS LIST (Vibration pickup)

Metal case (1)
Crystal or ceramic phono cartridge (1)
Hardened nail or steel spike (1)
Phone plug (1)
Shielded cable, 3 to 4 feet
Miscellaneous hardware

PARTS FOR OTHER ACCESSORIES

Phone pickup, Lafayette MS-16 (1)
Crystal cartridge, Argonne AR-56 (1)
Headphone, 2,000 ohm, magnetic, Telex 4626 (1)
Cord and phone plug, Telex 3280 (1)
High impedance earphone, Lafayette MS-278 (1)
Phone plugs (5)
Cable phone jack (1)
Shielded cable
Alligator clips (2)

SPARE PARTS KIT

Dark cable tacks (1 box)
Light cable tacks (1 box)
Transparent tape (1 roll)
Electrical tape (1 roll)
Flashlight (1)
Electrician's pocket knife (1)
Neon, line tester (1)
Magnifying glass (1)
Phone plug to coaxial cable adapter (1)
Spare B battery (1)
Spare A batteries (2)
Multicompartment plastic box (1)
Extra set of tubes CK512AX (2); CK525AX (1)

TOOL KIT

Screwdriver set, including flexible tape rule and long-nose pliers.
Small hammer
Drill saw
Carrying case—Aluminum skate box modified to hold electronic surveillance kit and accessories

The basic operational setup includes one of the pickup devices, the amplifier and an output device. For example, the rf pickup, amplifier and standard headset might be used for searching a room for a small hidden transmitter. In another instance, the vibration pickup, amplifier and standard headset might be used for opening a safe in a suspect's office or in listening for ticks in a package suspected of concealing a bomb.

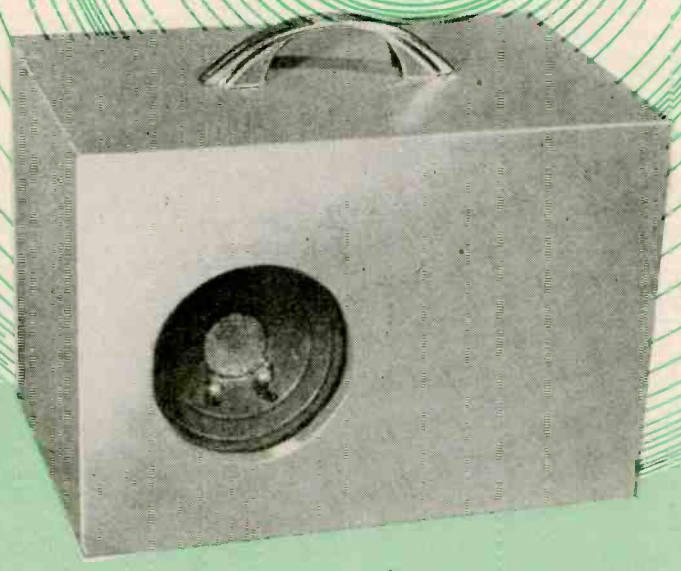
Often, the recorder cable is used to connect the amplifier to a standard tape or wire recorder to make a permanent record. For example, the vibration pickup, amplifier, recorder cable and a recorder might be used to record a suspect's conversation through a wall or partition. In more favorable circumstances, the remote microphone (hidden in the suspect's room) could be used for the same purpose. The amplifier's gain, coupled with the normal gain of a good recorder, gives an amazing sensitivity.

While the use of many kit components may be obvious from their very nature, their value depends greatly on the skill of the individual agent. As he acquires experience in using the kit, he can develop tricks and special techniques of his own to obtain the most from each piece of equipment. END

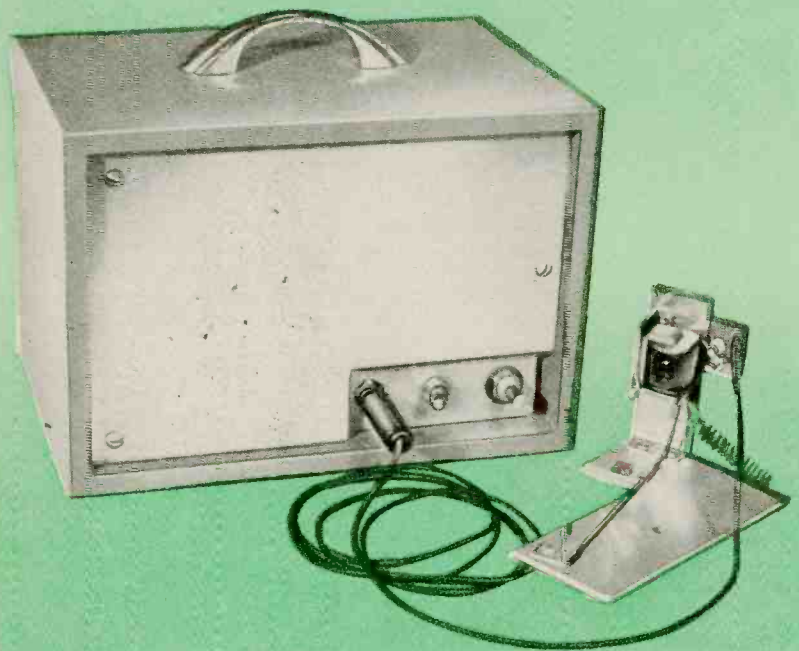
Audio signal triggers camera for fast action shots

a PHOTO-SOUND unit

By PETER J. VOGELGESANG



Panel view shows the 4-inch speaker.



Rear view with triggering device.

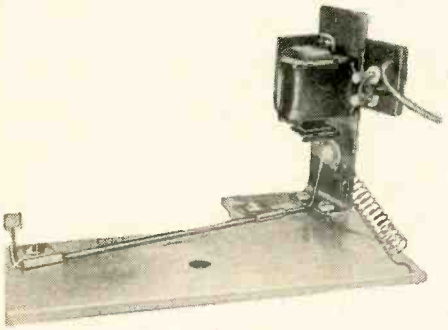
FAST films and fast shutters are the tools of the modern action photographer; the technical achievements of the photographic industry have eliminated the problem of the long exposure. Remarkable action pictures are being made every day by photographers who use comparatively simple camera equipment and ordinary films. For example, a photographer at ringside, using a press type camera and flash bulbs, can successfuly stop the swiftest punch a fighter can throw. He can stop the punch, that is, if his own reflexes are quick enough to anticipate it and trip the shutter at the proper instant. A photographer could stop a baseball player in the middle of a home-run swing of the bat, too, if he were capable of deciding in a fraction of a second whether the batter was going to follow through. So, while the photographer has the equipment with which to take fast action pictures, he is still confronted with the problem of synchronizing that equipment with the action he wishes to photograph.

Because sound almost always accompanies action, it is an excellent synchronization medium. A camera shutter tripped by the crack of a bat is sure to photograph the batter at the peak of his swing. The same would be true of a golfer striking a golf ball or a football player kicking. Sports is by no means the only field in which a sound-synchronized camera can be used. Any photogenic, fast-action phenomenon that makes sound is a good subject. It might be cars colliding at a thrill show or the blasting of rock in a stone quarry. There is material for countless prize-winning photos everywhere, and a sound-triggered camera will guarantee good results every time.

The first step in building a sound-triggered camera is the construction of an electrically actuated shutter. Many press type cameras come equipped with solenoid-actuated shutters, and those persons fortunate enough to possess such cameras have much of the problem already solved. It is virtually impossible to describe the construction of a mechanism that would be adaptable to all types of cameras. Instead, a principle is described from which an

actuating mechanism can be adapted to any particular make of camera.

The mechanism illustrated was constructed to fit a Rolleicord IV camera. The power required to trip the shutter is supplied by a 1-inch coil spring. The spring is stretched and the mechanism is cocked before each exposure. The shutter-triggering lever is held in the cocked position against the tension of the spring by the armature of a sensitive relay. A short pulse of electricity sent through the relay coil pulls the armature free of the triggering lever and releases it, thereby tripping the shutter and making the exposure. The action is almost instantaneous. The base of the mechanism is designed to be mounted by sandwiching it between the camera and tripod, eliminating the necessity of fastening anything to the camera. The device is very simple and can be adapted to almost any camera.

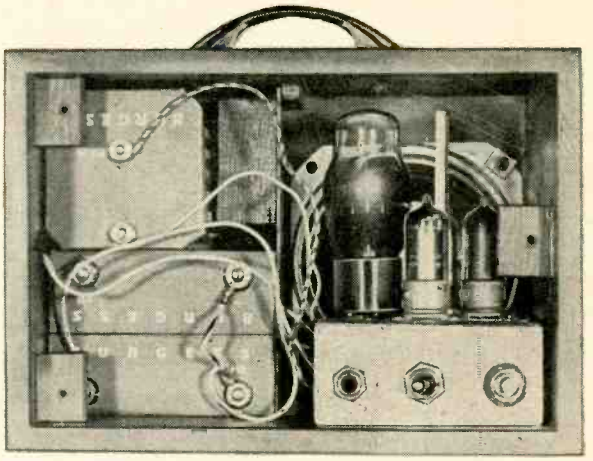


Closeup of camera-triggering device.

The electronic portion of the unit is equally simple. A 4-inch PM speaker is used as a microphone. The speaker feeds a two-stage audio amplifier through a voice-coil-to-grid transformer. The first tube of the amplifier is a pentode connected for maximum voltage gain; the second stage is triode-connected for lower output impedance. The sensitivity control is connected between the two stages.

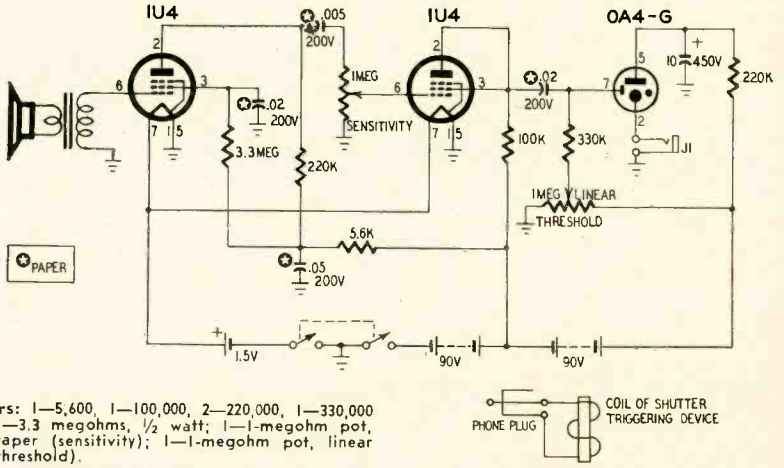
The output of the amplifier is fed to the starter anode of an 0A4-G. This tube is normally nonconducting because the voltage from cathode to anode is insufficient to cause ionization. However, a comparatively low voltage applied to the starter anode will start ionization and cause the entire tube to conduct. The cathode of the 0A4 is returned to ground through the coil of the shutter-triggering device. Each time a sound hits the microphone, the amplified voltage fires the 0A4 which in turn trips the shutter of the camera.

Once the 0A4 is fired, it will continue to conduct until the plate voltage is removed. To eliminate the necessity of opening the plate circuit of the 0A4 after each exposure, the plate voltage is supplied to the tube through a 220,000-ohm resistor. This resistor charges the 10-μf capacitor to the battery terminal voltage. However, when the 0A4 conducts, it discharges the 10-μf capacitor in less than a second. The resistance of the plate resistor is such that it will not sustain tube conduction. The capacitor discharge current is more than sufficient to energize the coil of the triggering mechanism but, since the peak current of the 0A4 must be limited to 100 ma, the resistance of the coil on the triggering mechanism should not be less than 2,000 ohms.



Compact cabinet of photo-sound unit contains batteries and small chassis.

If such is the case, a plate type relay may be installed in the cathode circuit of the tube and the normally open contacts used to energize the solenoid with the proper voltage. The contacts of the relay can be connected directly to the external receptacle of the flash gun unit.



Schematic diagram of photo-sound unit showing the external jack circuit.

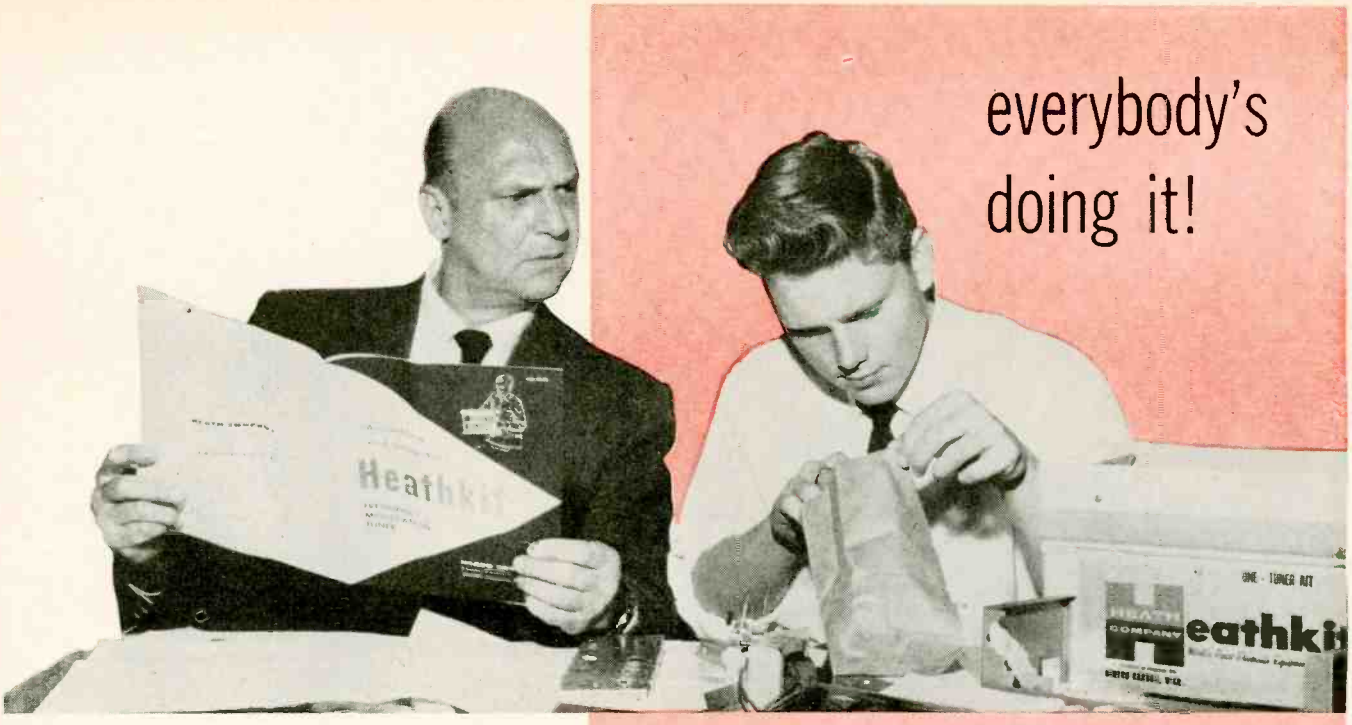
Resistors: 1—5,600, 1—100,000, 2—220,000, 1—330,000 ohms, 1—3.3 megohms, ½ watt; 1—1-megohm pot, audio taper (sensitivity); 1—1-megohm pot, linear taper (threshold).

Miscellaneous: 1—.005, 2—.02, 1—.05 µf, 200 volts, 1—10-µf 450-volt electrolytic, capacitors; 1—1.5-volt A battery (Burgess 4FH or equivalent); 2—90-volt B batteries (Burgess N60 or equivalent); 1—phone jack; 1—dpst switch; 2—1U4's and sockets; 1—0A4-G and socket; 1—4-inch PM speaker; 1—transformer, voice coil to grid (Stancor A-4744 or equivalent); 1—chassis and cabinet; 1—triggering device.

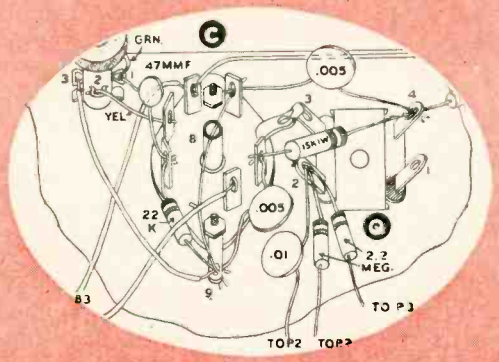
The starter anode of the 0A4 must be operated with positive dc bias obtained from the threshold potentiometer. This potentiometer is adjusted just below the point where the 0A4 will fire without additional voltage from the amplifier.

Most commercial shutter solenoids have too low a resistance to be used in the cathode circuit of the 0A4. If such

The unit is constructed on a small sheet-metal chassis and installed in a wooden box with batteries. The sensitivity control, power switch and jack are accessible through an opening in the back of the box. The threshold control is left as an internal adjustment. The unit is extremely sensitive. A low whistle will trigger it at a distance of 15 or 20 feet. END



Motion picture and TV personality, Jackie Coogan, looks on with unbelieving interest as his 14-year-old son, Anthony, prepares to assemble his latest Heathkit, a hi-fi FM tuner. The Coogans have found out about the fun and savings of building their own electronic equipment the Heathkit way . . . so why don't you?



You'll get plenty of these detailed pictorial diagrams in your Heathkit construction manual to show where each and every wire and part is to be placed. Everything you do is spelled out in pictures so you can't go wrong. That's what makes it such fun!

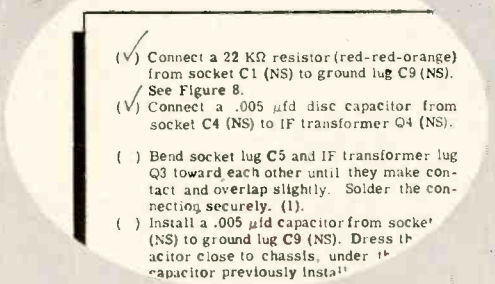
Heathkits®

By DAYSTROM

...fun to build and a thrill to own!

and here's why...

1. You get higher quality at lower cost by dealing direct, and by doing your own assembly.
2. You receive personal, friendly, service (before and after sale) for complete satisfaction.
3. You benefit from the latest in engineering designs because of our concentration on kit-form equipment only.
4. You may depend on performance as advertised—backed by Heath's world-wide reputation for quality.
5. You can take a full year to pay with the HEATH EASY TIME PAYMENT PLAN.


(√) Connect a 22 KΩ resistor (red-red-orange) from socket C1 (NS) to ground lug C9 (NS). See Figure 8.

(√) Connect a .005 μfd disc capacitor from socket C4 (NS) to IF transformer Q4 (NS).

( ) Bend socket lug C5 and IF transformer lug Q3 toward each other until they make contact and overlap slightly. Solder the connection securely. (1).

( ) Install a .005 μfd capacitor from socket (NS) to ground lug C9 (NS). Dress the capacitor close to chassis, under the capacitor previously install

Read the step . . . perform the operation . . . and check it off—it's just that simple. These plainly-worded, easy-to-follow, steps are combined with pictorial diagrams to take you through every phase of assembly. Let our experience be your teacher!

TIME PAYMENTS . . .

The Heath Time Payment Plan was designed for your convenience. Now, you can order the kits of your choice, and pay for them in small monthly installments. Write for full details.

HEATHKIT EXTRA PERFORMANCE 70-WATT AMPLIFIER KIT

For really high performance, with plenty of reserve power, the W-6M is a natural. The full 70-watts output will seldom, if ever, be required. However, this reserve insures distortion-less sound on power peaks. The W-6M will loaf along at normal listening levels and yet is always ready to extend itself when program material demands it, without the least amount of strain. The output circuit employs 6550 tubes with a special-design Peerless output transformer for maximum stability at all power levels. A quick-change plug selects 4, 8 and 16 ohms or 70-volt output and the correct feedback resistance. A variable damping control is also provided for optimum performance with any speaker system. Extremely good power supply regulation is possible through the use of a heavy-duty transformer along with silicon-diode rectifiers, which are noted for their very long life, and yet are smaller than a house fuse. Frequency response at 1 watt is ±1 db from 5 cps to 80 kc with controlled hf rolloff above 100 kc. At 70 watts output harmonic distortion is below 2%, 20 to 20,000 cps and IM distortion below 1%, 60 and 6,000 cps. Hum and noise 88 db below full output. In addition to high performance, its fine appearance makes it a pleasure to display in your living room. Proper layout of chassis insures ease of assembly by eliminating those cramped and difficult places to get at. Clear instructions—and top-quality components. Get started now and make this amplifier the heart of your hi-fi system. Shipped express only. Shpg. Wt. 50 lbs.

MODEL W-6M **$109.95**

MODEL W-6: Consists of W-6M kit, plus WA-P2 preamplifier. Express only. Shpg. Wt. 59 lbs. $129.70

HEATHKIT HIGH FIDELITY FM TUNER KIT

This tuner can bring you a rich store of FM programming, your least expensive source of high fidelity material. It covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures negligible drift after initial warmup. Features broadbanded circuits for full fidelity, and better than 10 uv sensitivity for 20 db of quieting, to pull in stations with clarity and full volume. Employs a high gain, cascode RF amplifier, and has AGC. A ratio detector provides high-efficiency demodulation without sacrificing hi-fi performance. IF and ratio transformers are prealigned, as is the front end tuning unit. Special alignment equipment is not necessary. Edge-lighted glass dial for easy tuning. Here is FM for your home at a price you can afford. Shpg. Wt. 8 lbs.

MODEL FM-3A **$25.95** *(with cabinet)*

HEATHKIT BROADBAND AM TUNER KIT

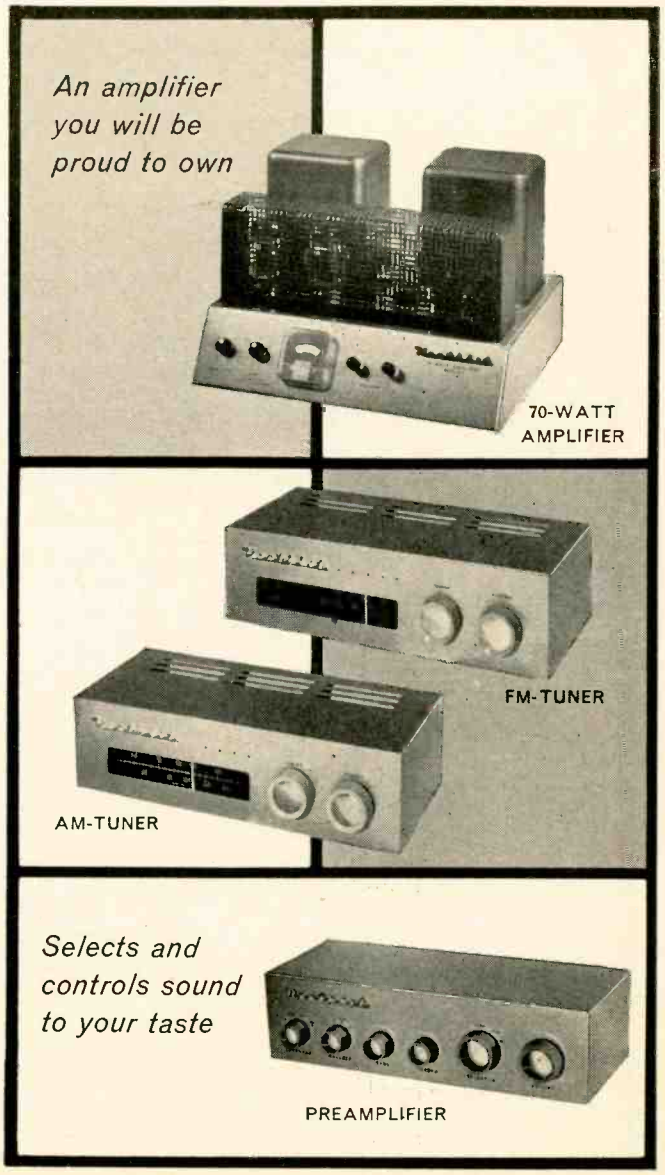
This AM tuner was designed especially for high fidelity applications. It incorporates a special detector using crystal diodes, and the IF circuits feature broad band-width, to insure low signal distortion. Audio response is ±1 db from 20 cps to 9 kc, with 5 db of preemphasis at 10 kc to compensate for station rolloff. Sensitivity and selectivity are excellent, and tuner covers complete broadcast band from 550 to 1600 kc. Quiet performance is assured by 6 db signal-to-noise ratio at 2.5 UV. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs, and built-in power supply. Edge-lighted glass slide-rule dial for easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 8 lbs.

MODEL BC-1A **$25.95** *(with cabinet)*

HEATHKIT MASTER CONTROL PREAMPLIFIER KIT

Designed for use with any of the Williamson-type amplifiers, the WA-P2 has five switch-selected inputs, each having its own level control to eliminate blasting or fading while switching through the various inputs, plus a tape recorder output. A hum control allows setting for minimum hum level. Frequency response is within ±1½ db from 15 to 35,000 cps. Equalization provided for LP, RIAA, AES, and early 78's. Separate bass and treble controls. Low impedance cathode follower output circuit. All components were specially selected for their high quality. Includes many features which will eventually be desired. Shpg. Wt. 7 lbs.

MODEL WA-P2 **$19.75** *(with cabinet)*



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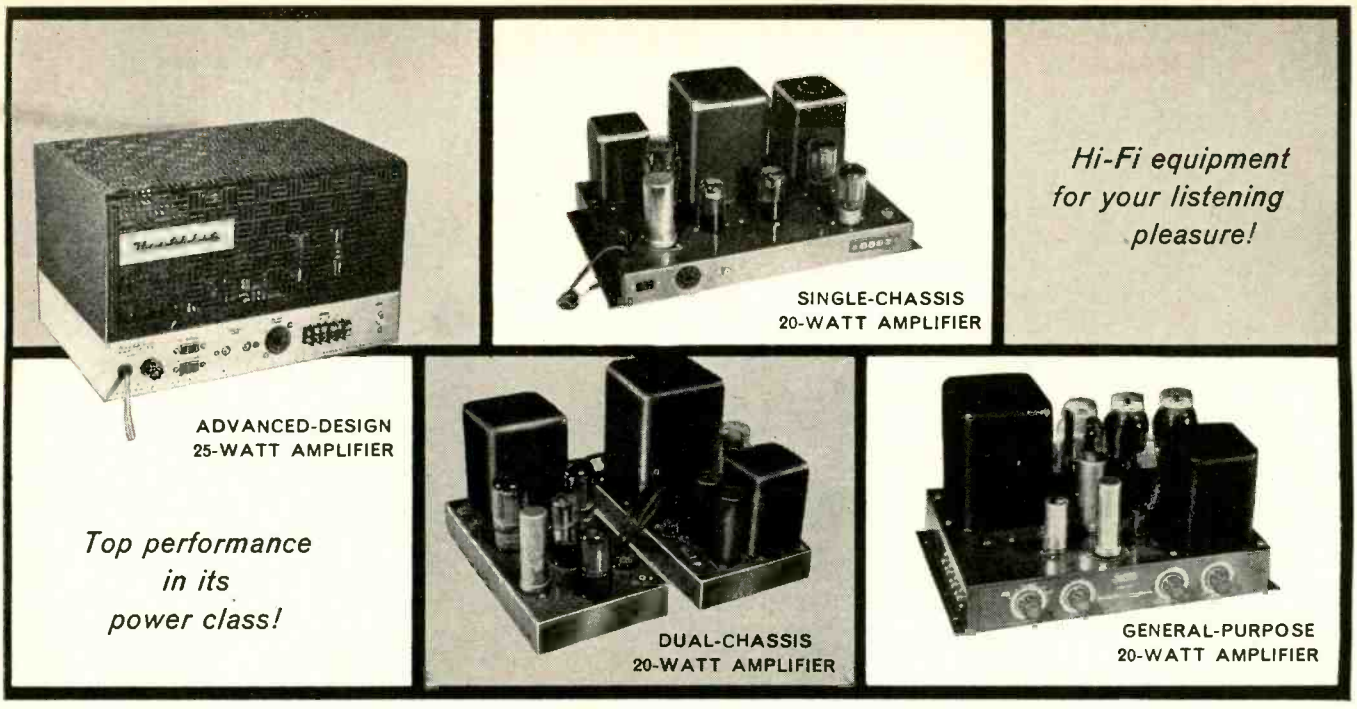

HEATHKIT ADVANCED-DESIGN 25-WATT HIGH FIDELITY AMPLIFIER KIT

Designed especially to satisfy critical audio requirements, the W-5M incorporates the extra features needed to compliment the finest in program sources and speaker systems. Faithful sound reproduction is assured with a frequency response of ±1 db from 5 to 160,000 cps at 1 watt, and harmonic distortion is less than 1% at 25 watts, with IM distortion less than 1% at 20 watts. Hum and noise are a full 99 db below rated output, assuring quiet, hum-free operation. Output taps are 4, 8 and 16 ohms. Exclusive Heathkit features include the "tweeter saver", and the "bas-bal" balancing circuit, requiring only a voltmeter for indication. Years of reliable service are guaranteed through the use of conservatively rated, high quality components. KT66 tubes and Peerless output transformer are typical. Shipped express only. Shpg. Wt. 31 lbs.

MODEL W-5M

MODEL W-5: Consists of W-5M kit above plus model WA-P2 preamplifier. Express only. Shpg. Wt. 38 lbs. $79.50

$59.75

HEATHKIT DUAL-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model W3-AM is a Williamson-type amplifier built on two separate chassis. The power supply is on one chassis, and the amplifier stages are on the other chassis. Using two separate chassis provides additional flexibility in installation. Features include the famous acrosound model TO-300 "ultralinear" output transformer and 5881 tubes for broad frequency response, low distortion, and low hum level. The result is exceptionally fine overall tone quality. Frequency response is ±1 db from 6 cps to 150 kc at 1 watt. Harmonic distortion is less than 1% and IM distortion is less than 1.3% at 20 watts. Hum and noise are 88 db below 20 watts. Designed to match the speaker system of your choice, with taps for 4, 8 or 16 ohms impedance. A very popular high fidelity unit employing top quality components throughout. Shipped express only. Shpg. Wt. 29 lbs.

MODEL W-3AM

MODEL W-3A: Consists of W-3AM kit above plus model WA-P2 preamplifier. Express only. Shpg. Wt. 37 lbs. $69.50

$49.75

HEATHKIT SINGLE-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model W4-AM Williamson-type amplifier will amaze you with its outstanding performance. A true Williamson circuit, featuring extended frequency response, low distortion, and low hum levels, this amplifier can provide you with many hours of listening enjoyment with only a minimum investment compared to other units on the market. 5881 tubes and a special Chicago-standard output transformer are employed to give you full fidelity at minimum cost. Frequency response extending from 10 cps to 100 kc within ±1 db at 1 watt assures you of full coverage of the audio range, and clean clear sound amplification takes place in circuits that hold harmonic distortion at 1.5% and IM distortion below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps on the output transformer are at 4, 8 or 16 ohms. Shipped express only. Shpg. Wt. 28 lbs.

MODEL W4-AM

MODEL W-4A: Consists of W-4AM kit above, plus model WA-P2 preamplifier. Express only. Shpg. Wt. 35 lbs. $59.50.

$39.75

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bring you the lasting satisfaction of personal accomplishment

HEATHKIT GENERAL-PURPOSE 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model A-9C will provide you with high quality sound at low cost. Features a built-in preamplifier with four separate inputs, and individual volume, bass and treble controls. Frequency response covers 20 to 20,000 cps within ±1 db. Total harmonic distortion is less than 1% at 3 db below rated output. Push-pull 6L6 tubes are used, with output transformer tapped at 4, 8, 16 and 500 ohms. A true hi-fi unit using high-quality components throughout, including heavy-duty "potted" transformers. Shpg. Wt. 23 lbs.

MODEL A-9C

$35.50

HEATHKIT "BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

The extremely popular Heathkit model SS-1 Speaker System provides amazing high fidelity performance for its size. Features two high-quality Jensen speakers, an 8" mid-range woofer and compression-type tweeter with flared horn. Covers from 50 to 12,000 CPS within ±5 db, in a special-design ducted-port, bass reflex enclosure. Impedance is 16 ohms. Cabinet measures 11½" H x 23" W x 11¾" D. Constructed of veneer-surfaced plywood, ½" thick, suitable for light or dark finish. All wood parts are precut and predrilled for easy, quick assembly. Shpg. Wt. 30 lbs.

MODEL SS-1
$39.95

HEATHKIT "RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

Extends the range of the SS-1 to ±5 db from 35 to 16,000 CPS. Uses 15" woofer and super-tweeter both by Jensen. Kit includes crossover circuit. Impedance is 16 ohms and power rating is 35 watts. Measures 29" H x 23" W x 17½" D. Constructed of veneer-surfaced plywood ¾" thick. Easy to build! Shpg. Wt. 80 lbs.

MODEL SS-1B
$99.95

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let you save up to ½ or more on all types of electronic equipment.

HEATHKIT SINE-SQUARE GENERATOR

The new AG-10 provides high quality, sine and square waves over a wide range, for countless applications. Some of these are; radio and TV repair work, checking scope performance, as a variable trigger source for telemetering and pulse work, and checking audio, video and hi-fi amplifier response. Frequency response is ±1.5 db from 20 CPS to 1 MC on both sine and square waves, with less than .25% sine wave distortion, 20 to 20,000 CPS. Sine wave output impedance 600 ohms, square wave output impedance 50 ohms, (except on 10v ranges). Square wave rise time less than .15 usec. Five-position band switch—continuously variable tuning—shielded oscillator circuit—separate step and variable output attenuators in ranges of 10, 1, and .1 volts for both sine and square wave, with extra range of .01 volt on sine wave. Both sine and square wave can be used at the same time without affecting either wave form. Power supply uses silicon-diode rectifiers. Shpg. Wt. 12 lbs.

MODEL AG-10
$49.95

HEATHKIT AUDIO ANALYZER KIT

The AA-1 is actually three instruments in one compact package. It combines the functions of an AC VTVM, an audio wattmeter, and an intermodulation analyzer. Input and output terminals are combined, and high and low frequency oscillators are built in. VTVM ranges are 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts (RMS). Wattmeter ranges are .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w and 150 w. IM scales are 1%, 3%, 10%, 30% and 100%. Provides internal load resistors of 4, 8, 16 or 600 ohms. A tremendous dollar value. Shpg. Wt. 13 lbs.

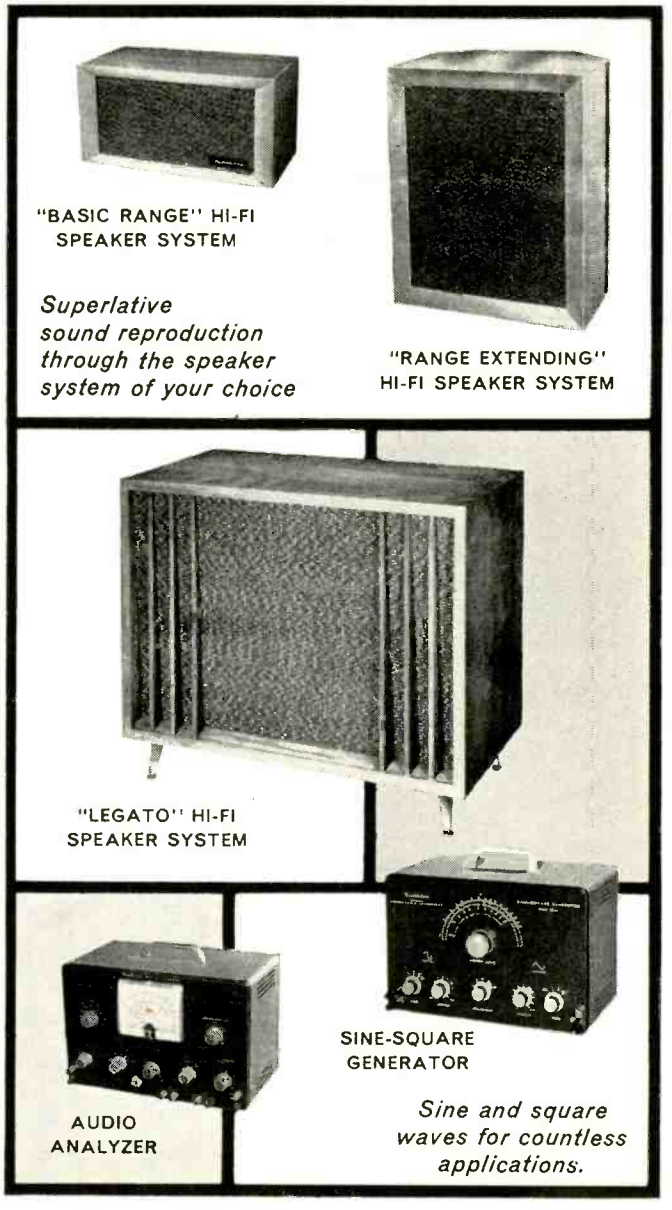
MODEL AA-1
$49.95

HEATHKIT "LEGATO" HIGH FIDELITY SPEAKER SYSTEM KIT

The quality of the Legato, in terms of the engineering that went into the initial design, and in terms of the materials used in its construction, is matched in only the most expensive speaker systems available today. The listening experience it provides approaches the ultimate in esthetic satisfaction. Two 15" theater-type Altec Lansing speakers cover 25 to 500 CPS, and an Altec Lansing high-frequency driver with sectoral horn covers 500 to 20,000 CPS. A precise amount of phase shift in the crossover network brings the high frequency channel into phase with the low frequency channel to eliminate peaks or valleys at the crossover point, by equalizing the acoustical centers of the speakers. The enclosure is a modified infinite baffle type, especially designed for these speakers. Cabinet is constructed of veneer-surfaced plywood, ¾" thick, precut and predrilled for easy assembly. Frequency response 25 to 20,000 CPS. Power rating, 50 watts program material. Impedance is 16 ohms. Cabinet dimensions 41" L x 22¼" D x 34" H.

Choice of two beautiful cabinets. Model HH-1-C in imported white birch for light finishes, and HH-1-CM in African mahogany for dark finishes. Shpg. Wt. 195 lbs.

MODEL HH-1-C
MODEL HH-1-CM
$325.00 EACH



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HEATHKIT "GENERAL PURPOSE" 5" OSCILLOSCOPE KIT

The model OM-2 Oscilloscope is especially popular with part-time service technicians, students, and high fidelity enthusiasts. It features good vertical frequency response ±3 db from 4 cps to over 1.2 mc. A full five-inch crt, and sweep generator operation from 20 cps to over 150 kc. Stability is excellent and calibrated grid screen allows precise signal observation. Extra features include external or internal sweep and sync, 1-volt peak-to-peak calibrating reference, 3-position step-attenuated input, adjustable spot shape control, push-pull horizontal and vertical amplifiers, and modern etched-metal circuits. Easy to build and a pleasure to use. Ideal for use with other audio equipment for checking amplifiers. Shpg. Wt. 21 lbs.

MODEL OM-2
$42.50

HEATHKIT AUDIO WATTMETER KIT

The AW-1 Audio Wattmeter can be used in any application where audio power output is to be measured. Non-inductive LOAD resistors are built in for 4, 8, 16 or 600 ohms impedance. Five power ranges cover 0-5 mw, 50 mw, 500 mw, 5 w, and 50 w full scale. Five switch-selected db ranges cover −10 db to +30 db. All indications are read directly on a large 4½" 200 microampere meter. Frequency response is ±1 db from 10 cps to 250 kc. Precision type multiplier resistors used for high accuracy, and crystal diode bridge for wide-range frequency response. This meter is used in many recording studios and broadcast stations as a monitor as well as servicing. A fine meter to help supply the answers to your audio operating or power output problems. Shpg. Wt. 6 lbs.

MODEL AW-1
$29.50

HEATHKIT AUDIO SIGNAL GENERATOR KIT

The model AG-9A is "made to order" for high fidelity applications, and provides quick and accurate selection of low-distortion signals throughout the audio range. Three rotary switches select two significant figures and a multiplier to determine audio frequency. Incorporates step-type and a continuously variable output attenuator. Output indicated on large 4½" panel meter, calibrated in volts and db. Attenuator system operates in 10 db steps, corresponding to meter calibration, in ranges of 0-.003, .01, .03, .1, .3, 1,3 and 10 volts RMS. "Load" switch permits use of built-in 600-ohm load, or external load of different impedance. Output and frequency indicators accurate to within ±5%. Distortion less than .1 of 1% between 20 and 20,000 cps. Total range is 10 cps to 100 kc. Shpg. Wt. 8 lbs.

MODEL AG-9A
$34.50

HEATHKIT HARMONIC DISTORTION METER KIT

All sounds consist of dominant tones plus harmonics (overtones). These harmonics enrich the quality and brightness of the music. However, additional harmonics which originate in the audio equipment, represent distortion. Used with an audio signal generator, the HD-1 will accurately measure this harmonic distortion at any or all frequencies between 20 and 20,000 cps. Distortion is read directly on the panel meter in ranges of 0-1, 3, 10, 30 and 100% full scale. Voltage ranges of 0-1, 3, 10 and 30 volts are provided for the initial reference settings. Signal-to-noise ratio measurements are also permitted through the use of a separate meter scale calibrated in db. High quality components insure years of outstanding performance. Full instructions are provided. Shpg. Wt. 13 lbs.

MODEL HD-1
$49.50

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are well known for their high quality and reliability.

HEATHKIT AUDIO VTVM KIT

This new and improved AC Vacuum Tube Voltmeter is designed especially for audio measurements and low-level AC measurements in power supply filters, etc. Employs an entirely new circuit featuring a cascode amplifier with cathode-follower isolation between the input and the amplifier, and between the output stage and the preceding stages. It emphasizes stability, broad frequency response, and sensitivity. Frequency response is essentially flat from 10 cps to 200 kc. Input impedance is 1 megohm at 1000 cps. AC (RMS) voltage ranges are 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover −52 db to +52 db. Features large 4½" 200 microampere meter, with increased damping in meter circuit for stability in low frequency tests. 1% precision resistors employed for maximum accuracy. Stable, reliable performance in all applications. Shpg. Wt. 5 lbs.

MODEL AV-3
$29.95

HEATHKIT COLOR BAR AND DOT GENERATOR

The CD-1 combines the two basic color service instruments, a Color Bar Generator and White Dot Generator in one versatile portable unit, which has crystal-controlled accuracy and stability (no external sync lead required). Produces white-dots, cross hatch, horizontal and vertical bars, 10 vertical color bars, and a new shading bar pattern for screen and background adjustments. Variable RF output on any channel from 2 to 6. Positive or negative video output, variable from 0 to 10 volts peak-to-peak. Crystal controlled sound carrier with off-on switch. Voltage regulated power supply using long-life silicon rectifiers. Gain knowledge of a new and profitable field by constructing this kit. Shpg. Wt. 12 lbs.

MODEL CD-1
$59.95

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are guaranteed to meet or exceed advertised specifications

HEATHKIT TV ALIGNMENT GENERATOR KIT

This fine TV alignment generator offers stability and flexibility difficult to obtain even in instruments costing several times this low Heathkit price. It covers 3.6 mc to 220 mc in four bands. Sweep deviation is controllable from 0 to 42 mc. The all-electronic sweep circuit insures stability. Crystal marker and variable marker oscillators are built in. Crystal (included with kit) provides output at 4.5 mc and multiples thereof. Variable marker provides output from 19 to 60 mc on fundamentals and from 57 to 180 mc on harmonics. Effective two-way blanking to eliminate return trace. Phasing control. Kit is complete, including three output cables. Shpg. Wt. 16 lbs.

MODEL TS-4A
$49.50

HEATHKIT "EXTRA DUTY" 5" OSCILLOSCOPE KIT

This fine oscilloscope compares favorably to other scopes costing twice its price. It contains the extra performance so necessary for monochrome and color-TV servicing. Features push-pull horizontal and vertical output amplifiers, a 5UP1 CRT, built in peak-to-peak calibration source, a fully compensated 3-position step-type input attenuator, retrace blanking, phasing control, and provision for Z-axis modulation. Vertical amplifier frequency response is within +1.5 and −5 db from 3 CPS to 5 MC. Response at 3.58 MC down only 2.2 db. Sensitivity is 0.025 volts RMS/inch at 1 kc. Sweep generator covers 20 CPS to 500 kc in five steps, five times the usual sweep obtained in other scopes through the use of the patented Heath sweep circuit. Etched-metal circuit boards reduce assembly time and minimize errors in assembly, and more importantly, permit a level of circuit stability never before achieved in an oscilloscope of this type. Shpg. Wt. 21 lbs.

MODEL O-11
$69.50

HEATHKIT ELECTRONIC SWITCH KIT

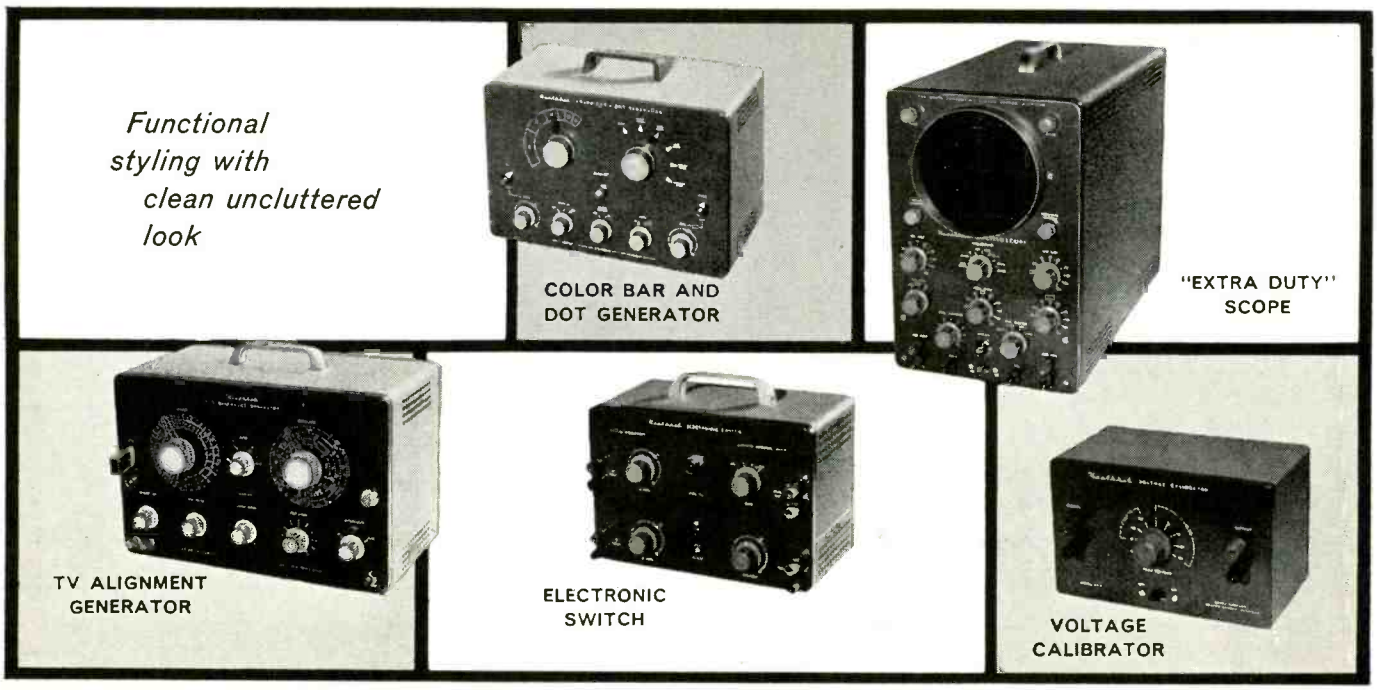
A valuable accessory for any oscilloscope owner. It allows simultaneous oscilloscope observation of two signals by producing both signals, alternately, at its output. Four switching rates. Provides gain for input signals. Frequency response ±1 db, 0 to 100 kc. A sync output is provided to control and stabilize scope sweep. Ideal for observing input and output of amplifiers simultaneously. Shpg. Wt. 8 lbs.

MODEL S-3
$21.95

HEATHKIT VOLTAGE CALIBRATOR KIT

This unit is an excellent companion for your oscilloscope. Used as a source of calibrating voltage, it produces near-perfect square wave signals of known amplitude. Precision 1% attenuator resistors insure accurate output amplitude, and multivibrator circuit guarantees good sharp square waves. Output frequency is approximately 1000 CPS. Fixed outputs selected by panel switches are; .03, 0.1, 0.3, 1.0, 3.0, 10, 30 and 100 volts peak-to-peak. Allows measurment of unknown signal amplitude by comparing it to the known output of the VC-3 on oscilloscope. Shpg. Wt. 4 lbs.

MODEL VC-3
$12.50



HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

HEATHKIT TUBE CHECKER KIT

Eliminate guesswork, and save time in servicing or experimenting. The TC-2 tests tubes for shorted elements, open elements, filament continuity, and operating quality on the basis of total emission. It tests all tube types encountered in radio and TV service work. Sockets are provided for 4, 5, 6 and 7-pin, octal, and loctal tubes, 7 and 9 pin miniature tubes, 5 pin hytron miniatures, and pilot lamps. Tube condition indicated on 4½" meter with multicolor "good-bad" scale. Illuminated roll chart with all test data built in. Switch selection of 14 different filament voltages from .75 to 117 volts. Color-coded cable harness allows neat professional wiring and simplifies construction. Very easy to build, even for a beginner. Shpg. Wt. 12 lbs.

MODEL TC-2

$29.50

HEATHKIT HANDITESTER KIT

The small size and rugged construction of this tester makes it perfect for any portable application. The combination function-range switch simplifies operations. Measures AC or DC voltage at 0-10, 30, 300, 1000 and 5000 volts. Direct current ranges are 0-10 ma and 0-100 ma. Ohmmeter ranges are 0-3000 (30 ohm center scale) and 0-300,000 (3000 ohm center scale). Very popular with home experimenters, electricians, and appliance repairmen. Slips easily into your tool box, glove compartment, coat pocket, or desk drawer. Shpg. Wt. 3 lbs.

MODEL M-1

$14.50

HEATHKIT PICTURE TUBE CHECKER KIT

The CC-1 can be taken with you on service calls so that you can clearly demonstrate the quality of a customer's picture tube in his own home. Tubes can be tested without removing them from the receiver or cartons if desired. Checks cathode emission, beam current, shorted elements, and leakage between elements in electromagnetic picture tube types. Self-contained power supply, and large 4½" meter. CRT condition indicated on "good-bad" scale. Relative condition of tubes fluorescent coating is shown in "shadowgraph" test. Permanent test cable with CRT socket and anode connector. No tubes to burn out, designed to last a lifetime. Luggage-type portable case. Shpg. Wt. 10 lbs.

MODEL CC-1

$22.50

HEATHKIT ETCHED-CIRCUIT VTVM KIT

This multi-purpose VTVM is the world's largest selling instrument of its type—and is especially popular in laboratories, service shops, home workshops and schools. It employs a large 4½" panel meter, precision 1% resistors, etched metal circuit board, and many other "extras" to insure top quality and top performance. It's easy to build, and you may rely on its accuracy and dependability. The V7-A will measure AC (RMS) and DC voltages in ranges of 0-1.5, 5, 15, 50, 150, 500 and 1500. It measures peak-to-peak AC voltage in ranges of 0-4, 14, 40, 140, 400, 1400 and 4000. Resistance ranges provide multiplying factors of X 1, X 10, X 100, X 1000, X 10k, X 100k, and X 1 megohm. Center-scale resistance readings are 10, 100, 1000, 10k, 100k, 1 megohm and 10 megohms. A db scale is also provided. The precision and quality of this VTVM cannot be duplicated at this price. Shpg. Wt. 7 lbs.

MODEL V7-A

$24.50

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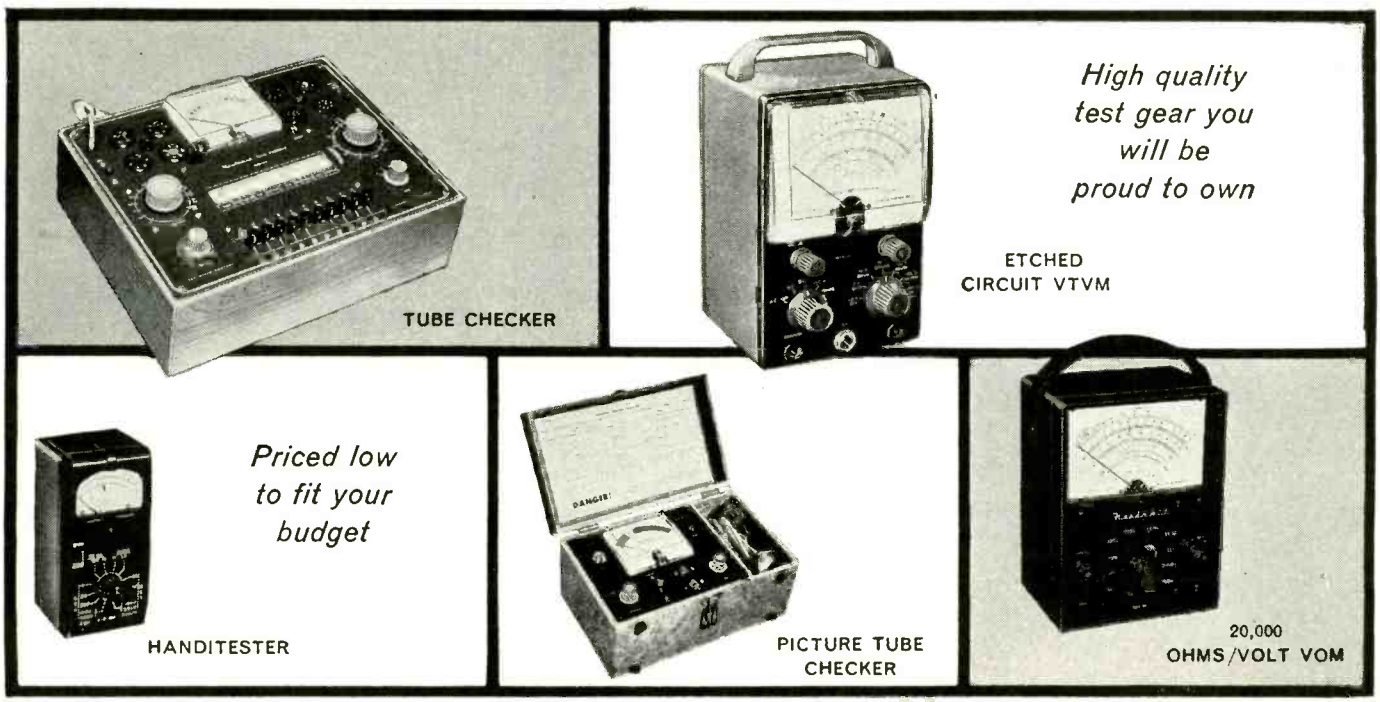
let you fill your exact needs from a wide variety of instruments

HEATHKIT 20,000 OHMS/VOLT VOM KIT

This fine instrument provides a total of 25 meter ranges on its two-color scale. It employs a 50 ua 4½" meter, and features 1% precision multiplier resistors. Requires no external power. Ideal for portable applications. Sensitivity is 20,000 ohms-per-volt DC and 5000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1500 and 5000 volts, AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are X 1, X 100 and X 10,000, with center-scale readings of 15, 1500 and 150,000 ohms. Covers −10 db to +65 db. Easy to build and fun to use. Attractive bakelite case with plastic carrying handle. Shpg. Wt. 6 lbs.

MODEL MM-1

$29.50



HEATHKIT RF SIGNAL GENERATOR KIT

Even a beginner can build this prealigned signal generator, designed especially for use in service work. Produces RF signals from 160 kc to 110 mc on fundamentals in five bands. Covers 110 mc to 220 mc on calibrated harmonics. Low impedance RF output in excess of 100,000 microvolts, is controllable with a step-type and continuously variable attenuator. Selection of unmodulated RF, modulated RF, or audio at 400 CPS. Ideal for fast and easy alignment of radio receivers, and finds application in FM and TV work as well. Thousands of these units are in use in service shops all over the country. Easy to build and a real time saver, even for the part-time service technician or hobbyist. Shpg. Wt. 8 lbs.

MODEL SG-8

$19.50

HEATHKIT LABORATORY RF GENERATOR KIT

Tackle all kinds of laboratory alignment jobs with confidence by employing the LG-1. It features voltage-regulated B+, double shielding of oscillator circuits, copper-plated chassis, variable modulation level, metered output, and many other "extras" for critical alignment work. Generates RF signals from 100 kc to 30 mc on fundamentals in five bands. Meter reads RF output in microvolts or modulation level in percentage. RF output available up to 100,000 microvolts, controlled by a fixed-step and a variable attenuator. Provision for external modulation where necessary. Buy and use this high-quality RF signal generator that may be depended upon for stability and accuracy. Shpg. Wt. 16 lbs.

MODEL LG-1

$48.95

HEATHKIT DIRECT-READING CAPACITY METER KIT

Here's a fast, simple capacity meter. A capacitor to be checked is merely connected to the terminals, the proper range selected, and the value read directly on the large 4½" panel meter calibrated in mmf and mfd. Ranges are 0 to 100 mmf, 1,000 mmf, .01 mfd, .1 mfd full scale. Not affected by hand capacity. Shpg. Wt. 7 lbs.

MODEL CM-1

$29.50

Heathkits...

By DAYSTROM

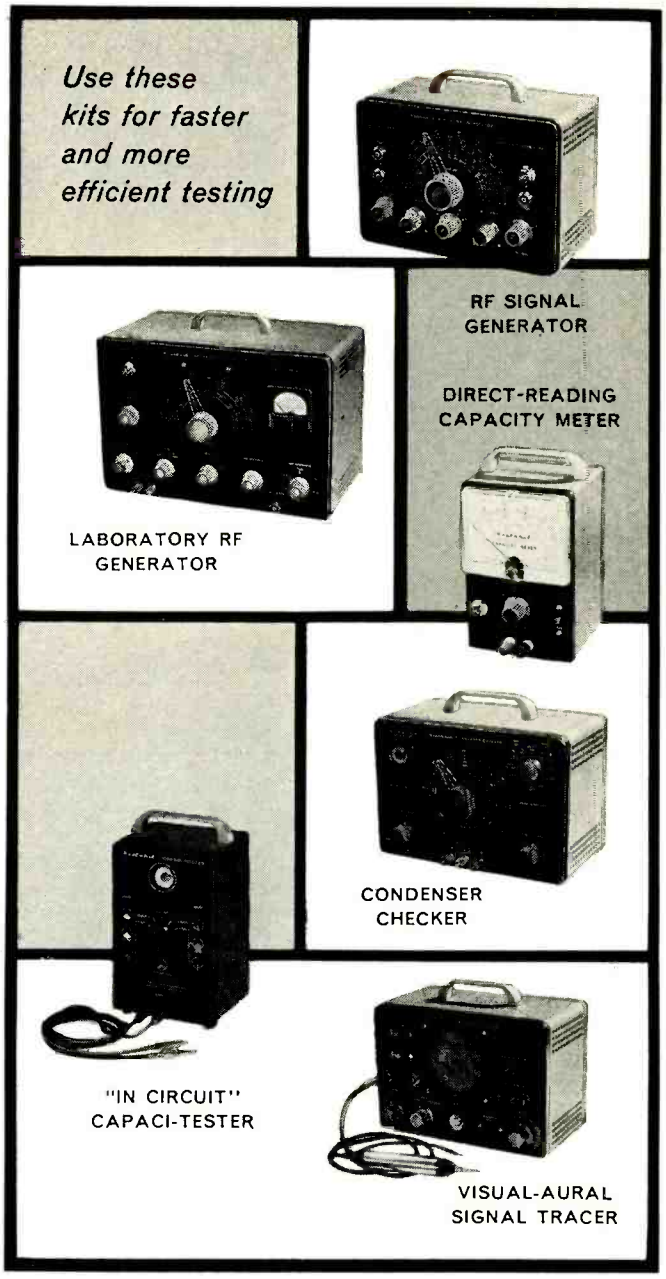
are educational
as well as functional

HEATHKIT "IN-CIRCUIT" CAPACI-TESTER KIT

With the CT-1 it is no longer necessary to disconnect one capacitor lead to check the part, you can check most capacitors for "open" or "short" right in the circuit. Fast and easy—to save your valuable time in the service shop or lab. Detects open capacitors from about 50 mmf up, so long as the capacitor is not shunted by excessively low resistance value. Will detect shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). (Does not detect leakage.) Employs 60 cycles and 19 megacycle test frequencies. Electron beam "eye" tube used as indicator. Compact, easy-to-build, and inexpensive. Test leads included. Shpg. Wt. 5 lbs.

MODEL CT-1

$7.95



HEATHKIT CONDENSER CHECKER KIT

This handy instrument uses an electron beam "eye" tube as an indicator to measure capacity in ranges of .00001 to .005 mfd, .5 mfd, 50 mfd and 1000 mfd. Also measures resistance from 100 ohms to 5 megohms in two ranges. Checks paper, mica, ceramic and electrolytic capacitors. Selection of five polarizing voltages. Shpg. Wt. 7 lbs.

MODEL C-3

$19.50

HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

Although designed originally for radio receiver work, the T-3 finds application in FM and TV servicing as well. Features high-gain channel with demodulator probe, and low-gain channel with audio probe. Traces signals in all sections of radio receivers and in many sections of FM and TV receivers. Built-in speaker and electron beam eye tube indicate relative gain, etc. Also features built-in noise locator circuit. Provision for patching speaker and/or output transformer to external set. Shpg. Wt. 9 lbs.

MODEL T-3

$23.50

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

HEATHKIT IMPEDANCE BRIDGE KIT

The model IB-2A employs a Wheatstone Bridge, a Capacity Comparison Bridge, a Maxwell Bridge, and a Hay Bridge in one compact package. Measures resistance from 0.1 ohm to 10 megohms, capacitance from 100 mmf to 100 mfd, inductance from 0.1 mh to 100 h, dissipation factor (D) from 0.002 to 1, and storage factor (Q) from 0.1 to 1000. A 100-0-100 ua meter provides for null indications. The decade resistors employed are of 1% tolerance for maximum accuracy. Completely self-contained. Has built in power supply, 1000-cycle generator, and vacuum-tube detector. Special two-section CRL dial insures convenient operation. Instruction manual has entirely new schematic that clarifies circuit functions in various switch positions. A true laboratory instrument, that will provide you with many years of fine performance. Shpg. Wt. 12 lbs.

MODEL IB-2A

$59.50

HEATHKIT "LOW RIPPLE" BATTERY ELIMINATOR KIT

This modern battery eliminator incorporates an extra low-ripple filter circuit so that it can be used to power all the newest transistor-type circuits requiring 0 to 12 volts DC, and the new "hybrid" automobile radios using both transistors and vacuum tubes. Its DC output, at either 6 or 12 volts, contains less than .3% AC ripple. Separate output terminals are provided for low-ripple or normal filtering. Supplies up to 15 amps on 6 volt range or up to 7 amps on 12 volt range. Output is variable from 0 to 8 or 0 to 16 volts. Two meters constantly monitor output voltage and current. Will also double as a battery charger. Shpg. Wt. 23 lbs.

MODEL BE-5

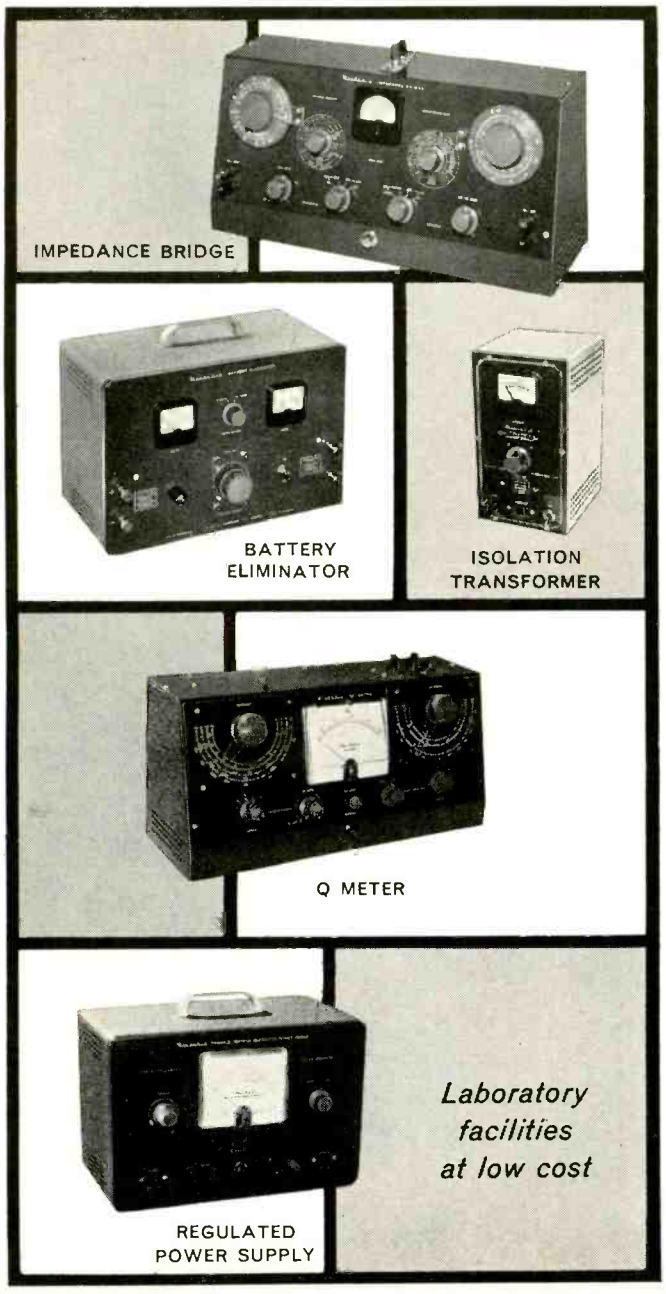
$39.95

HEATHKIT ISOLATION TRANSFORMER KIT

The model IT-1 is one of the handiest units for the service shop, home workshop or laboratory. Provides complete isolation from the power line. AC-DC sets may be plugged directly into the IT-1 without the chassis becoming "hot". Output voltage is variable from 90 volts to 130 volts allowing checks of equipment under adverse conditions such as low line voltage. Rated for 100 volt amperes continuously or 200 volt amperes intermittently. Panel meter monitors output voltage. Shpg. Wt. 9 lbs.

MODEL IT-1

$16.50



Heathkits...

By DAYSTROM

are designed with high-quality, name-brand components to insure long service life

HEATHKIT "Q" METER KIT

At this price the laboratory facilities of a Q Meter may be had by the average service technician or home experimenter. The Q Meter permits measurement of inductance from 1 microhenry to 10 milihenry, "Q" on a scale calibrated up to 250 full scale, with multipliers of 1 or 2, and capacitance from 40 mmf to 450 mmf ± 3 mmf. Built in oscillator permits testing components from 150 kc to 18 mc. Large 4½" panel meter is featured. Very handy for checking peaking coils, chokes, etc. Use to determine values of unknown condensers, both variable and fixed, compile data for coil winding purposes, or measure RF resistance. Also checks distributed capacity and Q of coils. No special equipment is required for calibration. A special test coil is furnished, along with easy-to-follow instructions. Shpg. Wt. 14 lbs.

MODEL QM-1

$44.50

HEATHKIT REGULATED POWER SUPPLY KIT

Here is a power supply that will provide DC plate voltage and AC filament voltage for all kinds of experimental circuits. The DC supply is regulated for stability, and yet the amount of DC output voltage available from the power supply can be controlled manually from 0 up to 500 volts. At 450 volts DC output, the power supply will provide up to 10 ma of current, and provide progressively higher current as the output voltage is lowered. Current rating is 130 ma at 200 volts output. In addition to furnishing B+ the power supply also provides 6.3 volts AC at up to 4 amperes for filaments. Both the B+ output and the filament output are isolated from ground. Ideal unit for use in laboratory, home workshop, ham shack, or service shop. A large 4½" meter on the front panel reads output voltage or output current, selectable with a panel switch. Shpg. Wt. 17 lbs.

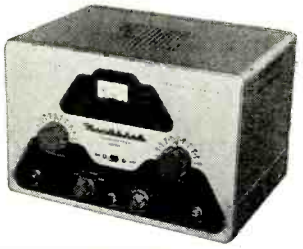
MODEL PS-3

$35.50

Terrific values in amateur equipment!

DX-100 TRANSMITTER

DX-20 TRANSMITTER



DX-35 TRANSMITTER

HEATHKIT DX-20 CW TRANSMITTER KIT

The Heathkit model DX-20 "straight-CW" transmitter features high efficiency at low cost. It uses a single 6DQ6A tube in the final amplifier stage for plate power input of 50 watts. A 6CL6 serves as crystal oscillator, with a 5U4GB rectifier. It is an ideal transmitter for the novice, as well as the advanced-class CW operator. Single-knob band switching is featured to cover 80, 40, 20, 15, 11 and 10 meters. Pi network output circuit matches various antenna impedances between 50 and 1000 ohms and reduces harmonic output. Top-quality parts are featured throughout, including "potted" transformers, etc., for long life. It has been given full "TVI" treatment. Access into the cabinet for crystal changing is provided by a removable metal pull-out plug on the left end of the cabinet. Very easy to build from the complete step-by-step instructions supplied, even if you have never built electronic equipment before. If you appreciate a good, clean signal on the CW bands, this is the transmitter for you! Shpg. Wt. 18 lbs.

MODEL DX-20

$35.95

Heathkits...

By DAYSTROM

are designed by licensed ham-engineers, especially for you

HEATHKIT DX-35 PHONE AND CW TRANSMITTER KIT

The DX-35 transmitter can be thought of as the "little brother" of the DX-100. It features both phone and CW operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 65 watt plate power input on CW, or controlled carrier modulation peaks up to 50 watts for phone operation. Modulator and power supplies are built right in and single knob band switching is combined with a pi network output circuit for complete operating convenience. The tight fitting cabinet presents a most attractive appearance, and is designed for complete shielding to minimize TVI. Back panel control provides convenient switch selection of three different crystals, reached through access door at rear of cabinet. A most remarkable power package for the price. Complete step-by-step instructions with pictorial diagrams to assure your success in assembly. Shpg. Wt. 24 lbs.

MODEL DX-35

$56.95

HEATHKIT DX-100 PHONE AND CW TRANSMITTER KIT

Listen to any ham band between 160 meters and 10 meters and note how many DX-100 transmitters you hear! The number of these fine rigs now on the air testifies to the enthusiasm with which it has been accepted by the amateur fraternity. No other transmitter in this power class combines high quality and real economy so effectively. The DX-100 features a built in VFO, modulator and power supplies, complete shielding to minimize TVI, and pi network output coupling to match impedances from approximately 50 to 600 ohms. Its RF output is in excess of 100 watts on phone and 120 watts on CW, for a clean strong signal on all the ham bands from 10 to 160 meters. Single-knob band switching and illuminated VFO dial and meter face add real operating convenience. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. High quality components are used throughout, such as "potted" transformers, silver-plated or solid coin silver switch terminals, aluminum heat-dissipating caps on the final tubes, copper plated chassis, etc. This transmitter was designed exclusively for easy step-by-step assembly. Shpg. Wt. 107 lbs.

MODEL DX-100

$189.50

FUNCTIONAL DESIGN . . .

The transmitters described on this page were designed for the ham, by hams who know what features are desirable and needed. This assures you of the best possible performance and convenience, and adds much to your enjoyment in the ham shack.

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

Automatically turns off transmitter and gives visual signal

"AUTOMATIC" CONELRAD ALARM

GRID DIP METER

"Q" MULTIPLIER

COMMUNICATIONS-TYPE RECEIVER

An ideal receiver for the beginning ham or short wave listener

HEATHKIT "AUTOMATIC" CONELRAD ALARM KIT

This conelrad alarm works with any radio receiver; AC-DC-transformer operated—or battery powered, so long as the receiver has AVC. Fully complies with FCC regulations for amateurs. When the monitored station goes off the air, the CA-1 automatically cuts the AC power to your transmitter, and lights a red indicator. A manual "reset" button reactivates the transmitter. Incorporates a heavy-duty six-ampere relay, a thyratron tube to activate the relay, and its own built-in power supply. A neon lamp shows that the alarm is working, by indicating the presence of B+ in the alarm circuit. Simple to install and connect. Your transmitter plugs into an AC receptacle on the CA-1, and a cable connects to the AVC circuit of a nearby receiver. A built-in sensitivity control allows adjustment to various AVC levels. Receiver volume control can be turned up or down, without affecting alarm operation. Build a Heathkit CA-1 in one evening and comply with FCC regulations now! Shpg. Wt. 4 lbs.

MODEL CA-1
$13.95

HEATHKIT "Q" MULTIPLIER KIT

The Heathkit Q Multiplier functions with any AM receiver having an IF frequency between 450 and 460 KC, that is not "AC-DC" type. It derives its power from the receiver, and needs only 6.3 volts AC at 300 ma (or 12 VAC at 150 ma) and 150 to 250 volts DC at 2 ma. Simple to connect with cable and plugs supplied. Adds additional selectivity for separating signals, or will reject one signal and eliminate heterodyne. A tremendous help on crowded phone and CW bands. Effective Q of 4000 for sharp "peak" or "null". Tunes any signal within IF band pass without changing the main receiver tuning dial. A convenient tuning knob on the front panel with vernier reduction between the tuning knob and the tuning capacitor gives added flexibility in operation. Uses a 12AX7 tube, and special high-Q shielded coils. Instructions for connecting to the receiver and operation are provided in the construction manual. A worthwhile addition to any communications, or broadcast receiver. It may also be used with a receiver which already has a crystal filter to obtain two simultaneous functions, such as peaking the desired signal with the crystal filter and nulling an adjacent signal with the Q Multiplier. Shpg. Wt. 3 lbs.

MODEL QF-1
$9.95

HEATHKIT GRID DIP METER KIT

A grid dip meter is basically an RF oscillator for determining the frequency of other oscillators, or of tuned circuits. Extremely useful in locating parasitics, neutralizing, identifying harmonics, coil winding, etc. Features continuous frequency coverage from 2 mc to 250 mc, with a complete set of prewound coils, and a 500 ua panel meter. Front panel has a sensitivity control for the meter, and a phone jack for listening to the "zero-beat." Will also double as an absorption-type wave meter. Shpg. Wt. 4 lbs.

MODEL GD-1B
$19.95

Low Frequency Coil Kit: Two extra plug-in coils to extend frequency coverage down to 350 kc. Shpg. Wt. 1 lb. No. 341-A. $3.00

HEATHKIT ALL-BAND COMMUNICATIONS-TYPE RECEIVER KIT

This communications-receiver covers 550 kc to 30 mc in four bands, and provides good sensitivity, selectivity, and fine image rejection. Ham bands are clearly marked on an illuminated dial scale. Features a transformer-type power supply—electrical band spread—antenna trimmer—headphone jack—automatic gain control and beat frequency oscillator. Accessory sockets are provided on the rear of the chassis for using the Heathkit model QF-1, Q Multiplier. Accessory socket is handy, also, for operating other devices that require plate and filament potentials. Will supply +250 VDC at 15 ma and 12.6 VAC at 300 ma. Ideal for the beginning ham or short wave listener. Shpg. Wt. 12 lbs.

MODEL AR-3
$29.95
(Less cabinet)

Cabinet: Fabric covered cabinet with aluminum panel as shown. Part no. 91-15A. Shpg. Wt. 5 lbs. $4.95.

Heathkits...

By DAYSTROM

are outstanding in performance and dollar value

HEATHKIT REFLECTED POWER METER KIT

The Heathkit reflected power meter, model AM-2, makes an excellent instrument for checking the match of the antenna transmission system, by measuring the forward and reflected power or standing wave ratio. The AM-2 is designed to handle a peak power of well over 1 kilowatt of energy and may be left in the antenna system feed line at all times. Band coverage is 160 meters through 2 meters. Input and output impedances for 50 or 75 ohm lines. No external power required for operation. Meter indicates percentage forward and reflected power, and standing wave ratio from 1:1 to 6:1. Another application for the AM-2 is matching impedances between exciters or R.F. sources and grounded grid amplifiers. Power losses between transmitter output and antenna tuner may be very easily computed by inserting the AM-2 in the line connecting the two. No insertion loss is introduced into the feeder system, due to the fact that the AM-2 is a portion of coaxial line in series with the feeder system and no internal connections are actually made to the line. Complete circuit description and operation instructions are provided in the manual. Cabinet size is 7-3/8" x 4-1/16" x 4-5/8". Can be conveniently located at operating position. Shpg. Wt. 3 lbs.

MODEL AM-2

$15.95

HEATHKIT VARIABLE FREQUENCY OSCILLATOR KIT

Enjoy the convenience and flexibility of VFO operation by obtaining the Heathkit model VF-1 Variable Frequency Oscillator. Covers 160-80-40-20-15-11 and 10 meters with three basic oscillator frequencies. Better than 10 volt average RF output on fundamentals. Plenty of output to drive most modern transmitters. It features voltage regulation for frequency stability. Dial is illuminated for easy reading. Vernier reduction is used between the main tuning knob and the tuning condenser. Requires a power source of only 250 volts DC at 15 to 20 miliamperes and 6.3 volts AC at 0.45 amperes. Extra features include copper-plated chassis, ceramic coil forms, extensive shielding, etc. High quality parts throughout. VFO operation allows you to move out from under interference and select a portion of the band you want to use without having to be tied down to only two or three frequencies through use of crystals. "Zero in" on the other fellow's signal and return his CQ on his own frequency! Crystals are not cheap, and it takes quite a number of them to give anything even approaching comprehensive coverage of all bands. Why hesitate? The model VF-1 with its low price and high quality will add more operating enjoyment to your ham activities. Shpg. Wt. 7 lbs.

MODEL VF-1

$19.50

Heathkits...

By DAYSTROM

are the answer for your electronics hobby.

HEATHKIT BALUN COIL KIT

The Heathkit Balun Coil Kit model B-1 is a convenient transmitter accessory, which has the capability of matching unbalanced coax lines, used on most modern transmitters, to balance lines of either 75 or 300 ohms impedance. Design of the bifilar wound balun coils will enable transmitters with unbalanced output to operate into balanced transmission line, such as used with dipoles, folded dipoles, or any balanced antenna system. The balun coil set can be used with transmitters and receivers without adjustment over the frequency range of 80 through 10 meters, and will easily handle power inputs up to 250 watts. Cabinet size is 9" square by 5" deep and it may be located any distance from the transmitter or from the antenna. Completely enclosed for outdoor installation. Shpg. Wt. 4 lbs.

MODEL B-1

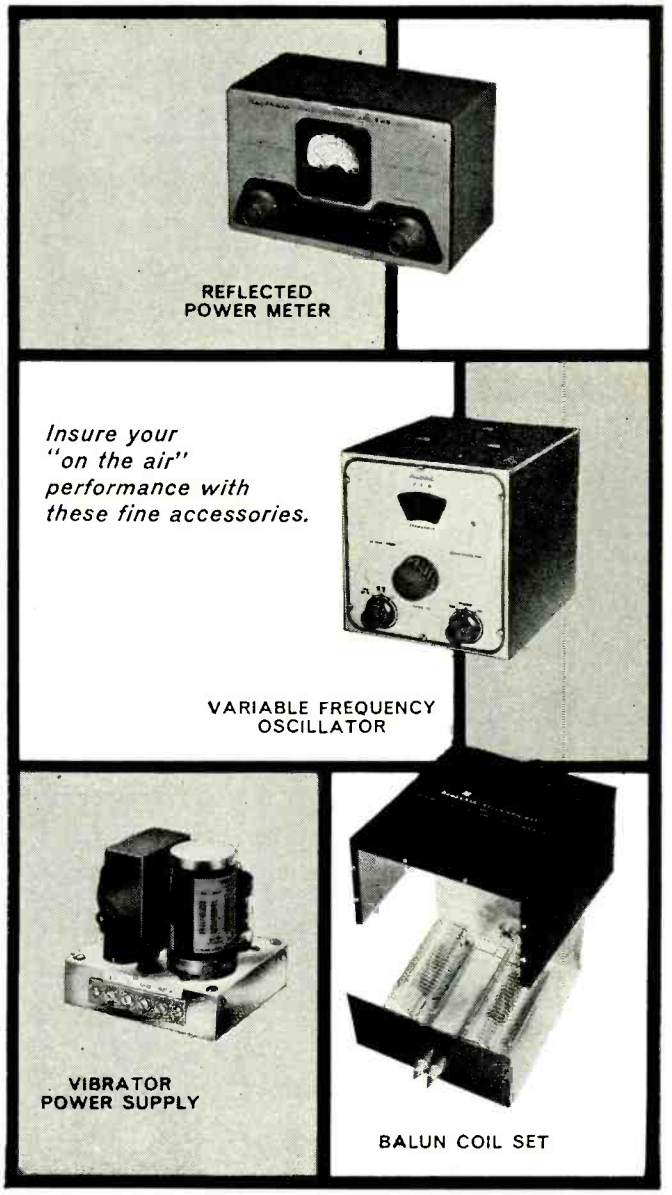
$8.95

HEATHKIT 6 OR 12 VOLT VIBRATOR POWER SUPPLY KITS

These little power supply kits are ideal for all portable applications with 6 volt or 12 volt batteries, when you are operating electronic equipment away from power lines. By replacing the power supplies of receivers, small public address systems, or even miniature transmitters with these units, they can be used with conventional 6 or 12 volt batteries. Use in boats, automobiles, light aircraft, or any field application. Each unit provides 260 volts DC output at up to 60 miliamperes. More than one power supply of the same model may be connected in parallel for increased current capacity at the same output voltage. Everything is provided in the kit, including a vibrator transformer, a vibrator, 6X4 or 12X4 rectifier, and the necessary buffer capacitor, hash filter, and output filter capacitor. Shpg. Wt. 4 lbs.

6 VOLT
MODEL VP-1-6
12 VOLT
MODEL VP-1-12

$7.95 Each



HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

HEATHKIT ELECTRONIC IGNITION ANALYZER KIT

Previous electronic experience is not necessary to build this fine ignition analyzer. The construction manual supplied has complete step-by-step instructions plus large pictorial diagrams showing the exact placement and value of each component. All parts are clearly marked so that they are easily identified. The IA-1 is an ideal tool for engine mechanics, tune-up men, and auto hobbyists, since it traces the dynamic action of voltage in an ignition system on a cathode-ray tube screen. The wave form produced is affected by the condition of the coil, condenser, points, plugs, and ignition wiring, so it can be analyzed, and used as a "sign-post" to ignition system performance. This analyzer will detect inequality of spark intensity, a poor spark plug, defective plug wiring, breaker-point bounce, an open condenser, and allow setting of dwell-time percentage for the points. An important feature of this instrument is its ability to check dynamic performance, with the engine in operation (400 to 5000 RPM). It will show the complete engine cycle, or only one complete cylinder. Can be used on all types of internal combustion engines where breaker-points are accessible. Use it on automobiles, boats, aircraft engines, etc. Shpg. Wt. 18 lbs.

MODEL IA-1
$59.95

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

This Heathkit professional-type radiation counter is simple to build successfully, even if you have never built a kit before. Complete step-by-step instructions are combined with giant-size pictorial diagrams for easy assembly. By "building it yourself" you can have a modern-design, professional radiation counter priced far below comparable units. Provides high sensitivity with ranges from 0-100, 600, 6000 and 60,000 counts-per-minute, and 0-.02, .1, 1 and 10 miliroentgens-per-hour. Employs 900-volt bismuth tube in beta/gamma sensitive probe. Probe and 8-foot expandable cable included in kit price, as is a radiation sample for calibration. Use it in medical laboratories, or as a prospecting tool, and for civil defense to detect radioactive fallout, or other unknown radiation levels. Features a selectable time constant. Meter calibrated in CPM or mR/hour in addition to "beep" or "click" from panel-mounted speaker. Prebuilt "packaged" high voltage power supply with reserve capacity above 900 volt level at which it is regulated. Merely changing regulator tube type would allow use of scintillation probe if desired. Employs five tubes (plus a transistor) to insure stable and reliable operation. Kit price includes batteries. Shpg. Wt. 8 lbs.

MODEL RC-1
$79.95

Heathkits...

By DAYSTROM

are supplied with comprehensive instructions that eliminate costly mistakes and save valuable time

HEATHKIT ENLARGER TIMER KIT

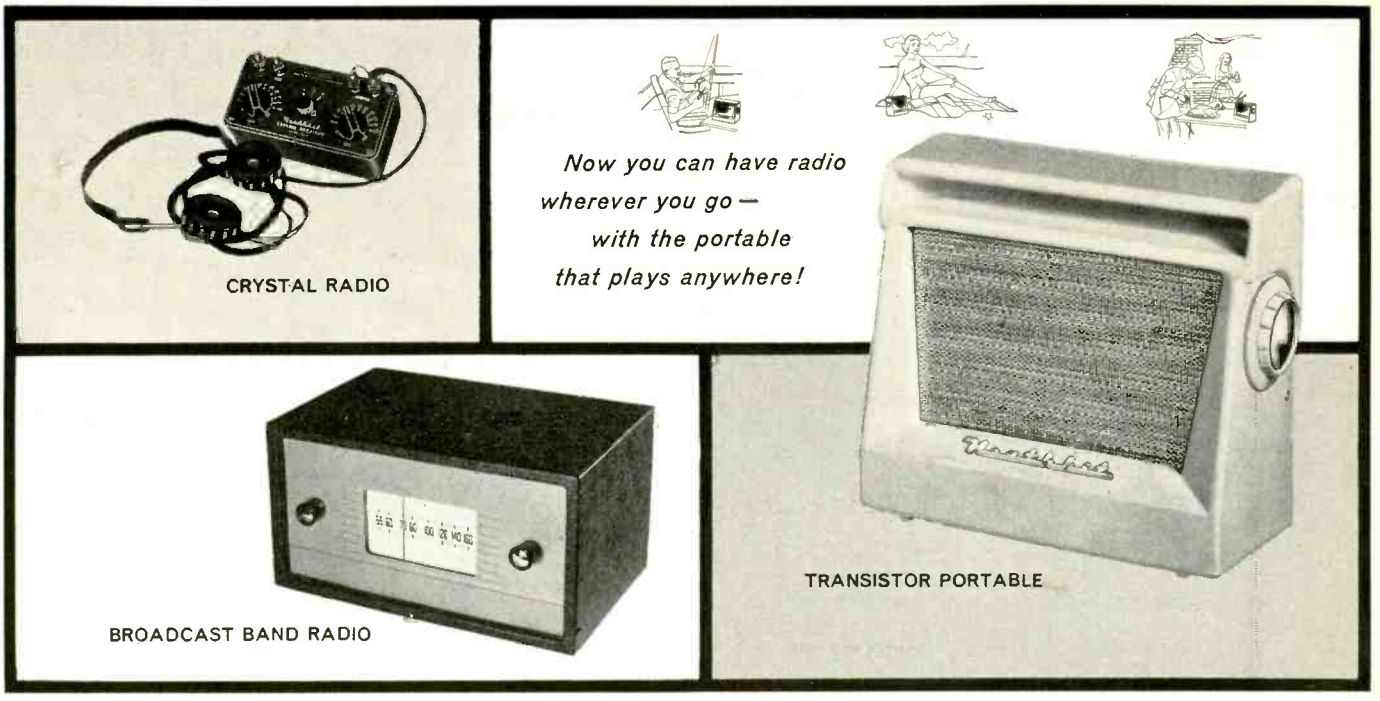
The ET-1 is an easy-to-build electronic device to be used by amateur or professional photographers in timing enlarger operations. The calibrated dial on the timer covers 0 to 1 minute, calibrated in 5-second gradations. The continuously variable control allows setting of the "on" cycle of your enlarger, which is plugged into a receptacle on the front panel of the ET-1. A "safe light" can also be plugged in so that it is automatically turned "on" when the enlarger is turned "off." Handles up to 350 watts with built-in relay. All-electronic timing cycle insures maximum accuracy. Timer does not have to be reset after each cycle, merely flip lever switch to print, to repeat time cycle. A control is provided for initial calibration. Housed in a compact plastic case that will resist attack of photographic chemicals. A fine addition to any dark room. Shpg. Wt. 3 lbs.

MODEL ET-1
$11.50

HEATHKIT BATTERY TESTER KIT

The BT-1 is a special battery testing device that actually "loads" the battery under test (draws current from it) while it is being tested. Weak batteries often test "good" with an ordinary voltmeter but the built-in load resistance of the BT-1 automatically draws enough current from the battery to reveal its true condition. Simple to operate with "good-weak-replace" scale. Tests all kinds of dry cell batteries within ranges of 0-15 volts and 0-180 volts. Slide switch provides for either 10 ma or 100 ma load, depending on whether you're testing an A or B battery. Not only determines when battery is completely exhausted, but makes it possible to anticipate failure by noting weak condition. Ideal for testing dry cell hearing aid, flashlight, portable radio, and model airplane batteries. Test batteries in a way your customers can understand and stimulate battery sales. Shpg. Wt. 2 lbs.

MODEL BT-1
$8.50



HEATHKIT CRYSTAL RADIO KIT

The Heathkit model CR-1 crystal radio is similar to the "crystal sets" of the early radio days except that it has been improved by the use of sealed germanium diodes and efficient "high-Q" coils. The sealed diodes eliminate the critical "cats whisker" adjustment, and the ferrite coils are much more efficient for greater signal strength. Housed in a compact plastic box, the CR-1 uses two tuned circuits, each with a variable tuning capacitor, to select the local station. It covers the broadcast band from 540 to 1600 kc. Requires no external power whatsoever. This receiver could prove valuable to emergency reception of civil defense signals should there be a power failure. The low kit price even includes headphones. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. The instruction manual also provides the builder with the basic fundamentals of signal reception so that he understands how the crystal receiver functions. An interesting and valuable "do-it-yourself" project for all ages. Shpg. Wt. 3 lbs.

MODEL CR-1
$7.95

Heathkits...
By DAYSTROM

are easy and fun to build, and they let you learn by "doing-it-yourself"

HEATHKIT TRANSISTOR PORTABLE RADIO KIT

Heath engineers set out to develop a "universal" AM radio, suitable for use anywhere. Their objective was a portable that would be as much "at home" inside as it is outside, and would feature top quality components for high performance and long service life. The model XR-1 is the result of these efforts. Six name-brand (Texas Instrument) transistors were selected for extra good sensitivity and selectivity. A 4" by 6" PM speaker with heavy magnet was chosen to insure fine tone quality. The power supply was designed to use six standard size "D" flashlight cells because they are readily available, inexpensive, and because they afford extremely long battery life (between 500 and 1000 hours). Costs you no more to operate from batteries than what you pay for operating a small table-model radio from the power line. An unbreakable molded plastic was selected for cabinet material because of its durability and striking beauty. Circuit is compact and efficient, yet components are not excessively crowded. Transformers are prealigned so it is ready for service as soon as construction is completed. Has built in rod-type antenna for reception in all locations. Cabinet dimensions are 9" L x 8" H x 3¾" D. Comes in holiday gray, with gold-anodized metal speaker grille. Compare this portable, feature by feature, to all others on the market, and you'll appreciate what a tremendous dollar value it represents! Shpg. Wt. 4 lbs.

MODEL XR-1
$34.95
(Less batteries)
(With cabinet)

HEATHKIT BROADCAST BAND RADIO KIT

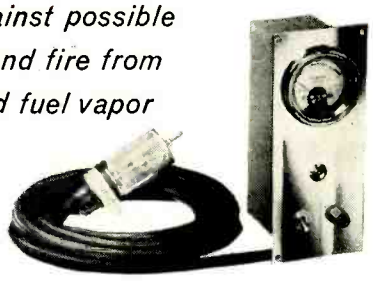
This table-model broadcast radio is fun to build, and is a fine little receiver for your home. It covers the standard broadcast band from 550 to 1600 kc with good sensitivity and selectivity. The 5½" PM speaker provides surprisingly good tone quality. High-gain IF transformers, miniature tubes, and a rod-type built in antenna, assure good reception in all locations. The power supply is transformer operated, as opposed to many of the economy "AC-DC" types. It's easy to build from the step-by-step instructions, and the construction manual includes information on operational theory, for educational purposes. Your success is assured by completely detailed information which also explains resistor and capacitor color codes, soldering techniques, use of tools, etc. A signal generator is recommended for final alignment. Shpg. Wt. 10 lbs.

Cabinet: Fabric covered cabinet with aluminum panel as shown. Shpg. Wt. 5 lbs. Part no. 91-9A. $4.95.

MODEL BR-2
$18.95
(Less cabinet)

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

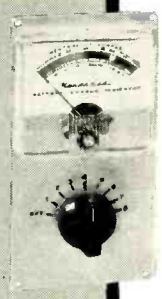
protects against possible explosion and fire from undetected fuel vapor



FUEL VAPOR DETECTOR

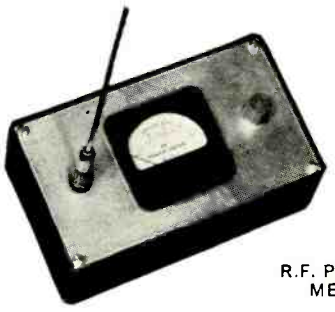
detects electrolysis currents which cause deterioration of underwater metal fittings on your boat

ELECTROLYSIS DETECTOR



indicates condition and charge of batteries for safe cruising

BATTERY CHARGE INDICATOR



R.F. POWER METER

HEATHKIT FUEL VAPOR DETECTOR KIT

Protect your boat and its passengers against fire or explosion from undetected fuel vapor by building and using one of these fine units. The Heathkit Fuel Vapor Detector indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shows if it is safe to start the engine. A pilot light on the front panel shows when the detector is operating, and it can be left on continuously, or just used intermittently. A panel control enables initial calibration of the detector when installed. Features a hermetically-sealed meter with chrome bezel, and a chrome-plated brass panel. It is very simple to build and install, even by one not having previous experience. Models FD-1-6 (6 volts DC) and FD-1-12 (12 volts DC) operate from your boat batteries. The kit is complete in every detail, even to the inclusion of a spare detector unit. Shpg. Wt. 4 lbs.

6 volt MODEL FD-1-6
12 volt MODEL FD-1-12
$35.95 EACH

HEATHKIT BATTERY CHARGE INDICATOR KIT

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MODEL CI-1
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HEATHKIT ELECTROLYSIS DETECTOR KIT

The Heathkit model ED-1 Electrolysis Detector indicates the extent of electrolysis currents between the boat's common ground and underwater fittings, except on boats having metal hulls. These currents, undetected, could cause gradual corrosion and deterioration of the propeller or other metal fittings below the water line. It is particularly helpful when installing electrical equipment of any kind, or to determine proper polarity when power is obtained from a shore supply. Easy-to-build, the model ED-1 consists of a hermetically-sealed, waterproof meter, special sensing plate, and sufficient wire to install, including the necessary hardware. Mounts on instrument panel where it can be easily seen. Requires no power for operation, and gives instant warning to guard your boat for a lifetime. Shpg. Wt. 2 lbs.

MODEL ED-1
$9.95

HEATHKIT RF POWER METER KIT

The Heathkit RF Power Meter Kit is designed to sample the RF field in the vicinity of your transmitter, whether it be marine, mobile, or fixed. Output meter is merely placed in some location close to the transmitter, to pick up RF radiation from the antenna. Requires no batteries, electricity, nor direct connection to the transmitter. It provides you with a continuing indication of transmitter operation. You can easily detect if power is dropping off by comparing present meter readings with past ones. Operates with any transmitter having output frequencies between 100 kc and 250 mc, regardless of power. Sensitivity is 0.3 volts RMS full scale, and a special control on the panel allows for further adjustment of the sensitivity. Meter is a 200 ua unit, mounted on a chrome-plated brass panel. The entire PM-1 measures only 3¾" W x 6¼" L x 2" D. An easy way to put your mind at ease concerning transmitter operation. Shpg. Wt. 2 lbs.

MODEL PM-1
$14.95

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MODEL DF-1

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(Available after November 15)

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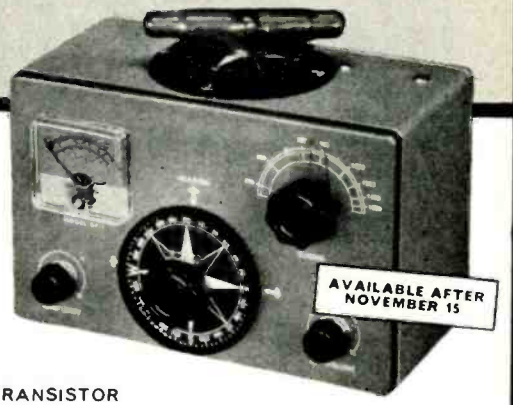

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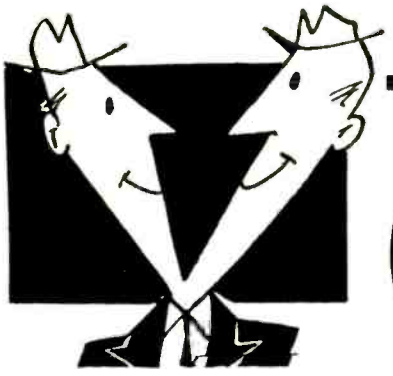


TWO CHANNELS?...EASY!

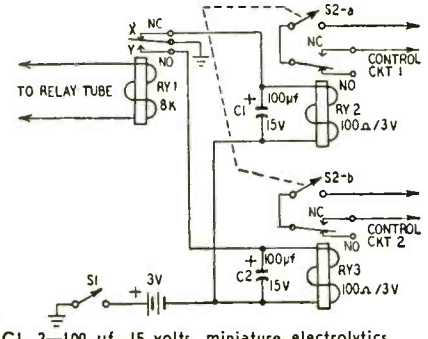
Modify your one-channel remote-control system for two-channel operation

By E. L. SAFFORD, Jr.

ONCE in a great while an idea comes along which is so simple and practical, that it becomes an outstanding contribution to the field of radio control. Such an idea is the brainchild of Lt. Col. William Sydnor, which allows anyone who has a single-channel receiver to make a simple addition and get two control channels.

If a standard single-channel receiver relay is connected to two time-delay secondary relays (Price 100-ohm type shunted by a 100-μf 15-volt electrolytic capacitor) as illustrated in Fig. 1, two control channels are available when the proper code is transmitted. Note that if the receiver relay (Ry1) armature is caused to vibrate so that the time it is away from, say, contact X is less than the time it takes capacitor C1 to discharge through the windings of Ry2, that relay will be actuated and remain so as shown. The same reasoning applies to relay Ry3. This vibratory action of the armature then must be in the vicinity of 25 to 30 cycles. When this pulse rate is transmitted, control relays Ry2 and Ry3 are actuated and open the control circuits. Now, we must be able to close (de-energize) either relay as desired if the control circuit is to be operated at will.

If the pulse rate becomes a continuous carrier or tone, the receiver relay does not vibrate. It is energized and the armature makes contact with Y, staying there as long as the signal is transmitted. This causes Ry3 to remain energized, holding its control circuit open, but allows Ry2 to de-energize and close its circuit. The reverse is also true: if the signal is cut off, the receiver



C1, 2—100 μf, 15 volts, miniature electrolytics
Ry1—spdt, 8,000 ohms, plate circuit
Ry2, 3—spdt, 100 ohms, 3 volts (Price type 1001)
S1—spst, toggle
S2—dpst, toggle
Battery, 3 volts

Fig. 1—Circuit of decoder unit.

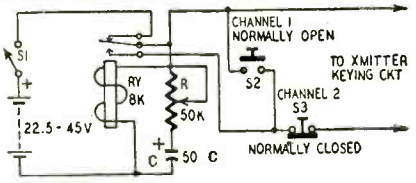
relay armature remains on contact X, holding Ry2's circuit open and allowing Ry3 to close its control circuit. The code then consists of a fast pulse rate for no control, full signal for channel 1 and no signal for channel 2.

The coder

The coder is as simple as the decoder. It consists of a relay connected to form a buzzer. If the relay is similar to the one used in the receiver, the receiver relay will be able to follow its vibrations. The variable resistor and the capacitor across the relay allow some control of the vibrating frequency (see Fig. 2).

To use the unit, close switch S1, causing the armature to vibrate. Adjust resistor R and the receiver plate relay so that the receiver's control relays operate properly. To send signals to channel 1 or channel 2, either S2 or S3 is depressed.

Because of the high vibration frequency and the low delay time, it is possible to send pulses fast enough (using the pushbutton switches) to operate the compound type escapements



R—pot, 50,000 ohms
C—50 μf, 50 volts, miniature electrolytic
Ry—spdt, 8,000 ohms, plate circuit
S1—spst, toggle
S2—spst, normally open, pushbutton
S3—spst, normally closed, pushbutton
Battery, 22.5 to 45 volts

Fig. 2—Encoder unit circuit for two-channel operation with a one-channel remote-control circuit.

in either channel. This allows up to six functions of control and fail-safe neutrals.

Several types of pulser units are available. They are constructed with circular magnets. These units, when fed a pulse-width–pulse-spacing code, allow proportional control of, say, a plane rudder. See Chapter 2, *Radio-Control Handbook* (Gernsback Library). It seems quite feasible to modify such a unit to replace the two decoder relays, as shown in Fig. 3. Centering springs are required so that the magnet armature will spring away from the contact when pulsing is stopped and not result in a bounce which might cause a standard escapement to skip. This method could be used to energize a steering motor for a boat or car.

A second idea which also seems feasible, if you are experiment-minded, would be to construct a unit to replace all three relays. Such a unit is shown in Fig. 4. If you build a solenoid with a winding equivalent to that of a 8,000–10,000-ohm relay and add a light compression spring within the hollow core so the magnetic plunger is pulled against it when the coil is energized, it is possible to cause the moving armature attached to the plunger to float between the two control contacts. A solenoid is suggested since the pull on the plunger is roughly proportional to the current flowing through the windings and the magnetic path is not broken by an air gap as in a relay type of unit.

With such a device, small and light, the receiver's relay stage could be modified so that the amount of current drawn through the tube would be proportional to a pulse-spacing–pulse-width variation. Pulses would be transmitted as before, but this time the width and spacing would be adjusted until the armature of the solenoid floated between the two contacts. Operation of the two channels would then be as previously described. The details are left to the builder's ingenuity, but remember, two channels are better than one. END

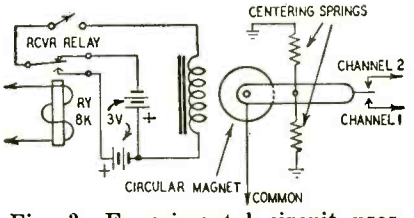


Fig. 3—Experimental circuit uses pulser.

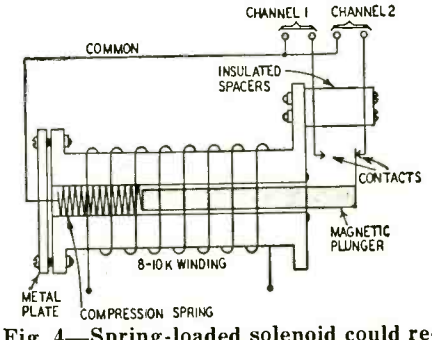
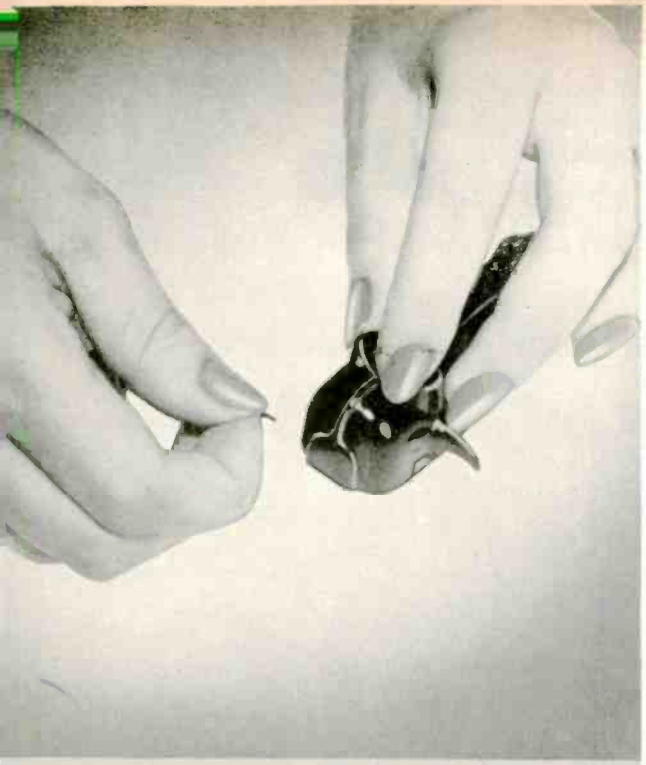


Fig. 4—Spring-loaded solenoid could replace all three relays in receiver circuit.



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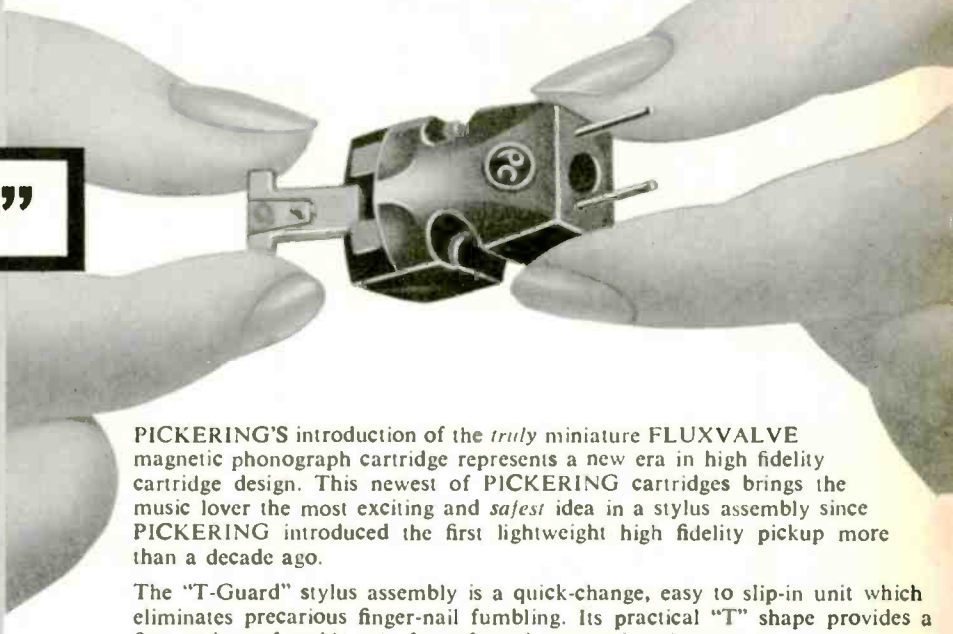

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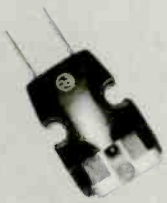

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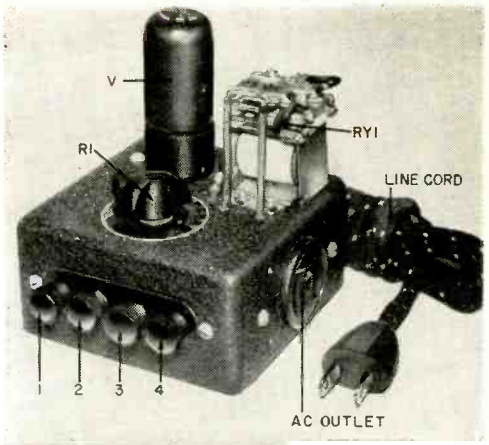
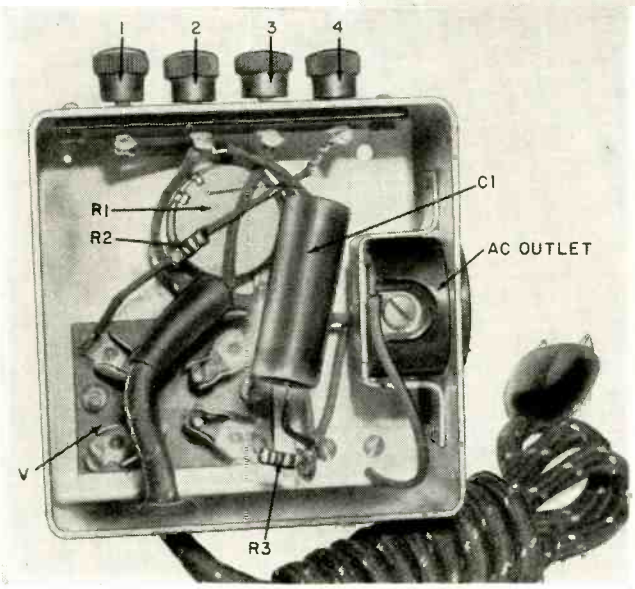




Top—The sensitive standby relay.

Left — Bottom view of relay chassis. Parts layout is not critical.

LIGHT, voice and radio are but a few examples of the signals that will operate this relay which stands by indefinitely, drawing practically no power.

A relay that operates on voltage changes and draws only a few μa from the control element is not new, but it usually requires tubes that deteriorate and whose filaments draw power while the circuit is inactive. This circuit uses one cold-cathode tube that lasts almost indefinitely if operated within its ratings and the only power consumed when standing idle is that drawn by a 100,000-ohm potentiometer across the ac line.

The heart of the circuit is a Chatham 313C gas-filled, cold-cathode trigger tube. It has a cathode, anode and a starter anode, and operates like a positive-grid thyratron.

The main gap (anode to cathode) will not conduct current until the anode is about 185 volts positive. Then the tube voltage drops instantly to 75, the main-gap sustaining voltage, and the current depends only on the resistance in series between the tube and power supply.

The starter gap (starter anode to cathode) behaves like the main gap but, being closer spaced, has a firing voltage of 70 and a sustaining voltage of 60. Again there must be enough series resistance in the circuit to limit the current to a safe value.

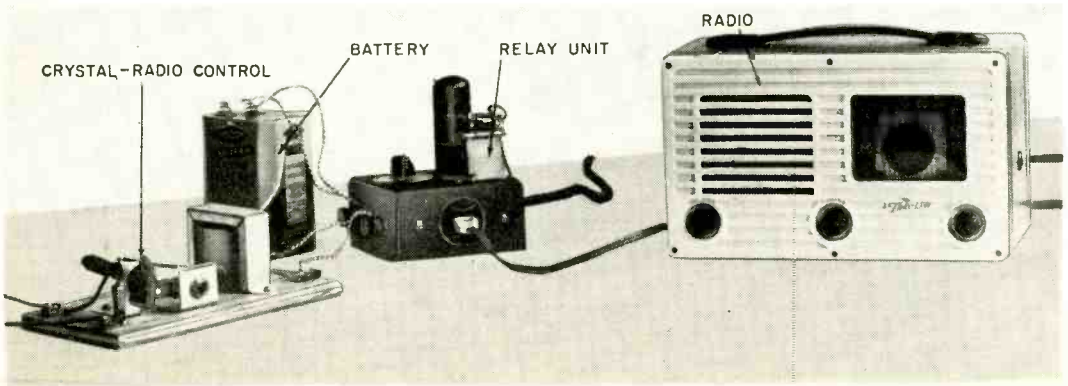
The tube is useful for control purposes due to the fact that a current of a few microamperes in the starter gap slightly ionizes the gas in the tube and greatly reduces the voltage necessary to fire the main gap. Fig. 1 shows how the main-gap firing voltage depends on the starter-gap current. As in a thyratron, once the main gap has fired the starter has no more control over it. The only way to stop conduction is to reduce the anode voltage below the sustaining value.

To use the tube as a relay, it is necessary to add the control voltage to a pedestal voltage high enough to give a total of 70 volts or more on the starter anode, while simultaneously applying voltage to the main gap. The load (relay) is in the main-gap series circuit. The problem is to get a high enough voltage from the control so that control signals will fire the tube but variations in the pedestal supply voltage will not.

The relay circuit

The relay circuit shown in the photos and in Fig 2-a needs no dc power supply. The 313C tube operates satisfactorily on ac because it conducts very little current in the reverse direction.

The circuit used on 117 volts ac can operate only at instants when the anodes are positive. The sensitivity control is set so that the peak voltage from the cathode is less than 70, say 65 volts. Terminals 3 and 4 connect to the control and, if it is putting out 5 volts with terminal 4 positive, the starter gap will fire. The starter-gap current will then fire the main gap which conducts current until the voltage falls below the sustaining value.



Left — Crystal set control connected to turn on a radio.

Right — Some controls that will operate the relay.

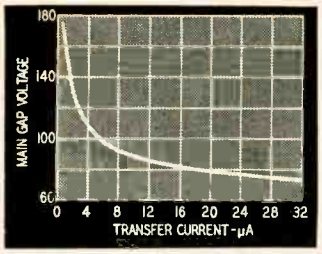


Fig. 1 — **Transfer characteristics of Chatham 313C cold-cathode tube.**

For long tube life, the average cathode current should not exceed 10 ma and the peak cathode current should not exceed 30 ma. In 117-volt ac operation the peak cathode current restriction makes a 3,300-ohm limiting resistor in series with the relay necessary. Any of the following relays or others in between will then work:

Coil resistance (ohms)	*Actuating Current (ma)*
1,000	2.0
2,500	1.5
5,000	1.0

If you want it to lock on a single signal, the relay must have double-pole contacts capable of handling the desired current so that one set can serve in the locking circuit. For locking action, a battery large enough to close the relay is connected to terminals 1 and 2 of Fig. 2-a, with 2 positive.

The most likely source of such a relay is a surplus dealer. If you cannot get this relay—or if you have others on hand—use a single-pole plate circuit relay and connect it to a double-pole low-voltage relay as shown in Fig. 2-b for the locking effect. Often a relay rated at higher current will work with careful adjustment.

Test the completed relay circuit as follows: Short control terminals (3 and 4) together, leaving terminals 1 and 2 open. Then plug the relay circuit into the ac line and turn up the sensitivity control. The plate circuit relay should close positively as soon as the sensitivity control is turned up enough (about half rotation) so that it closes at all. If it starts to close at one setting and closes positively at a higher setting of the sensitivity control, you need a more sensitive relay.

Since the terminals are "hot" and the circuit components may be damaged by accidentally shorting other than the control terminals, unplug the relay when making any connections to it.

Photocell relay

A phototube connected to the relay circuit as shown in Fig 3-a will close the relay on increasing light intensity. Almost any gas or vacuum phototube (868, 929, 930, etc.) will work. The load resistor can be anywhere from 1 to 20 megohms. Higher resistances usually give a more sensitive circuit.

As the light increases, the increased phototube current gives a greater voltage drop across the load resistance and raises the starter anode voltage. The intensity level that fires the tube depends on the sensitivity control setting.

If you want decreasing values of light to operate a relay, connect the phototube as shown in Fig. 3-b. Note that the cathode of the phototube connects to the bottom line lead of Fig. 2-a. Add a terminal connected to this line if you intend to use the relay this way.

Sound-powered relay

A carbon microphone connected through a 6-volt battery and a high-ratio transformer to the control terminals gives a sound-operated relay (Fig. 4). I used a Stancor A-4747 input transformer which has a 1 to 137 ratio.

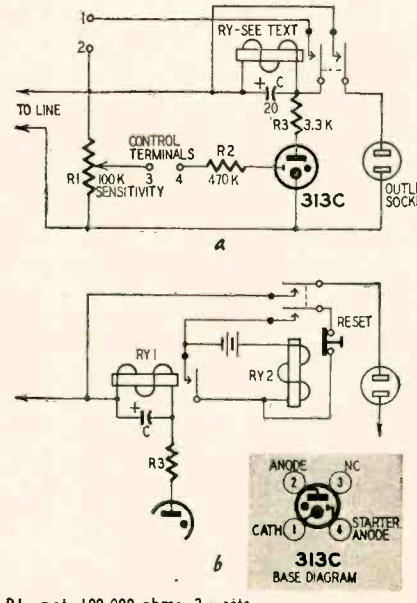
To operate, adjust the sensitivity control to a point slightly below firing voltage, and turn on the microphone. This unit could serve as a sound-powered burglar alarm or for controlling displays by voice commands.

Radio-powered relay

A crystal set such as shown in Fig. 5, coupled to the control terminals through a high-impedance stepup transformer, will turn on the relay whenever the radio station tuned starts broadcasting. The idea for this application came from the Sylvania booklet *Electronic Shortcuts for Hobbyists*. A good outdoor antenna and a good ground will be essential in most cases.

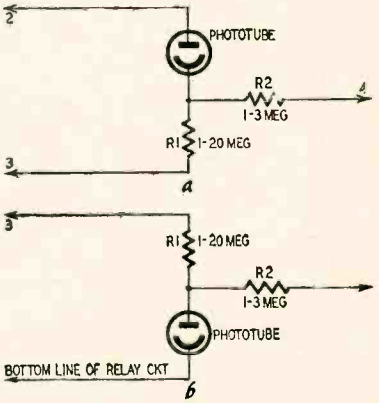
The relay operates on the audio signals rather than on the carrier and the difficulty lies in getting a suitable transformer to step up the audio voltage. Ideally it would have an input impedance of 3,000 ohms or more and a ratio of 1 to 10 or more. The closest standard transformer I have found that will work is the Stancor A-4726 (discontinued) which has an input of 2,500 ohms and a ratio of 1 to 6.3. (This is not the transformer shown in the photograph.) Others that may be tried are the Chicago IN-16 and Triad A-42Z universal interstage transformers with 1-to-6-turns ratios.

Using the Stancor A-4726, the circuit



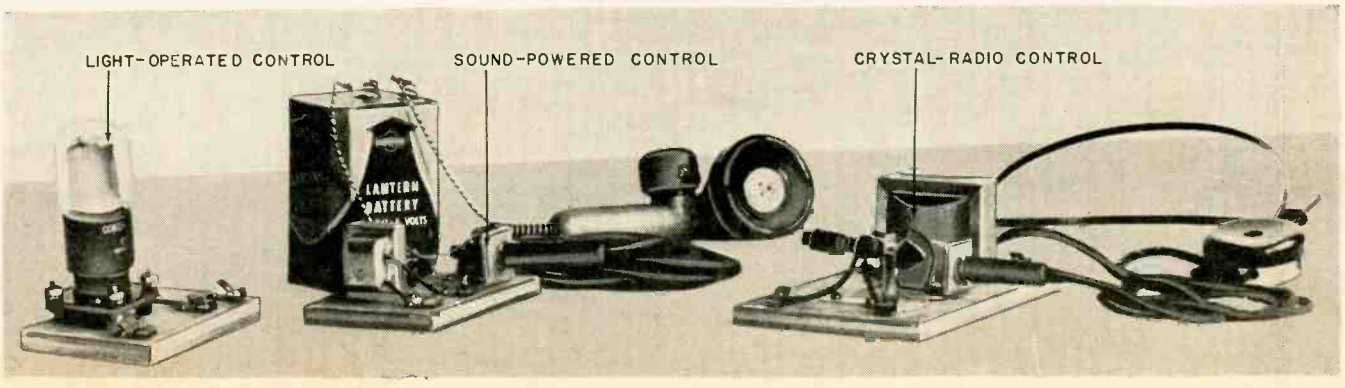
R1—pot, 100,000 ohms, 2 watts
R2—470,000 ohms, ½ watt
R3—3,300 ohms, 1 watt
C—20-μf 150-volt electrolytic
Ry1, 2—see text
V—313C, Chatham cold cathode (State Labs Inc., 649 Broadway, New York, N. Y.)
Tube socket—4 prongs
Chassis 4 x 4 x 2 inches
Terminal strip—4 lug
Outlet socket—117 volts
Line cord
Miscellaneous hardware

Fig. 2-a—Standby relay circuit; 2-b—modification allows locking effect.



R1—1-20 megohms, ½ watt
R2—3 megohms, ½ watt
V—phototube, 868, 929, 930
Socket for phototube

Fig. 3-a—Increase in light keys relay; 3-b—Relay triggered by decrease in light.



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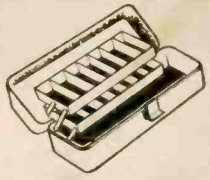

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WONDER-HELIX

model	type
AX811	Gold Anodized
WX811	Regular

POWER-HELIX

model	type
AX911	Gold Anodized
PX911	Regular

STAR-HELIX

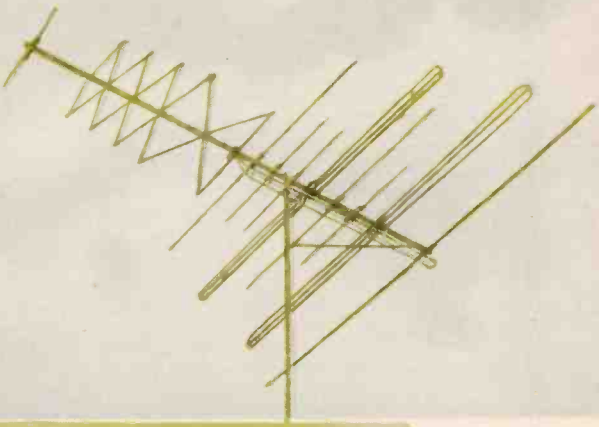
model	type
AX711	Gold Anodized
SX711	Regular

SUPER-HELIX

model	type
AX511	Gold Anodized
RX511	Regular

JUNIOR-HELIX

model	type
AX311	Gold Anodized
JX311	Regular



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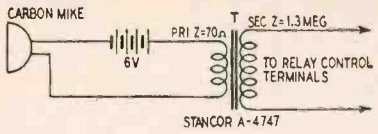
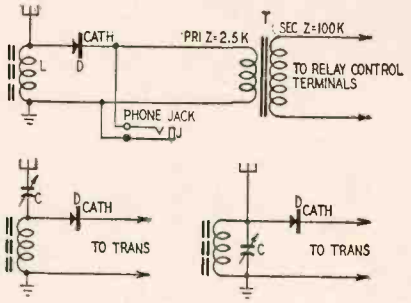


T—input transformer 370 ohms to 1.3 megohms (Stancor A-4747 or equivalent)
Carbon microphone
Battery—6 volts

Fig. 4 — Sound-powered control for stand-by relay.



C—365-μμf tuning capacitor
D—1N34 crystal diode
J—phone jack
L—ferrite-core antenna coil
T—input transformer (see text)

Fig. 5—Crystal-radio control circuits.

adjustment is critical. Tune the crystal set to a powerful station, using the headphones or, better yet, a high-resistance (20,000 ohms per volt) dc voltmeter, to get maximum output. If you use a voltmeter, disconnect the transformer while tuning as it shorts out the direct voltage. Series or parallel capacitance tuning (Fig. 5) may also help, depending on your antenna.

Finally adjust the sensitivity control so that the relay just closes on the loud audio signals and doesn't close at all when the station is detuned. After adjusting, unplug the headphones to get more output to the relay.

If left tuned to a particular station frequency, the relay circuit can turn on a receiver or sound an alarm when that station starts broadcasting.

Other applications

You can operate the relay circuit with many other controls—thermistors, capacitance circuits and wired wireless controls, for example. The only requirement is that they give voltage changes of at least 3 volts if dc or 4-volt peaks at not more than 5,000 cycles if ac. *Be sure that any control used is isolated from ground as the relay has an internal ground from the power line.*

The relay will work better on any low-output control if it is supplied from a dc source (top line Fig 2-a positive). Modify the main-gap limiting resistor (R3 in Fig. 2-a) so the current is no more than 10 ma after the tube voltage drops to 75. The tube will then drive a less sensitive relay. If you use batteries for the power supply, the circuit becomes more dependable for small-signal triggering since line-voltage fluctuations are eliminated. Also, when using dc, no locking circuit and relay capacitor are necessary. Once energized, the relay will stay closed until the main-gap voltage is reduced. END

MULTIPLEXING and YOU

Multiplex systems allow simultaneous transmission of two or three programs on one FM channel

By DON LEWIS *

Bogen model RM-2, a crystal-controlled multiplex receiver.

THE FCC authorized multiplexing by FM broadcast stations two years ago, and since then several stations have gone into this field. It provides a way for a single FM station to transmit additional programs privately at the same time as regular public broadcasts. Multiplex transmissions cause no interference with the public or main FM channel. If you turn the dial of your FM receiver to a station that is multiplexing, you will hear the usual program on the public channel, with no trace of the multiplex transmission. However, if you are a subscriber with a multiplex receiver, you then would hear the special program being transmitted by the station's subchannel.

How it works

At the FM station, an FM subcarrier having a center frequency such as 41 kc is impressed pick-a-back on the main-carrier wave. This is accomplished in a special exciter unit of the FM transmitter by a slight shift in the phase of the frequency-modulated main carrier at a specific point in the frequency-multiplier chain of the transmitter (see Fig. 1). The subcarrier is impressed on the main carrier at a level such that the main carrier is frequency-modulated 10 to 20% by the subcarrier. The subcarrier, in turn, is frequency-modulated by the audio program signals associated with the multiplex service. The frequency deviation of the subcarrier usually is plus or minus 6 to 12 kc, depending on the type of system, transmission requirements and other factors. The frequency deviation of the main channel is reduced so that modulation is approximately 70% on program peaks, or about 3 db below the maximum modulation percentage permitted by FCC rules and regulations.

At the receiver, the main carrier is amplified and detected in the normal manner by a special FM receiver. This functions basically in the manner of conventional receivers but is designed throughout to provide maximum phase linearity.

A receiver with suitable performance characteristics is important. Any appreciable nonlinearity will increase the amount of intermodulation and introduce crosstalk in the subchannel from the main-channel signals.

In multiplex receivers now in commercial service (see Fig. 2), one or two stages of rf amplification are employed to give maximum sensitivity and increase quieting action. By a conventional heterodyne method, using a crystal-controlled oscillator, the main FM carrier is beat downward to an intermediate frequency such as 10.7 mc. This if signal is usually passed through two or more if stages, each having good phase-linearity characteristics. The amplified rf carrier next goes through one or two limiter stages, also designed to minimize intermodulation due to nonlinearity. Then the FM signal is demodulated by a wideband discriminator with good linearity characteristics. From the main discriminator, the audio program signals, modulating the main carrier, may be passed through a standard de-emphasis network and audio amplifier to operate one speaker in a stereophonic system, for example. From the main discriminator, the multiplex subcarrier is fed through a bandpass filter which accepts subcarrier signals within a given subchannel frequency range and rejects signals of other frequencies. After the desired subcarrier has been filtered in this manner, it is amplified, limited and fed to an FM subcarrier demodulator whose function it is to convert the frequency variations in the subcarrier to audio program signals.

Following the demodulation process, audio-frequency signals from the subcarrier discriminator are applied to a low-pass filter which removes the residue of the subcarrier. Where hi-fi multiplex reception is required, the low-pass filter may be designed to cut off at a

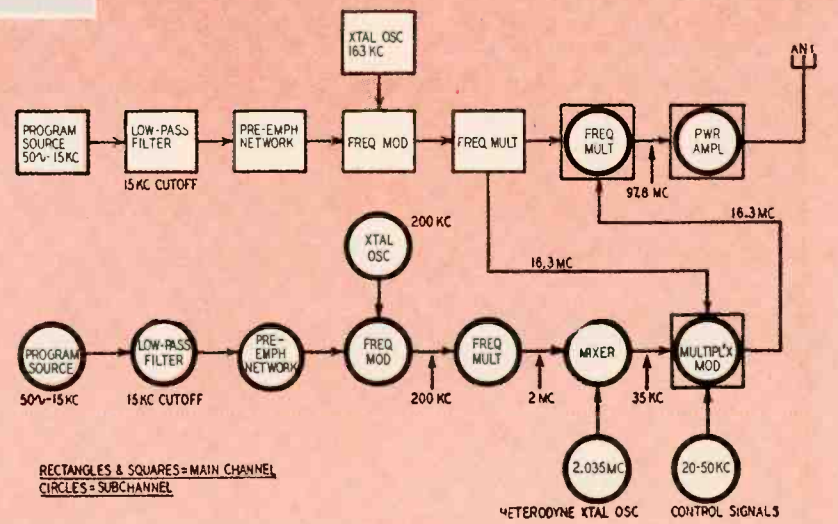


Fig. 1—Block diagram of a two-channel multiplex transmitter.

When your editor first discussed this article with the author, Mr. Lewis feared that perhaps the subject was a bit premature and actually hesitated for some months. However, within days after the article was completed, a new FM station came on the air and disclosed it would transmit stereophonic programs by multiplex. Your editor's crystal ball was right on frequency. The station is WGHF at Brookfield, Conn., near the New York border. It is operated by W. G. H. Finch and A. J. Detzer, two retired Navy captains. Captain Finch pioneered FM and facsimile in New York City many years ago and now will pioneer stereo by multiplex. On the main-channel frequency of 95.1 mc, 20,000-watt power, they are broadcasting excellent high-fidelity programs. Of their two subchannels, one provides station income by carrying background music. The other will be combined with the main channel for stereocasting. WGHF has not yet released information on how listeners will be able to adapt their FM receivers to pick up the stereo channel. Inquiries may be addressed to WGHF at Brookfield, Conn.

*Multiplex Services Corp., New York, N.Y.

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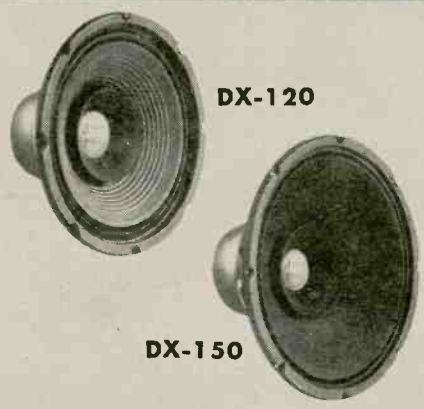

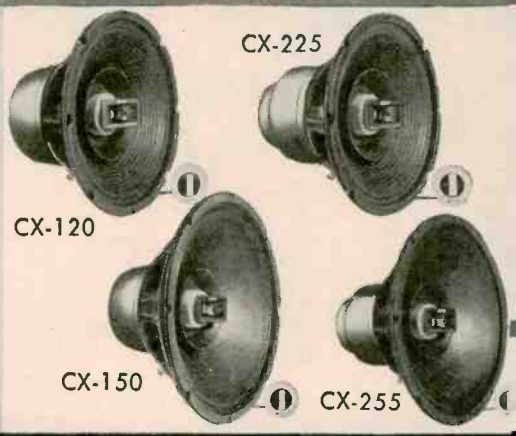

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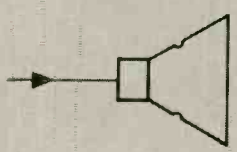


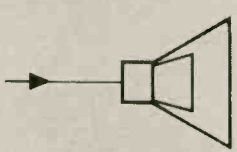
The new Jensen UX Series provides a new high in single-cone single voice coil loudspeakers at unusually low cost, actually outperforming comparable (and even more complex) units selling for much more. A listening test will convince you that this is a maximum value buy in hi-fi listening pleasure.

Of course, there are special design elements that enable us to give so much for so little. The cone is artfully dual acting, the center sector operating effectively for unusually extended highs, while the whole moves to reproduce the lows.

Withal, there is superb balance and cleanness. And, if you choose, you can step up performance later with the inexpensive KTX-2 Step-Up Kit which substitutes a compression driver tweeter for the top.

UX-80. 8-in. Speaker. Net **$14.50**
UX-120. 12-in. Speaker. Net **$19.50**

DUAX* 2-ELEMENT SYSTEMS

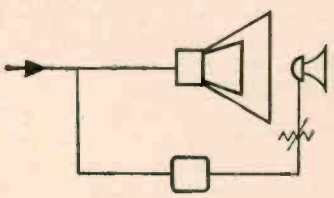


A step-up in the reproduction scale is the DX Series in which two carefully coordinated cones are driven by one voice coil. (Some call these "coaxials," but we reserve the name for still more elaborate systems and higher performance.)

The separate auxiliary radiator gives the designer a chance to attain a wider frequency range than with a single cone (albeit dual acting as in UX Series). The result is, with low cost, additional performance and added listening pleasure. We know of no similar speakers with equal sound, none with as high efficiency or as low distortion at anywhere near DX Series cost. Again you can step-up performance easily at anytime with KTX-2 Kit to substitute high-order compression driver tweeter operation at the high end.

DX-120. 12"; 1-lb. mag. Net **$25.50**
DX-150. 15"; 1-lb. mag. Net **$35.50**

COAXIAL 3-ELEMENT SYSTEMS



Still better than the "all paper" system with single voice coil is the use of a compression driver tweeter for the highs. The least expensive way to do this is to nestle a supertweeter coaxially inside the cone; it must cross over high in the frequency scale at 3500 to 4000 cycles. The third element is the diffusion radiator which shapes and disperses middle-high response. (Some call such speakers "Triaxial," though Jensen alone is entitled to use this registered name, applied by us to true 3-way speakers only.) Again, we guarantee more and better sound, cleaner hi-fi at lower cost, than all comparable speakers. And you can step up performance correctly and impressively with a real C.D. horn 600-4000 cps mid-channel (KTX-3 Kit) that leaves you with a *real* 3-way system.

12" Models. CX-120*.....**$49.50**
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*Denotes 1-lb. magnet; others 1¾ lbs.

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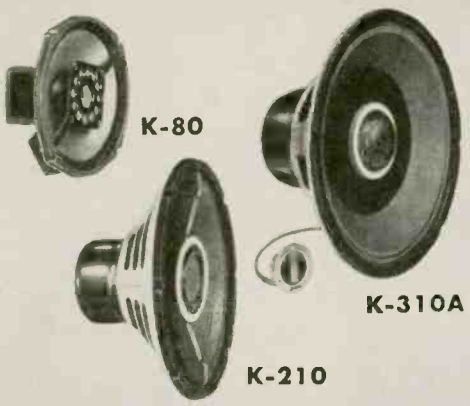

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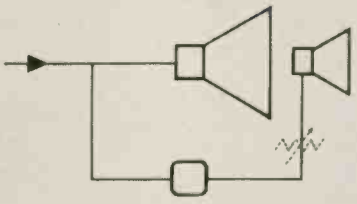
2-WAY SYSTEMS

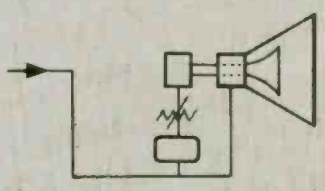


By using two completely independent (but carefully coordinated) speakers, each with its own magnetic system, voice coil and cone, the true two-way system spans the frequency range to obvious advantage in smoothness and extent, cleanness, low distortion and uniformity of angular dis-person.

Coaxial mounting makes them a convenient unitary package. Please note that we at Jensen use the term "coaxial" only in referring to a speaker with two completely independent systems.

Lowest in cost in the Jensen coaxial family is this fine group of speakers employing "cone" type direct radiator units for both tweeter and woofer. Available in 8, 12 and 15-inch models, they provide a maximum of value in true two-way system speakers.

K-80. Coaxial, 8-in. Net **$16.75**
K-210. Coaxial, 12-in. Net **$27.50**
K-310A. Coaxial, 15-in. Net **$39.75**

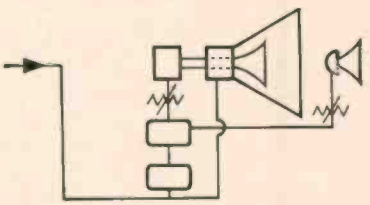


The highest type of performance in the coaxial two-way loudspeaker is attained by the use of a compression-driver horn-loaded tweeter for the high end. When properly designed, there results an outstanding clarity, realism and instrumental separation not achieved by lesser designs. By adopting the expensive "thru bore" construction, the tweeter horn can be made long enough to operate at the lowest practicable crossover frequency, a very desirable feature for the very best sound.

In this manner, the very popular Jensen H-222 and H-520 give you the "tops" in fine coaxial performance. Crossover is at 2000 cycles. Though many will see no need to, you can step-up performance to full three-way with KTX-1 Range-Extender Supertweeter Kit.

H-222. Coaxial, 12-in. Net. **$62.50**
H-520. Coaxial, 15-in. Net. **$79.50**

TRIAXIAL* & TRIAX*
3-WAY SYSTEMS



The true three-way speaker system divides the range in three parts with three electrically and acoustically distinct and independent elements, each designed to perform near-ideally in its portion of the range.

The famous G-610A TRIAXIAL was the first (and until our new G-600), *the only speaker made in accordance with this concept!* It employs a heavy woofer and two compression driver horn-loaded elements for m-f, and h-f channels. (The woofer cone acts as the final section of the m-f horn.) Its performance is so outstanding that it easily rates as the world's most wanted hi-fi speaker.

Now, for those who would like a G-610A, but are dissuaded by the price tag, Jensen announces the new lighter, less expensive G-600 TRIAX with similarly outstanding features and performance.

G-610A. Triaxial, 15". Net **$252.75**
G-600. Triax, 15". Net **$129.50**

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point slightly above 15,000 cycles. From the low-pass filter, the audio signals on the multplex channel are amplified and appear at the loudspeaker.

Multiplex uses

Up to now, virtually all FM multiplexing by broadcast stations has been for supplying background music in restaurants, hotels, factories, offices and other commercial establishments. Reception by nonauthorized persons is not intended and, in fact, any commercial unauthorized reception is considered to be a violation of the basic protective provisions of Section 605 of the Communications Act, which assures privacy for users of radio or wire services.

Background music presently is the most profitable and obvious use for multiplex although this transmission method is not limited to that service alone. Like any other new medium, its potentials and applications will increase as the art matures and expands. This is where stereophonic broadcasting comes in.

Until now, stereophonic music has been broadcast by transmitting the stereo programs through two stations, usually the AM and FM outlets of the same broadcasting company. Two receivers are required, one AM and one FM. With multiplexing a single FM station can be used for both stereo channels by transmitting one stereo signal on the public channel and the other on a multiplex channel. The listener needs only one FM receiver with a multiplex adapter.

The quality of stereophonic programs by multiplex was demonstrated for the first time in 1950 by William S. Halstead of Multiplex Development Corp. and later by Major Armstrong, shortly before his death. Special programs by an instrumental trio were transmitted from the studio of FM broadcast station KE2XKH in downtown Manhattan, New York City. Reception tests were at the Reeves Sound Studios, in mid-Manhattan, for representatives of the broadcast industry, FCC, other Government agencies and the press. In these first transmissions, the presence effect of the artists was remarkable, with listeners being able to sense the relative location of the different instruments of the trio and the movement of a singer as she moved between microphones. Since these early tests, additional stereo transmissions have been conducted with two 15,000-cycle channels. These numerous tests showed that stereophonic transmission by multiplex is not only practical but offers a superior way of rendering this high-fidelity service.

Following these demonstrations, the FCC was petitioned to permit the use of multiplexing by FM broadcast stations. It required nearly 5 years for authorization, due to the question of the legality of adding a private point-to-point type of service to a public broadcast channel. This cuts squarely across the basic definition as to what constitutes a public broadcast service. (Similarly, the present subscription TV controversy concerns using a public-service channel for a nonpublic function.)

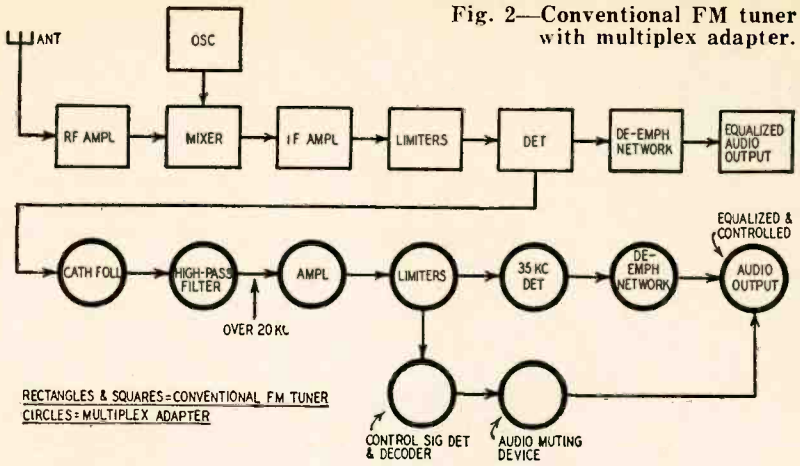


Fig. 2—Conventional FM tuner with multiplex adapter.

Approval of the multiplex petition recognized that multiplexing would permit certain FM stations to continue for a time to render specialized program services by what is termed the "simplex" transmission method. These stations were profitably engaged in transmission of special background music on their public channels, with commercials and other nonmusic material being deleted automatically by ultrasonic control or beep signals.

Simplexing provided many FM stations with enough revenue to weather the economic storms of this broadcast medium. However, the FCC considered that music directed to subscribers was not a public service as called for by FCC rules and regulations. Multiplexing permits these stations to move their simplex operation from the main to a subchannel. They can then derive revenue from sponsored main-channel programs as well as draw income from subscribers to the subchannel service.

As presently visualized, the multiplex stereophonic receiver would be available in either of two forms—a specially designed receiver with built-in multiplex circuitry or a multiplex adapter which would attach to your present receiver. There would be separate volume controls and you could tune in the main channel of any station or flick a switch to bring in the subchannel. If stereophonic music is broadcast, both could be picked up simultaneously.

Existing FM receivers

Ordinary FM radios were not engineered for multiplex reception. However, most of these receivers can be upgraded by the addition of minor parts or circuit changes. An adapter then can be attached without serious crosstalk problems. Service technicians could do this. Suitable multiplex kits containing the necessary components and a schematic could be packaged and stocked by radio shops. A receiver with built-in multiplex will probably be in the price range of present good-quality FM receivers. A multiplex adapter for a home FM receiver will cost about the same as an inexpensive FM tuner.

Initially stereophonic broadcasts will be a repetition of the chicken-and-egg process experienced in the development of television and other forms of broadcasting. After all, receivers are not automatically sold before a station begins broadcasting. Like the birth and growth of television, a station must initiate this broadcasting to a ghost audience with demonstrations to interest the general public in buying receivers.

The growing number of excellent stereophonic tapes now on the market will be the basic material for programs. Many broadcasts now picked up live would also be broadcast stereophonically, thereby improving the quality of such transmissions. Stereophony would add a great deal to the realism and dramatic effect of plays and other shows.

In certain parts of the United States where there are relatively few radio stations, it is conceivable that multiplexing may be used primarily for providing a variety of programs rather than for stereophony. At present, for example, many daytime-only stations provide evening programs on their affiliated FM transmitter. In some areas, it is very difficult to provide static-free AM programming at any time of day or night. The listener's choice becomes severely limited. Since such places cannot support a great number of FM stations, it might be more practical for an FM station to perhaps provide sports programs, network programs and other nonmusical shows on the main channel and transmit music and news on a subchannel. This way, one station could have twice as many programs as at present, twice as much advertising income, twice as many listeners—and its technical operating expenses would still be about the same as before. Such an arrangement would not prevent providing stereophonic music.

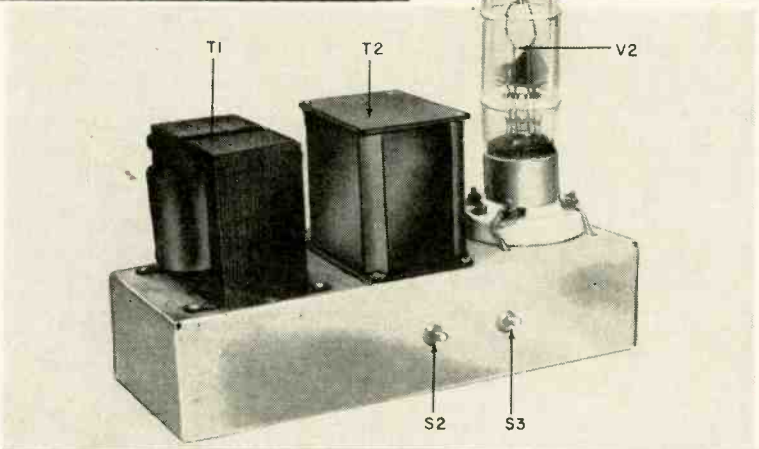
Although there are other excellent uses for this development, which can all be in our future, the primary thought is that multiplex is with us now. Radio stations need only begin multiplexing a service such as stereophonic programs. The public has already given a welcome acceptance to stereophony, so there will undoubtedly be a similar response when it is initiated in this new multiplex entertainment medium. END

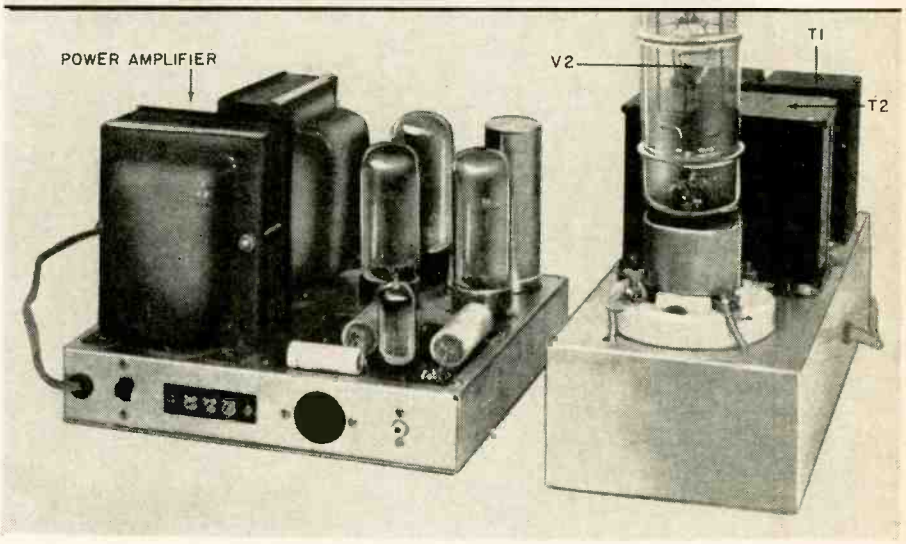
500-million-mc TRANSCEIVER

This super-high-frequency communications system uses cesium-vapor lamps

By HAROLD PALLATZ

Completed cesium-vapor lamp transmitter. Phototube and function-selector switch not installed.





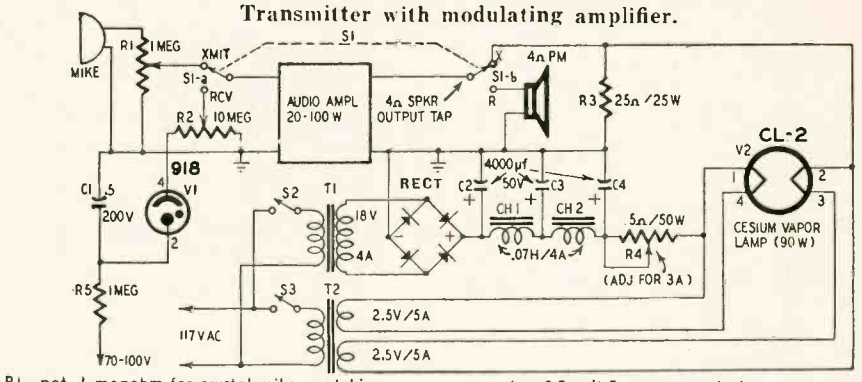
Transmitter with modulating amplifier.

NO license of any kind is required for this two-way communications system. The waves transmitted by the cesium vapor lamps are only some 40 millionths of an inch long (about 500 million megacycles per second). These frequencies act more like light waves than radio waves and in fact are only slightly removed from the visible spectrum. The waves travel in straight lines and distance is limited only by the power of your equipment or the curvature of the earth, whichever comes first.

Circuit hookup is very simple and is actually easier than for regular transmitters (see diagram). All you need is an audio amplifier, dc power supply (18 volts at 3 amperes) and a cesium vapor lamp. The lamp is modulated by the audio amplifier output. For greater distance a parabolic reflector can be placed behind the lamp. The reflector concentrates the waves in a small highly directional beam and directs waves that would ordinarily be lost as stray radiation. For night work where no light should show at all, the faint pink glow of the lamp may be eliminated with an infra-red filter.

The receiver section consists of the same amplifier with a speaker replacing the lamp in the output and a phototube replacing the microphone at the input. A dpdt toggle switch changes from "transmit" to "receive" and the entire system may be used as a transceiver. (The components of my receiver are simply soldered to the photocell socket terminals and receiver and mike are alternately plugged into the amplifier.)

Voice transmission will be virtually



R1—pot, 1 megohm for crystal mike, matching value for magnetic mike
R2—pot, 10 megohms
R3—25 ohms, 25 watts
R4—5 ohms, 50–100 watts
R5—1 megohm, 1/2 watt
C1—0.5 μf, 200 volts
C2, 3, 4—4,000 μf, 50 volts; two 2,000-μf 50-volt capacitors in parallel
*CH1, 2—.07 h, 4 amp
S1—spdt toggle
S2, 3—spst toggle
*T1—rectifier transformer, 117-volt primary; 18-volt 4-amp secondary
*T2—filament transformer, 117-volt primary; two 2.5-volt 5-amp secondaries
V1—918 phototube
*V2—cesium vapor lamp, 90 watts
*RECT—28 volts, 4 amps, full-wave bridge, selenium
Speaker—4-ohm voice coil
Socket—jumbo 4-pin bayonet
Amplifier—20–100-watt output. Must have 4-ohm output winding that can carry 3-amp dc
Mike—crystal or magnetic
*Infra-red filter—used only where no glow from vapor lamp is to show
*These items obtainable from Barry Electronics Corp., 512 Broadway, New York 12, N.Y.

Circuit of the transceiver.

distortion-free as the lamp response is from dc to 10,000 cycles. Clarity will depend mainly upon your audio system. Static and other transmission noises in regular radio-wave transmitters will be almost nonexistent. About the only noise you are likely to run into is possible pickup from a street light or other bulb operating on ac. This is minimized by the directivity of the units. Normal daylight does not have a rapidly changing light level. About the only thing daylight will do is put a bias on the phototube (never point a phototube at the sun), which in some cases will require a readjustment of the input gain control. Daylight transmission may also require more shielding of the phototube, particularly on long-distance transmissions, to prevent the weaker signals from becoming completely masked out.

Dc power supply

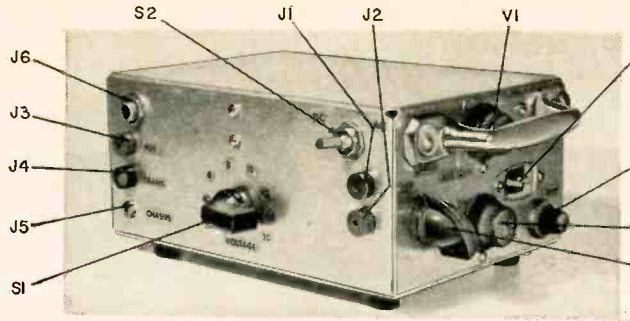
It is very important to have a hum-free dc power supply, just as it is in a transmitter intended for speech. The diagram shows the circuit of a typical unit. A 18- or 24-volt aircraft battery (lead storage type) that will stand 3 amperes of constant drain can also be used.

This will give you hum-free results but has the inconvenience of requiring constant attention for recharging and refilling. Since cesium vapor lamps have a negative resistance characteristic, some means of limiting the maximum current must be used. For this we use a slide type wirewound resistor.

In use, the two filaments of the lamp are lit for about a minute (up to 15 minutes on breaking in a tube for the first time). *Do not turn on the B supply until the filaments have been on for a minimum of 30 seconds.* An arc is struck by tapping on the microphone (this causes a high-voltage peak across the lamp which ignites the arc). The slider is moved on the resistor until approximately 3 amperes are flowing through the lamp. The filaments can then be turned off and the plate current should be about the same. If you have difficulty in starting your lamp, you can tilt it slowly until it starts.

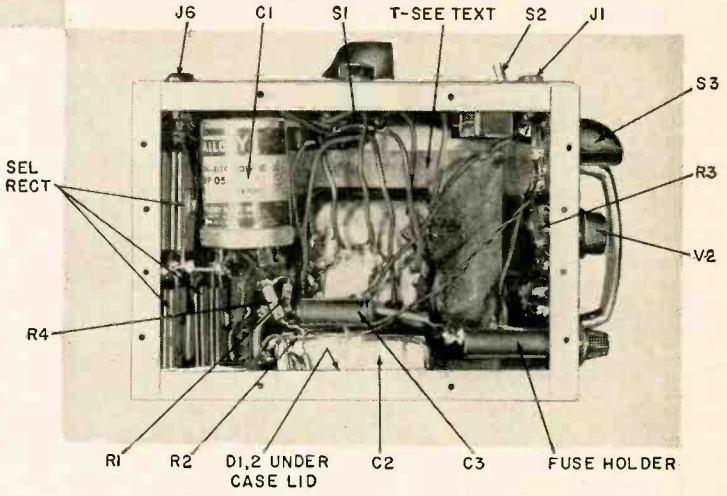
Since the penetration of infra-red waves is slightly different from light waves, you will still be able to communicate even under conditions of poor visibility due to fog. The size of the water-vapor molecule is the restricting agent. Water-vapor particles smaller than the wavelength of our transmitter are relatively transparent. Large vapor particles will in some cases completely stop the rays.

For code enthusiasts, the microphone may be replaced with an oscillator and a telegraph key. Communication will be the same as with low-frequency radio waves but will have the advantages of simpler construction and no code speed requirements. When your code speed does pick up from these practice sessions it will be easier to obtain higher-grade licenses. END



The low-voltage supply. Transistors are mounted on front of case.

All parts fit easily into aluminum case.



transistor LOW-VOLTAGE SUPPLY

Need ac, dc, pure dc or regulated dc? Then you want this transistorized device

By I. QUEEN
EDITORIAL ASSOCIATE

ALMOST every experimental laboratory, individual researcher or service shop needs some kind of low-voltage power supply. This power source provides three types of output: ac, regular dc and pure dc. The ac is suitable for filament supplies, motors and relays. Regular dc is for low-hum filament circuits, small dc motors and relays, battery charging, electroplating and wherever a 5% ripple can be tolerated. The pure dc source is actually a battery eliminator as its ripple is less than 0.1%. It is excellent for audio circuits using power transistors and can energize portable transistor radios. Pure dc is available either as *unregulated variable voltage* or as *regulated 12.6 volts.*

Except for the regulated output, the voltage is variable in small steps. The ac has a maximum of 19–20 volts at 3 amps, dc the same voltage at about 2 amps continuous. The *pure* dc delivers 14 volts maximum at 1 amp. If more is drawn the voltage drops. The load is always insulated from the line. Peak-to-peak ripple at full output is less than 10 mv. Note that this is the *peak-to-peak* value observed on a scope. The rms value is far below this, and is therefore well below 0.1%. The pure dc therefore closely approaches a battery supply.

None of the circuits is critical in any way. You don't have to use components identical to those described here and you don't need to include *all* the circuits. Perhaps you don't want or need the *regulated* feature or maybe you can do without a *variable* voltage. It's easy to adapt this device to fit your own needs.

The ac circuit

A tapped transformer secondary provides the variable voltage output. Three center-tapped filament transformers, each 6.3 volts, are connected in series to provide a total of 19 volts (see Fig. 1). Each transformer should be rated at 3 amps. These transformers are common radio items.

To select voltage, a tap switch is needed. Grayhill type 5006 is excellent for the purpose since it has six terminals, is tiny and can handle up to 5 amps.

The transformer shown in the photos is an old model-train type which happened to be available. It was removed from its metal case (which was ready to fall apart) and the tapped leads connected to the Grayhill switch. It provides variable output up to 14 volts, in steps of 2 volts, plus a maximum terminal of 20 volts. It is, therefore, nearly equivalent to a series of three filament transformers. If you have such a transformer well and good, but the filament units are electrically equivalent and much easier to mount in the box.

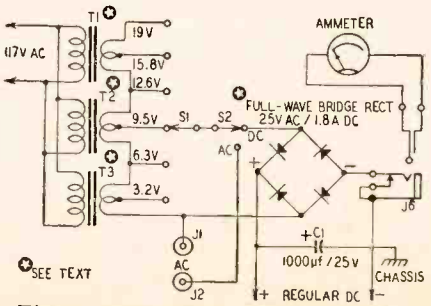


Fig. 1—Ac and regular dc circuit.

When switching ac voltage, it is preferable to rotate the switch to the desired value *before* connecting the load. The switch handles 5 amps continuously but is rated to *break* much less current.

For easy manipulation and good appearance you may wish to mark each voltage tap as I did. The ac output is led to insulated pin jacks on the front of the box. Green jacks were chosen to color-code the ac.

Regular dc circuit

When converting ac to dc at high current, we are faced with two problems: rectification and filtration. The first is solved by using low-voltage bridge rectifiers. The second problem is partly solved by a large capacitance (C1) across the output terminals. Good filtering is difficult without a choke coil capable of carrying high currents. Such coils are not regular radio components and do not even appear in radio catalogs, other than those issued by a few firms specializing in battery chargers, eliminators and other high-current supplies. For this reason we settled for 5% ripple.

The ac voltage (selected by the rotary switch) is fed to selenium rectifiers. The diagram shows a single bridge but actually three are used, in parallel, to increase current capacity. Each bridge may be a Federal 1017 or Sarkes-Tarzian 604-B. Either can deliver 600 ma continuously. A total of at least 1.8 amps may be drawn continuously when three bridges are connected in parallel. For shorter periods,

Model TD-55 — Terms: $6.95 after 10 day trial then $5.00 per month for 4 months.

Model TV-12 — Terms: $22.50 after 10 day trial then $10.00 per month for 5 months.

Model TV-40 — Terms: $3.85 after 10 day trial then $4.00 per month for 3 months.

Model TW-11 — Terms: $11.50 after 10 day trial then $6.00 per month for 6 months.

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EMISSION TYPE TUBE TESTER

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Elemental switches are numbered in strict accordance with R.M.A. specification. One of the most important improvements, we believe, is the fact that the 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

Complete with carrying case..... **$26.95 NET**

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PICTURE TUBE TESTER

Not a Gadget—Not a Make-Shift Adapter, but a Wired Picture Tube Tester With a Meter for Measuring Degree of Emission—at Only $15.85

Of course you can buy an adapter for about $5—which theoretically will convert your standard tube tester into a picture-tube tester; or a neon type instrument which sells for a little more and is supposed to be "as good as" a metered instrument. Superior does not make nor do they recommend use of C.R.T. adapters or neon gadgets because a Cathode Ray Tube is a very complex device, and to properly test it, you need an instrument designed exclusively to test C. R. Tubes and nothing else.

Tests ALL magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton! !

- Tests all magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Test for open elements.

EASY TO USE: Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base (ion trap need not be on tube). Throw switch up for quality test . . . read direct on Good-Bad scale. Throw switch down for all leakage tests.

Only..... **$15.85 NET**

Superior's New Model TV-12

TRANS-CONDUCTANCE TUBE TESTER

TESTING TUBES

- **Employs improved TRANS-CONDUCTANCE circuit.** An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- **NEW LINE VOLTAGE ADJUSTING SYSTEM.** A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.
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- **NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY.** Permits application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit.

Extra Feature

Model TV-12 Also Tests Transistors!

A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

The Model TV-12 will accommodate all transistors including NPN's, PNP's Photo and Tetrodes, whether made of Germanium or Silicon, either point contact or junction contact types.

Housed in hand-rubbed oak cabinet..... **$72.50 NET**

Superior's New Model TW-11

STANDARD PROFESSIONAL TUBE TESTER

- Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.
- Uses the new self-cleaning Lever Action Switches for individual element testing. **Because all elements are numbered according to pin-number in the RMA base numbering system,** the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.
- The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. **Thus it is impossible to damage a tube by inserting it in the wrong socket.**
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE: SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types. *Housed in hand-rubbed oak cabinet*..... **$47.50 NET**

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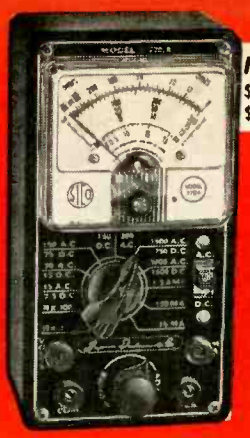

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- ✓ Audio Frequency Generator
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R. F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

BAR GENERATOR: Pattern consists of 4 to 16 horizontal bars or 7 to 20 vertical bars.

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DOT PATTERN GENERATOR (FOR COLOR TV): The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence.

MARKER GENERATOR: The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency.)

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Superior's New Model 670-A SUPER-METER

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ADDED FEATURE: Built in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
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D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers.)
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- ✓ IT'S A TV ANTENNA TESTER

SPECIFICATIONS

✓CAPACITY BRIDGE SECTION 4 Ranges: .00001 Microfarad to .005 Microfarad; .001 Microfarad to .5 Microfarad; .1 Microfarad to 50 Microfarads; 20 Microfarads to 1000 Microfarads. Will also measure the power factor of all condensers from .1 to 1000 Microfarads.

✓RESISTANCE BRIDGE SECTION 2 Ranges: 100 ohms to 50,000 ohms; 10,000 ohms to 5 megohms.

✓SIGNAL TRACER SECTION With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc.

✓TV ANTENNA TESTER SECTION Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? Locates a break in any TV antenna and measures the location of the break in feet from the set terminals.

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● Compact—measures 3⅛" x 5⅞" x 2¼". ● Uses "Full View" 2% accurate, 850 Microampere D'Arsonval type meter. ● Housed in round-cornered, molded case. ● Beautiful black etched panel.

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Complete with test leads..... **$15.85 NET**

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- ☐ Model TV-12.....Total Price $72.50 $22.50 within 10 days. Balance $10.00 monthly for 5 months.

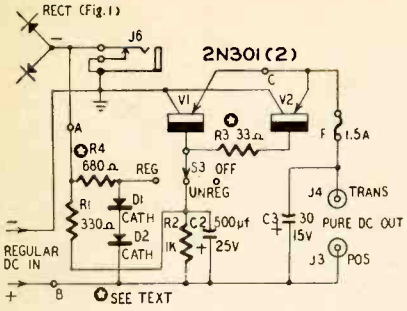


Fig. 2—Circuit for changing regular dc into pure dc.

up to 3 amps will not cause undue rectifier heating.

Each rectifier has four elements and its terminals are coded for easy identification. To parallel them, simply connect like terminals.

The *regular dc* output is connected to a pair of pin jacks. The positive one ***must*** be insulated and may be colored red. The negative terminal is not insulated. As shown in the diagram, the negative output of the bridge is tied to the chassis (through a phone jack). The jack (J6) is normally closed and permits inserting a meter in series with the dc power so that current may be monitored or checked. The meter will measure the *total* dc drawn from the unit.

No line switch has been used in this device but you can quickly shut off its output without removing the cord. If you are using the dc terminals, switch (S2) to ac. Conversely if you are using ac, switch (S2) to dc. A line switch may be installed in the line cord, of course.

The 5% ripple compares favorably with outputs of commercial dc power supplies used for battery charging, energizing solenoids, etc. It is even suitable for powering transistor radios and other transistor circuits where slight hum modulation is not serious.

Pure dc output

Generally we rely on some L-C combination to do a good filtering job. At low voltages, capacitance is no problem. For example, a 1,000-μf 25-volt unit for C1 is small and cheap. Coils are another story. A coil to handle 1.5 amps or more is a special item. It would be bulky and expensive, for it must be wound with heavy wire.

You are probably aware that a transistor *saturates* when supplied with sufficiently high collector voltage at rather low base current. For example, increasing collector voltage from 6 to 8 (33%) may produce a rise in current from 0.5 to 0.52 amps (4%). If the bias is nearly pure dc, the output will also be pure dc, despite considerable ripple in the collector supply voltage.

Fig. 2 shows the circuit for obtaining pure dc from regular dc. For unregulated (and variable) voltages switch S3 is thrown to UNREG.

Two RCA 2N301 transistors are used to filter the output. The bases of V1 and V2 are fed through an R-C network that easily eliminates much of the ripple (since current is low in this circuit). The load is connected in the emitter returns. Measurement shows approximately 800-mv peak-to-peak ripple between points A and B. Yet with full load, output ripple is *less* than 10 mv peak to peak, almost too small to detect on a sensitive scope.

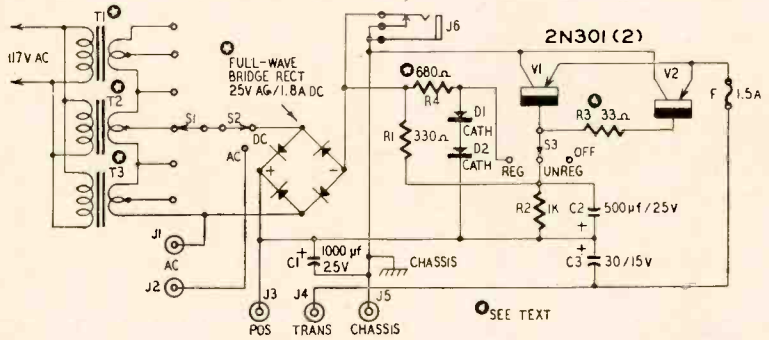
It is unlikely that the transistors you use will be matched perfectly, so one will tend to do more than its share in handling the current. For this reason a resistor is needed in series with the base of the more efficient transistor. This resistor (R3) is shown as 33 ohms, but you may wish to experiment to find the correct value for your own transistors. To do so, plug a meter into J6 to measure total current. Also, temporarily cut the lead to one emitter (at C) and insert another ammeter here. This meter will measure input to only one transistor, so it should indicate approximately half the total current shown by the other ammeter. R3 is placed in series with the base of the transistor supplying more than its share of power (V2 in this case). Choose R3 so that V1 and V2 divide the load equally. This should be done while nearly maximum current (for example, 1.5 amps) is drawn.

The bias filter network R1, R2, C2 is not critical. R1 affects output and ripple to some extent. If reduced in value, it provides greater output but tends to raise the ripple. R2 controls regulation and output. If its value is decreased, the output drops while regulation (output voltage *vs.* load current) improves slightly. The values for R1 and R2 shown in Fig. 2 were found to be optimum. A 1.5-amp fuse protects the transistors.

The photos show how the transistors mount directly to the case. The metal conducts heat from the transistors, keeping their temperature to a minimum. Each 2N301 is mounted with a pair of 6-32 machine screws. The flange (collector connection) of each transistor thus returns to negative potential, and the metal case serves as a heat sink. On the inside of the box, a nine-pin miniature socket plugs onto the transistor pins. Use pin 5 for the base and pin 9 for the emitter of each transistor. For convenience, each socket may also be screwed down to the box from the inside. In this way you may remove either transistor at any time (for test or temporary use elsewhere) merely by removing the machine screws and unplugging the 2N301. The transistor can always be returned by screwing it back to the box.

Using the power supply

When operated near maximum output, the transistors will become warm to the touch, but they should never be too hot to hold. Both should be at nearly the same temperature if they are sharing the load equally. At a flange temperature of 80°C, a 2N301 can dissipate up to 7.5 watts so it is ideal for the application described here.



R1—330 ohms
R2—1,000 ohms
R3—33 ohms, see text
R4—680 ohms, see text
All resistors ½ watt unless noted
C1—1,000 μf, 25 volts, miniature electrolytic
C2—500 μf, 25 volts, miniature electrolytic
C3—30 μf, 15 volts, miniature electrolytic
D1, 2—Regulator diodes (Texas Instruments 652C8)
F—1.5 amps
J1, 2, 3, 4—pin jacks, insulated
J5—pin jack, uninsulated
J6—phone jack, normally closed
S1—single pole, 6 position, rotary (Grayhill 5006 or equivalent)
S2—spdt, toggle
S3—single-pole 3-position rotary
T1, 2, 3—filament transformers: primary 117 volts; secondary, 6.3 volts, 3 amps
V1, 2—2N301
RECT—Bridge, 2 amps, 25 volts (Federal 1017 or equivalent) (3 25-volt 600-ma bridges in parallel)
Fuse holder
Sockets, 9 pins, miniature (2)
Case, 3 x 5 x 7 inches
Knobs
Miscellaneous hardware

Fig. 3—Complete power supply circuit.

Regulated dc

The unregulated supply provides nearly 18 watts of pure dc, and since the output is variable it can be adjusted for the load. Sometimes, however, a load fluctuates considerably, yet it is desired that the voltage remain nearly constant. A Class-B amplifier is such a load. When switched to REG, the circuit of Fig. 2 delivers a regulated voltage.

Two silicon reference diodes, Texas Instruments 652C8, are connected in series. These are rated at 6.3 volts each, so the total regulated voltage will be approximately 12.6. Actually, Texas Instrument diodes are available in steps of 0.1 volt so you can use any type that regulates close to 6 volts.

R4 controls current through the diodes and may need careful selection. With the load terminals open, maxi-

mum diode current should not exceed 22 ma. On the other hand, a value of current that is too low will drop the available load current that can be regulated. When a load is connected, there will be a drop in diode current. This is because base current into the transistor *opposes* current flow through the diodes and R4. As the load current rises, the diode flow will fall until, at 6 ma or less, there is no regulating action.

A maximum regulating current of approximately 1.25 amps is available. No-load output will be approximately 12.5 volts. At 1.25 amps, the voltage will drop to slightly more than 11. For minimum ripple, the load should not exceed about 1 amp and the voltage will be 11.5.

The complete diagram of this power supply is shown in Fig. 3. To use it, first switch S2 to ac or dc as desired, then plug the load leads into the correct jacks. If regular voltage is to be used, connect to J3 and J5. For transistor filtered voltage, use J3 and J4.

The transistor switch S3 must be set as desired: regulated or unregulated. The OFF position is selected when the transistors are not being used, when the load requires ac or regular dc.

END

CORRECTION

In the parts list for the TV sound tuner (June, 1957, page 46) the dimensions of the forms for L1 and L2 are erroneous. The forms (Cambridge Thermionic Corp. type LS3 or equivalent) are ⅜ inch in diameter and 1⅛ inches long. The number of turns and the winding lengths are correct as given in the parts list.

Thirty-Five Years Ago

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Modern Electrics	1908
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Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In October, 1923, *Science and Invention* (formerly *Electrical Experimenter*)

A Modern (Electronic) Charlatan, by A. B. Tripp.
How Radio Aids Mine Rescue, by W. B. Arvin.
Baloons to Support Antennae.
Leviathan's Radio Transmitter.
Radio Doll.
Radio-Directed Torpedo of Tomorrow.
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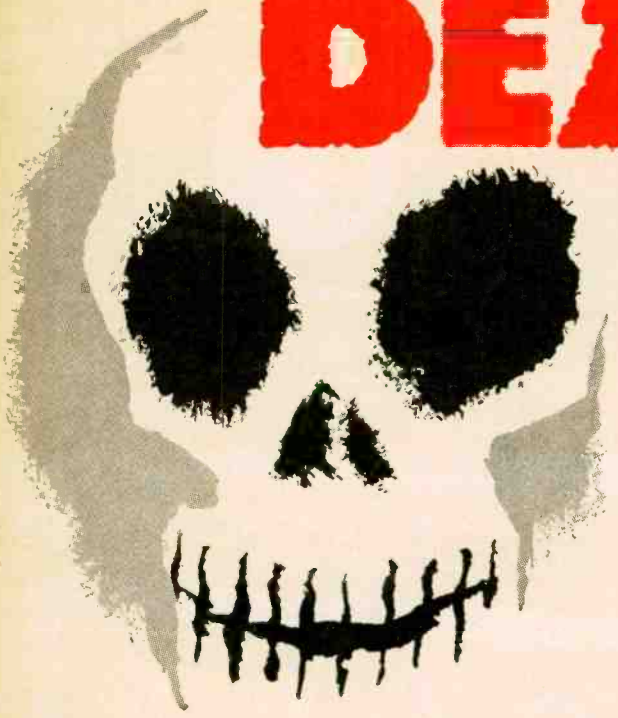

DEATH rides the HOT CHASSIS

Improperly grounded electrical equipment can kill . . .

By FRED SHUNAMAN
MANAGING EDITOR

PUBLIC attention has been focused sharply on the hazards of transformerless electronic equipment by the electrocution of a 6-year-old boy, Howard Erenstein Jr. of Skokie, Ill. He apparently brushed his bare leg or other part of his body against the metal stand of a 17-inch portable TV while reaching for a knife in the drawer of a sink cabinet.

The danger is not confined to TV receivers. On the same day a musician, Wm. Sennit of London, England, was killed by his own electric guitar. Nor is it rare. Within the last few months another small child—a 4-year-old boy—was killed while crawling under a TV set stand. Appearing in a local paper the event did not receive the burst that followed the accident in a Chicago suburb. Local papers continually carry stories of people being killed by wire antennas attached to ac–dc receivers, by receivers falling into bathtubs, etc. A compilation of the annual deaths caused by household electronic and electric equipment would produce what might truly be called a shocking total.

What's it all about?

What causes the danger and why is transformerless or portable equipment so often mentioned? Equipment with transformers, it is true, can become defective and cause accidents, but the danger is not as great.

In the home, electricity is usually brought in on two conductors, at about 117 volts. One of the two conductors is grounded close to the point the electric lines enter the house. This is in itself a safety measure, but has one drawback. The ungrounded or hot wire can form a circuit with any object connected to earth (Fig. 1). Your radiators, washstands, sinks, furnaces, water and steam pipes and even such small objects as the switch plates on the walls can become—with the hot lead—part of an electric circuit.

Probably the world's most dangerous piece of electronic equipment is a small hot-chassis type ac–dc radio removed from its case. If the attachment plug is inserted in the wall receptacle in one direction, there is a difference of 117 volts between the chassis and any grounded object. If the plug is turned around, the chassis is at ground voltage and quite harmless (Fig. 2). But if the chassis is hot, any person who touches it and any grounded object at the same time is across the electric line. The part of the body in the circuit and the amount of moisture on the skin determine that person's chances of survival. If the path is through vital organs—as from one hand to the other or (as in the Skokie case) from a leg through the the body to the one hand—the result is likely to be fatal. Very dry skin may act as a partial insulator, but damp skin lowers resistance dangerously.

In transformerless TV and radio equipment, one side of the circuit is directly connected to one side of the electric line. In much of such equipment, the metal chassis on which the components are mounted is part of that circuit—in some others a single lead or bus—usually forming the negative-dc lead of the circuit as well—is connected directly to the ac line. This bus is often connected to the chassis through a small capacitor shunted by a large resistance, to increase operational stability. In

(*Continued on page* 109)

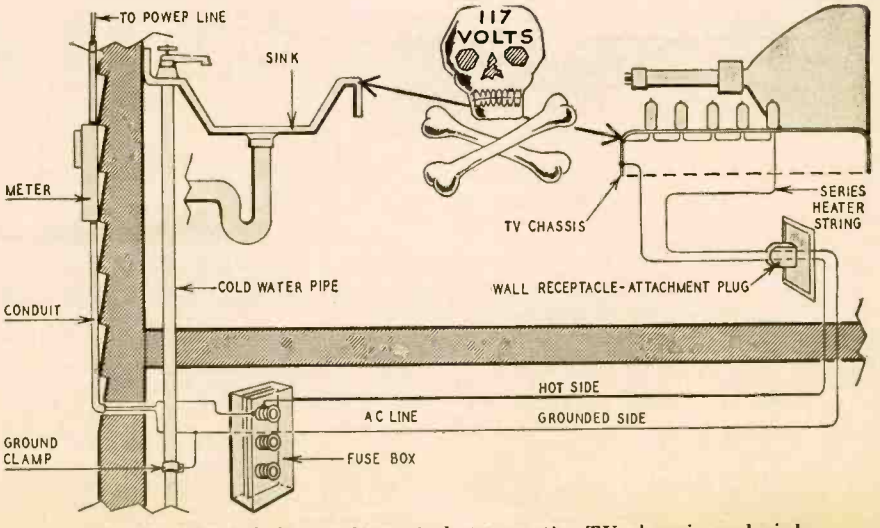

Fig. 1—The full line voltage is between the TV chassis and sink.

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ALLIED'S giant buying power passes biggest savings on to you—you do the easy assembly and your finished instrument equals the performance and appearance of equipment selling for several times the low KNIGHT-KIT cost. Your savings are BIG.

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knight-kit High Fidelity FM-AM Tuner Kit

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- Latest Time-Saving Printed Circuit Design
- Flywheel Tuning
- Automatic Frequency Control
- 2.5 μv FM Sensitivity
- True High Fidelity Response
- Beautiful Custom-Styled "Space Saver" Case

The best-looking, best-performing FM-AM tuner kit your money can buy! Carefully designed for quick, easy construction—a tuner you'll enjoy assembling and be proud to own, both for its amazing musical performance and outstanding beauty. Covers the full AM broadcast band and 88 to 108 mc FM. On FM, *sensitivity is a remarkable 2.5 microvolts for 20 db of quieting;* hum and noise, —60 db; IF bandwidth, 200 kc at 50% down on curve; response, ± 0.5 db, 20-20,000 cps. On AM, *sensitivity is 3 microvolts for 10 db signal-to-noise ratio;* IF bandwidth, 8 kc at 50% down on curve; response, 20-8000 cps. Outstanding features include: Inertia Flywheel Tuning for effortless, accurate tuning; Automatic Frequency Control (plus AFC disabling) to "lock-in" FM stations; printed circuit board (with most of the kit wiring already done for you) assures time-saving, error-free assembly; pre-aligned RF and IF coils; tuned RF stage on FM; drift-compensated oscillator; neon glow tuning pointer; cathode follower output; two output jacks—one for recorder, one for amplifier; rotatable built-in ferrite antenna for AM. Includes beautiful French-gray case with chrome-finished tapered feet, 4 x 13 x 8". Ideal for use with 18, 20 or 30 watt KNIGHT-KIT amplifiers. Ready for easy assembly. Shpg. wt., 12 lbs.

Model Y-787. FM-AM Tuner Kit. Net only..... **$49.95**

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- The Last Word in Custom Hi-Fi Styling
- Full 18 Watts with Superb Hi-Fi Specifications
- 8 Inputs for Every Desired Signal Source
- Printed Circuit Switch and Printed Circuit Boards
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Here is a custom-styled, easy-to-build complete Hi-Fi amplifier at a price that defies comparison. Delivers full 18 watts output with wide-range, flat frequency response for true hi-fi reproduction. Features 8 inputs for every possible signal source, including NARTB equalized tape head input. At full 18 watts output, distortion is only 0.5%; uses new RCA 6973 hi-fi output tubes. Frequency response is ± 1 db, 20-30,000 cps; tape head and magnetic cartridge sensitivity, 5 microvolts for 18 watts output; hum and noise level better than 60 db below 18 watts. Output taps for 4, 8 or 16 ohm speakers. Controls: Input and Record Equalization; Bass Boost and Attenuate; Treble Boost and Attenuate; Volume. Simplest assembly is made possible through the use of an exclusive printed circuit switch and two printed circuit boards—most of the kit wiring is already done for you. With custom-styled French-gray "space-saver" case on tapered feet finished in chrome, 4 x 13 x 8". Complete with case, tubes, all parts, and step-by-step instructions, for easy, error-free assembly. Shpg. wt., 15 lbs.

Model Y-786. 18-Watt Hi-Fi Amplifier Kit. Net only..... **$39.95**

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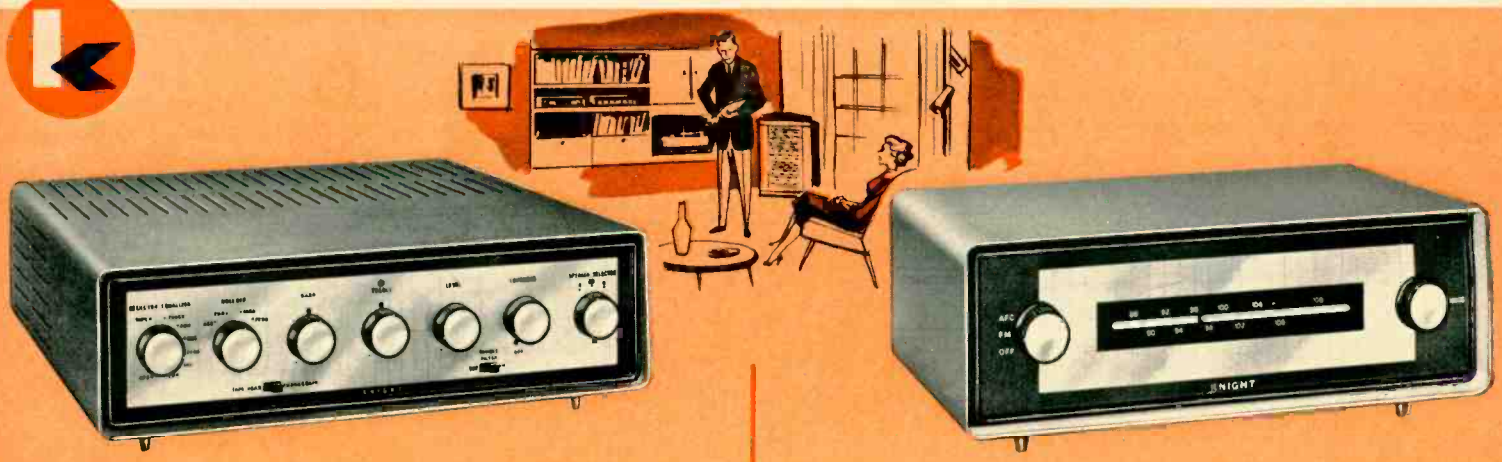

knight-kit 30-Watt Complete Hi-Fi Amplifier Kit

Model Y-762

$76.95

Only $7.69 down

- Full Equalization, ±½ db of Recommended Accuracy
- Printed Circuit Switches • Printed Circuit Boards
- 8 Inputs For Every Possible Signal Source
- Full 30 Watts Output • Custom-Styled Beauty

Comparable to the best in Hi-Fi—at far less cost! Deluxe features include: Linear-deluxe Williamson-type circuit for flawless response; equalization for all records within ½ db of recommended accuracy; 2 exclusive new printed circuit switches in preamp section (no complex wiring to do); 3 printed circuit boards for time-saving, error-free assembly; separate, continuously variable Level and Loudness controls; use of premium 12AY7 tube for low noise and hum; DC on all filaments of preamp tubes; exclusive A-AB-B speaker selector switch (use speakers of mixed impedances without mismatch). 8 inputs: Tape Head direct; G.E. and Pickering cartridges; Ceramic cartridge; Microphone; Auxiliary; Tape Preamp; Tuner (with separate Level Set control). Power amplifier response, ± ½ db, 15-100,000 cps at full 30 watt level; distortion—harmonic, 0.55% at 30 watts—IM, 0.74% at 20 watts. Separate Bass and Treble controls; rumble filter switch; variable damping. Output, 8 and 16 ohms. With smart French-gray cabinet, 4 x 15 x 15". Ready for easy, money-saving assembly. Shpg. wt., 32 lbs.

Model Y-762. 30-Watt Hi-Fi Amplifier Kit. Net only..... **$76.95**

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Model Y-751

$38.95

Only $3.89 down

- Authentic High Fidelity FM Response
- Flywheel Tuning • Automatic Frequency Control
- Printed Circuit • Pre-Adjusted Coils and IF's
- 4 Microvolt Sensitivity Guaranteed

Here is top value in creative engineering, impressive hi-fi performance and distinctive design—a tuner you'll be proud to build and own. Covers the full FM band, 88 to 108 mc. Features Automatic Frequency Control (with disabling feature) to "lock-in" stations and prevent drift; Inertia Flywheel Tuning for velvet-smooth, accurate station selection; pre-adjusted RF coils; pre-aligned IF's; cascode broad-band RF amplifier; drift-compensated oscillator; neon bulb pointer. All critical wiring is already done for you in the form of a printed circuit board—assembly is simple. Sensitivity is 4 microvolts for 20 db of quieting across entire band; output, 2 volts at 1000 microvolts input; IF bandwidth, 200 kc; response, 20-20,000 cps. with only 0.6% distortion. Output jacks for amplifier and tape recorder; cathode follower output. Ideal for use with the KNIGHT-KIT amplifiers, or any amplifier with phono-tuner switch. Features custom-styled case in French-gray, with tapered chrome-finished feet, 4 x 13 x 8". Includes all parts, tubes and step-by-step instructions for easy assembly. Shpg. wt., 12 lbs.

Model Y-751. Hi-Fi FM Tuner Kit. Net only..... **$38.95**

knight-kit Deluxe 3-Way Speaker System Kit

Model Y-937

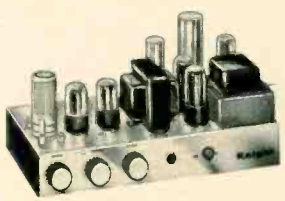
$89.50

Only $8.95 down

- Pre-Finished "Quik-Craft" Corner Enclosure
- Klipsch Designed and Licensed
- Famous Knight 12" 3-Way Speaker
- Easy to Assemble—Top Hi-Fi Quality
- Choice of Enclosure Finishes

Deluxe quality high fidelity speaker system at a money-saving low price. Easy to assemble—all you need is a screwdriver. System includes KNIGHT "Quik-Craft" corner-type folded-horn enclosure kit, and the famous-value KNIGHT 3-Way 12-inch speaker. Just assemble the enclosure—*no finishing required*—all surfaces are finished in hand-rubbed Korina blonde, mahogany or walnut. The speaker is the new 3-way type: 12" woofer cone for bass (full 1¾ pound woofer magnet), conical radiator for mid-frequencies, built-in compression-type tweeter (with wired level control and calibrated dial) for highest frequencies. Unexcelled enclosure efficiency and superb speaker performance combine to cover the whole spectrum of audible sound for true hi-fi response from 35 to 15,000 cps, ± 3 db. Kit includes 12" 3-Way speaker, prefinished enclosure panels, grille cloth, hardware and instructions. *Specify Korina blonde, mahogany or walnut when ordering.* Shpg. wt., 44 lbs.

Model Y-937. 3-Way Speaker System Kit. Net only..... **$89.50**



knight-kit 10-Watt Hi-Fi Amplifier Kit

Y-753

$23.50

$2.35 down

Low-cost, authentic hi-fi amplifier. Response, ± 1 db, 30-20,000 cps. Input for crystal phono or tuner; chrome-plated chassis is punched for preamp kit below, to permit use of magnetic phono. Only 0.5 volt drives amplifier to full output. Separate bass and treble controls. Only 1% harmonic distortion. Matches 8-ohm speaker. 7 x 13 x 6". With all parts, tubes and instructions. Shpg. wt., 13 lbs.

Model Y-753. Net only.. **$23.50**
Y-235. Preamp Kit..... **$ 3.10**
Y-757. Metal Cover.... **$ 3.95**

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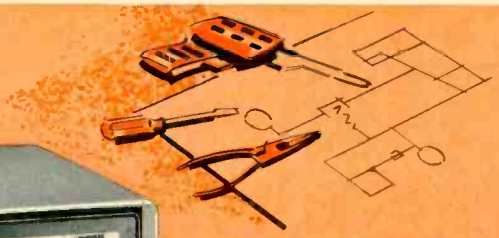


So Easy To Build
Anyone can build KNIGHT-KIT Hi-Fi. No experience required to get top results!

knight-kit High Fidelity Preamplifier Kit

Model Y-754
$39.95
Only $3.99 down

- Exclusive Printed Circuit Switches and Boards
- Equalization ±½ db of Recommended Accuracy
- 8 Inputs Including Tape Head
- Self-Powered
- DC on All Tube Filaments
- Custom-Styled

Sensational Hi-Fi design at amazing low cost. Provides precise record equalization guaranteed within ½ db of recommended accuracy!—more accurate than all but the most expensive factory-built preamps. Includes exclusive new KNIGHT-KIT printed circuit switches for easy, error-free assembly; 2 printed circuit boards eliminate all other wiring, except for power supply and control leads—so easy to build. Has built-in power supply; includes premium 12AY7 and ECC82 tubes. Frequency response, ± 0.5 db, 10-50,000 cps. Has 8 inputs: Tape Head; G.E. Phono; Pickering Phono; Ceramic; Microphone; Auxiliary; Tape Preamp; Tuner. Level adjustment for tuner input. Includes separate Bass and Treble controls; separate Level and Loudness controls; Rumble Filter switch; DC on all tube filaments; cathode follower output; 2 extra AC outlets. You get every advanced hi-fi feature in this easy-to-build preamplifier at the lowest possible cost. Includes beautiful custom-styled French-gray case, with tapered chrome-finished legs, 4 x 13 x 8". With all parts, tubes, step-by-step instructions; ready for easy assembly. Shpg. wt., 12½ lbs.

Model Y-754. Hi-Fi Preamp Kit. Net only..... **$39.95**

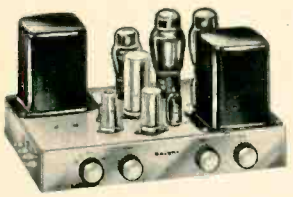
knight-kit 25-Watt Hi-Fi Basic Amplifier Kit

Model Y-755
$44.50
Only $4.45 down

- Hi-Fi Response, ± 0.5 db, 10 to 120,000 cps
- Only 0.15% Distortion at 30 Watts Output
- Printed Circuit Wiring Board
- Chrome-Plated Chassis
- Williamson-Type Circuit with Over 25 Watts Output

Here's superb Hi-Fi performance at less than half the cost of a comparable commercially-assembled unit. Williamson-type linear-deluxe circuit delivers over 25 watts of virtually undistorted reproduction. Ideal for use with the KNIGHT-KIT preamp at left. Includes printed circuit board for simplified, error-free assembly. Remarkable hi-fi response, ± 0.5 db, 10-120,000 cps at 20 watts. Harmonic distortion, 0.15% at 30 watts; IM, 0.4% at 20 watts. Hum level, 85 db below 25 watts output. Output impedances, 4, 8 and 16 ohms; output tubes, 2-5881. Includes balance control for precise matching of the output tubes; variable damping control for maximum performance with any speaker system—prevents low-frequency distortion from overdamping or underdamping. Very attractive black and chrome styling, 6¼ x 14 x 9". An outstanding engineering achievement in a basic hi-fi amplifier, delivering performance equal to the finest commercially assembled units. Includes all parts and tubes; with step-by-step instructions, ready for easy assembly. Shpg wt., 25 lbs.

Model Y-755. 25-Watt Amplifier Kit. Net only..... **$44.50**
Y-759. Metal Cover for above; black finish. 5 lbs. Net..... **$4.25**



knight-kit 20-Watt Hi-Fi Amplifier Kit

Y-750
$35.75
$3.57 down

True hi-fi for less! Complete with full set of controls and built-in preamplifier. Response, ± 1 db, 20-20,000 cps; distortion 1% at 20 watts. Inputs for magnetic phono, microphone, crystal phono or recorder, and tuner. Compensation positions for 78 and LP records. Separate bass and treble controls. Output impedances, 4, 8, 16 and 500 ohms. Chrome-plated chassis. 7 x 13 x 8¾". Ready for easy assembly. Shpg. wt., 20 lbs.

Model Y-750. Net only.. **$35.75**
Y-758. Metal Cover..... **$4.15**

knight-kit 2-Way Hi-Fi Speaker System Kit

Model Y-789
$49.95
Only $4.99 down

- Easy to Assemble—Pre-Finished Enclosure
- High Fidelity Response, 45 to 14,000 cps
- 12" Woofer and Horn-Type Tweeter
- A Wonderful Money-Saving Speaker Value

BIG SAVINGS—assemble your own quality KNIGHT-KIT 2-way speaker system—it's quick and easy! The cabinet is *pre-finished* in full-grained, high luster blonde or mahogany—you just assemble 7 pieces, mount the speaker components and enjoy rich, thrilling hi-fi sound—at incomparably low cost. Special Jensen-engineered baffle features "ducted port" construction to bring out the full beauty of bass notes, perfectly matching the Jensen woofer and compression tweeter; genuine L-pad control is rear-mounted to permit adjustment of tweeter for best tonal balance. Impedance, 16 ohms. The assembled unit delivers a frequency response of 45 to 14,000 cps. Enclosure measures 26 x 19 x 14". Beautifully styled to blend in any room. Kit includes Jensen 12" woofer, Jensen compression-type tweeter, pre-finished wood parts (with grille cloth installed), acoustic material, glue, hardware and step-by-step instructions. Absolutely no furniture finishing required. *Specify blonde or mahogany finish when ordering.* Shpg. wt., 33 lbs.

Model Y-789. 2-Way Speaker System Kit.
Net only..... **$49.95**

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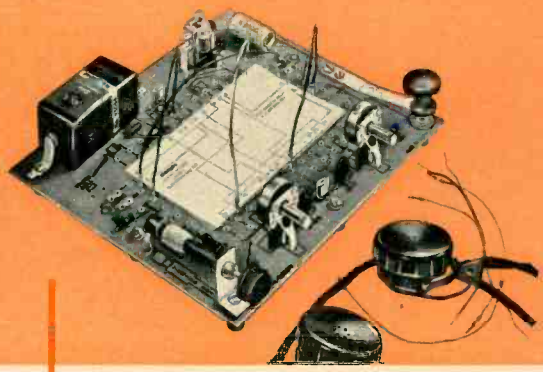
Fascinating ALLIED knight-kits FOR EXPERIMENTERS AND HOBBYISTS



knight-kit 2-Transistor Pocket Radio Receiver Kit

Model Y-262 $14.65

- Loud, Clear Local Reception
- Newest Printed Circuit Board
- Built-In Loop Antenna
- Complete Kit—Nothing Else To Buy

It's fun to build this pocket-size two-transistor radio—and you'll enjoy its crystal-clear local broadcast-band reception wherever you go! Fits in your pocket, or with its button-down flap, can be worn from your belt. Completely self-contained with built-in ferrite loopstick antenna—no external antenna needed. Extremely efficient reflex type 2-transistor circuit actually does the work of 3 transistors! Printed circuit board reduces building time to about one hour. Has air-dielectric variable capacitor for easy, accurate station tuning. Operates for months and months on long-life alkaline battery supplied. Sensitive miniature earpiece provides crystal-clear tone. Handsome tan carrying case, plastic-impregnated, is styled to resemble leather; only 4x3¾x1¾". Kit includes all parts, transistors, earpiece, battery and case. Shpg. wt., 1½ lbs.

Model Y-262. Net only **$14.65**

knight-kit "Trans-Midge" Transistor Receiver Kit

Model Y-767 $2.45

Tiny, cigarette-pack-size one-transistor radio kit—fascinating to build—so low-priced. This novel miniature receiver will provide endless listening pleasure the moment assembly is completed. Covers the local AM broadcast band with exceptional sensitivity and selectivity. Special features include: Efficient, slug-tuned coil for excellent station separation; external knob for easy station tuning; low-drain transistor operating for months from single penlight cell supplied; hinged-back, red plastic case. Kit includes all parts, transistor, battery, compact case and easy-to-follow instructions for quick assembly. (External antenna and headphones required.) Shpg. wt., 8 oz.

Model Y-767. Net only **$2.45**
J-149. 4000 Ohm Headphones. 1 lb. .. **$2.15**
C-100. Antenna Kit. 1½ lbs. **$1.03**

knight-kit 10-Circuit Transistor Lab Kit

Model Y-299 $15.75

Sensational experimenters' transistor kit—an electronic marvel! Perfect for experimenter, student or hobbyist. Assemble basic parts once, then complete project after project (10 in all), by simply plugging leads into proper jacks on printed circuit board—no wiring changes needed. You learn how transistors operate by "plugging in" to make any one of the following circuits; AM radio for strong headphone reception; 2-stage audio amplifier; wireless broadcaster; code practice oscillator; electronic timer; electronic switch; electronic flasher; photoelectronic relay; voice-operated relay; capacity-operated relay. Includes all parts, 2 transistors, battery, headphones, circuit leads, relay, photocell, special guide cards for each project, explanation of each circuit. 3 lbs.

Model Y-299. Net only **$15.75**

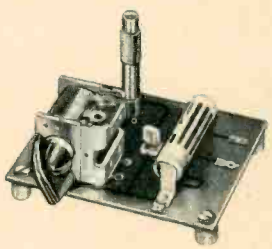
knight-kit 5-Transistor Superhet Personal Portable Radio Kit

Model Y-766 $29.95

- Styled to Equal the Finest
- Push-Pull Audio Drives 3½" Speaker
- Printed Circuit for Easy Building
- 200 Hour Battery Playing Life

Beautiful, easy-to-build transistorized personal portable with every ultra-modern design feature: 5 Texas Instrument Co. transistors; latest printed circuit chassis for easy, error-free assembly; bigger-than-average 3½" speaker; class B push-pull audio output; built-in high-gain ferrite loopstick antenna; plus phone jack output for private listening. Provides sensitive reception of the AM broadcast band with exceptional tone quality. Ultra-smart high-impact ivory plastic case has handsome gold trim with ebony accents; includes pull-out handle; only 7½x3⅜x1¾". With all parts, transistors, 9 volt transistor radio battery, carrying case and instructions anyone can easily follow. Shpg. wt., 2 lbs.

Model Y-766. Net only **$29.95**



1-Transistor Radio Kit

$3.95

Offers excellent AM local broadcast headphone reception. Printed circuit board for easy assembly. Operates from single penlight cell for months. Complete with all parts, transistor and penlight cell. (Antenna and headphones required.) Shpg. wt., 1 lb.

Model Y-765. Net only **$3.95**

"10-In-One" Electronic Lab Kit

$12.65

Famous experimenters' kit. Builds any of 10 fascinating projects, including broadcast receiver, wireless phono oscillator, code practice oscillator, signal tracer, relays, etc. Shpg. wt., 5 lbs.

Model Y-265. Net only **$12.65**

"6-In-One" Electronic Lab Kit

$8.45

A favorite with beginners. After basic wiring is completed, you make circuit changes without soldering. Builds any of six favorite projects, including radio, wireless broadcaster, etc. Shpg. wt., 3 lbs.

Model Y-770. Net only **$8.45**

Crystal Set Hobby Kit

$2.15

Entertaining, educational. Delivers clear headphone reception of local broadcast stations. With all parts, ready for easy assembly. (Antenna and headphones required.) Shpg. wt., 1 lb.

Model Y-261. Net only **$2.15**

Wireless Broadcaster Kit

$9.50

Play music or make announcements through your radio set—no connection to set required! Loads of fun—easy to build. Works up to 50 feet from set. Shpg. wt., 3 lbs.

Model Y-705. Net only **$9.50**

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FUN TO BUILD . . . INSTRUCTIVE . . . LATEST CIRCUITS FOR TOP PERFORMANCE

WIDEST CHOICE OF QUALITY HOBBYIST KITS

Interruption of light beam triggers relay, which in turn sounds chime or bell, turns on lights, etc.

knight-kit Photoelectronic Relay Kit

Model Y-702 $13.50

Advanced-design, ultra-sensitive photoelectronic relay—build it yourself and save! Dozens of uses: for automatic control of lights, door announcer, burglar alarm, counting devices, etc. Provides dependable operation up to 250 feet with white light, up to 125 feet with "unseen" light (red filter) from Light Source Kit listed below. Selectable operation, with "trip" for burglar alarm to provide continuous ringing of alarm; and "auto" if relay is to operate each time beam is broken (for chimes, counting devices, turning on lights at darkness). Has SPST relay operated from thyratron; 6.3 v. terminals provide power for accessories. For 105-120 v. 50-60 cy. AC use. 6 lbs.

Model Y-702. Relay Kit. Net only . . **$13.50**

Model Y-703. Light Source Kit. With bulb and red filter. Shpg. wt., 3½ lbs. Net. **$6.75**

knight-kit "Ocean Hopper" All-Wave Radio Kit

Model Y-740 $11.95

This top-performing regenerative receiver puts a world of listening pleasure at your finger-tips. Tuning range (using coils listed below) is virtually world-wide; covers 155 kc to 35 mc, including every type of radio transmission: AM broadcast, marine, aircraft, distress channels, direction-finding, Amateur, frequency standard, foreign broadcast, and police. With handspread tuning. For use with headphones or 3-4 ohm PM speaker. Kit is supplied with standard broadcast band coil and all tubes and parts. (Less extra coils, headphones, speaker and cabinet.) Shpg. wt., 5 lbs.

Model Y-740. Net only **$11.95**

Y-746. Cabinet for above. 1½ lbs. Net **$2.90**

Extra coils available: Long Wave Coil (155-470 kc). Net 79c. Short Wave (1.65—4.1 mc; 2.9—7.3 mc; 7—17.5 mc and 15.5—35 mc). Each 65c.

knight-kit "Space-Spanner" Bandswitching World-Wide Radio Kit

Model Y-243 $15.95

- Broadcast or Short Wave Reception Sensitive Regenerative Circuit
- Convenient Bandspread Tuning
- Built-In Loudspeaker

Imagine the thrill of hearing overseas broadcasts on a precision receiver you've built yourself—and then, at the flip of a switch, being able to tune to your favorite local broadcast station! Bandswitch selects exciting short wave, including foreign broadcasts, amateur calls, aircraft, police and marine radio on the 6.5 to 17 mc range, as well as standard 540-1700 kc broadcasts. Features highly sensitive regenerative circuit. Includes built-in 4" PM speaker and beam-power tube for strong volume and clear tone. Headphone connectors are available for private listening; switch cuts out speaker. Controls: Bandspread, Main Tuning, Antenna Trimmer, Bandswitch, Regeneration, Volume. 7x10x6". Easy to build from step-by-step instruction manual. For 110-120 v., 50-60 cy. AC or DC. (Less cabinet.) Shpg. wt., 5 lbs.

Model Y-243. Net only **$15.95**

Y-247. Cabinet for above. Shpg. wt. 2 lbs. Net. **$2.90**

"Ranger II" Superhet Receiver Kit

$17.25

Popular Broadcast band receiver built and enjoyed by thousands. Features built-in antenna, automatic volume control, ball-bearing tuning condenser, PM dynamic speaker. Handsome plastic cabinet. Easy to assemble. AC or DC operation. Shpg. wt., 8 lbs.

Model Y-735. Net only **$17.25**

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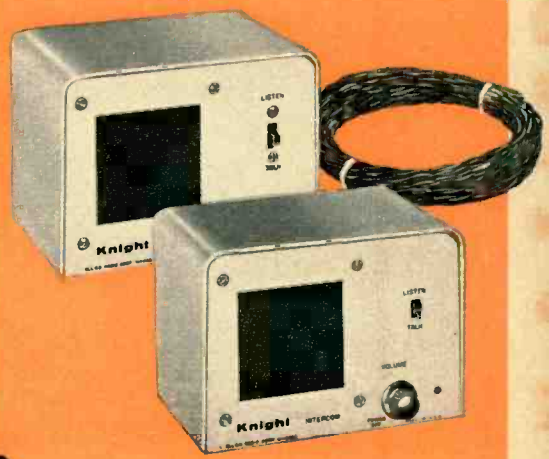
Model Y-295 $14.75

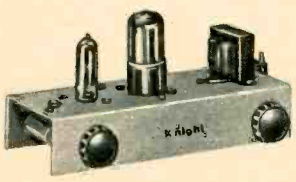
- Low Cost—Easy to Assemble
- High Gain—Clear Tone
- Handsome Metal Cabinets
- Includes 50-Foot Cable

Easy to build at lowest cost—ideal for home, office, shop or school. Consists of Master unit and Remote unit. Remote unit may be left "open" for answering calls from a distance, for "baby sitting", etc. Remote also may be set for "private" operation—cannot be "listened-in" on, but it can be called and can originate calls. Master unit includes high-gain 2-stage amplifier, combination volume control and on-off switch, plus pilot light. Each unit has 4" PM dynamic speaker. System responds to even a whisper. Handsome Antique white cabinets, each 4¾x6½x4⅜". With all parts, tubes and 50-ft. cable (up to 200-ft. may be added). For 110-120 v., AC or DC. 8 lbs.

Model Y-295. Master and one Remote. Net only . . **$14.75**

Y-296. Extra Remote Station Kit. 3 lbs. **$3.75**





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Build it yourself—and save! Ideal for use in a portable phonograph—just add record player and 3-4 ohm speaker. 1½ watts output. Inverse feedback circuit. Easy to assemble. Shpg. wt., 3 lbs.

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Ideal for beginners learning the code. Transistorized circuit. Operates for months from single penlight cell supplied. Clear, crisp 500 cycle tone. Jacks for headphones; screw terminals for key. 1 lb.

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Y-141. Picture Tube Adapter. 1 lb. Net ..... **$ 4.25**

knight-kit RF Signal Generator Kit

Model Y-145 **$19.75**

Build this wide-range, extremely stable RF signal generator—save two-thirds the cost of a comparable wired instrument! Large, semi-circular dial is clearly calibrated; range is covered in 5 separate bands for close accuracy in setting individual frequencies. Ideal for aligning RF and IF stages in radio and TV sets and for troubleshooting audio equipment. Delivers output on fundamentals from 160 kc all the way out to 112 mc; useful harmonics to 224 mc. Has built-in 400-cycle sine-wave audio oscillator for modulating RF; audio is also available externally. Features high-stability Colpitts circuit. Convenient jack for external modulation. Maximum audio output 10 volts; RF output over 0.1 volt on all ranges. Step and continuous-type attenuator controls. Supplied with precision-wound coils that require no adjustment. 7 x 10 x 5". Shpg. wt., 11 lbs.

Model Y-145. Net only **$19.75**

knight-kit 1000 Ohms/Volt VOM Kit

Model Y-128 **$16.95**

Exceptional accuracy and versatility at amazing low cost. Ideal for service shop, lab or Amateur use. Large 4½", 400 microamp meter with separate scales for AC and DC voltage and current, decibels and resistance. *Uses 1% precision resistors;* has 3-position function switch and 12-position range switch. *38 ranges* include: AC, DC and output volts, 0-1-5-10-50-500-5000 (1000 ohms/volt sensitivity); Resistance, 0-1000-100,000 ohms and 0-1 meg (center scale readings of 60, 150 and 1500 ohms); Current, AC or DC, 0-1-10-100 ma and 0-1 amp; Decibels, −20 to +69 in 6 ranges. Precision resistors are used as shunts and multipliers to assure exceptional accuracy of measurements. With all parts, battery, test leads and black bakelite case with convenient carrying handle, 6¾ x 5¼ x 3¾". A great value in an easy-to-build quality instrument. Shpg. wt., 2½ lbs.

Model Y-128. Net only **$16.95**

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- 200 μa Movement, 4½" Meter
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- Balanced-Bridge, Push-Pull Circuit
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Top buy in an extremely stable, highly accurate VTVM. Easy to assemble—entire chassis is printed circuit board. Perfect for radio-TV service work, lab and Amateur use. Features low-leakage type switches; 1% film-type precision resistors; balanced-bridge, push-pull circuit (switch to any range without readjusting zero set); zero center scale and direct-reading db scale; polarity reversing switch. Ranges: Input Resistance, 11 megs; DC and AC rms, 0-1.5-5-15-50-150-500-1500; AC Peak-to-Peak, 0-4-14-40-140-1400-4000; Response, 30 cycles to 3 mc; Ohms, 0-1000-10K-100K and 0-1-10-100-1000 megs; db, −10 to +5. Includes all parts, tubes, battery, test leads and portable case, 7¾ x 5¼ x 4-⅜". Easy to assemble. Shpg. wt., 6 lbs.

Model Y-125. Net only **$24.95**
Y-126. Hi Voltage Probe; extends DC to 50,000 v. ..... **$ 4.75**
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$32.95 High current rating; continuously variable filtered output; delivers 15 amps at 6 volts, 10 amps at 12 volts. May be used as battery charger. Two meters provide simultaneous current and voltage readings. Shpg. wt., 18 lbs.

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Transistor Checker Kit

$8.50 Checks gain ratio of all types of transistors; checks germanium and silicon diodes; checks for continuity and shorts. A valuable instrument at very low cost. Easy to assemble. Shpg. wt., 2½ lbs.

Model Y-149. Net only **$8.50**

Flyback Checker Kit

$19.50 Checks condition of all types of horizontal output transformers and deflection yokes, as well as TV linearity and width coils. 4½" meter; widest range in its field. Shpg. wt., 6 lbs.

Model Y-118. Net only **$19.50**

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$43.75 Extreme linearity on a par with costly lab instruments; fundamentals to 250 mc; output flat within 1 db; electronic blanking. Easy, money-saving assembly. Shpg. wt., 16 lbs.

Model Y-123. Net only **$43.75**

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Model Y-140. Net only **$29.50**

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Model Y-135 $26.50

A remarkable value in an easy-to-build instrument which permits visual and aural signal tracing of RF, IF, video and audio circuits. Has *highest gain in its price class.* Traces signal from antenna to speaker. Reproduces signal at plate or grid connection of any stage. Identifies and isolates "dead" stages. Features: usable gain of *91,000;* "magic eye" with calibrated attenuators for signal presence indication and stage-by-stage gain measurements; built-in 4" PM speaker; combination 2-position probe, one for RF (6 mmf. input), the other for audio. Provides noise test; built-in watt-meter calibrated from 25 to *1000 watts;* provision for external scope or VTVM. Binding posts provide output transformer and speaker substitution test, plus external 280 volts B+. With all parts, tubes and probe. 7x10x5". 12 lbs.

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knight-kit 5" Wide-Band Oscilloscope Kit

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Only $6.90 down

- 5 mc Width for Color TV
- Horizontal Sweep to 600 kc
- 25 mv/inch Sensitivity
- Z-Axis Input
- Printed Circuit Construction

Equals or betters the performance of commercially wired scopes costing far more. Two printed circuit boards and laced wiring harness assure wiring accuracy and cut assembly time. Ideal for lab use, color TV servicing and high frequency applications. Wide sweep range—*15 to 600,000 cps.* Vertical response, ± 3 db, 5 cps to 5 mc; only 1 db down at 3.58 mc color burst. High vertical sensitivity of .025 rms v/inch. Input capacity, 20 mmf. Outstanding features: cathode follower inputs; 2nd anode provides 1400 volts high-intensity trace; push-pull amplifiers; positive and negative locking; frequency-compensated attenuator; Z-axis input; one volt P-P calibrating voltage; astigmatism control; retrace blanking circuit; DC positioning control. Includes CRT. 14½ x 9½ x 16". 40 lbs.

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Model Y-146 $42.00

Only $4.20 down

- Phantastron Linear Sweep
- 25 mv/inch Sensitivity
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Feature for feature the world's best oscilloscope kit value. A standout in its class with all these fine features: *Printed Circuit* wiring board and laced harness for quick, error-free assembly. *Phantastron Sweep Circuit* for high linearity of sweep from 15 to 150,000 cps. *25 Millivolts Per Inch Sensitivity*—3 times that of similarly priced scope kits. *Calibration Voltage*—1 volt peak-to-peak square wave, fully regulated. *Vertical Amplifier*—frequency response ± 3 db, 3 cps to 1.5 mc (± 6 db to 2.5 mc). Includes: Directly coupled positioning controls; retrace blanking circuit; frequency-compensated vertical input attenuator; positive and negative internal sync; high 2nd-anode voltage for high-intensity trace; input capacity, 45 mmf. Kit includes CRT. 9½ x 13¾ x 17¾". 26 lbs.

Model Y-146. Net only **$42.00**

Resistance Substitution Box

$5.95

Easily determines resistor values required in a circuit. Makes available 36 standard 1-watt resistance values in 2 ranges between 15 ohms and 10 megohms, with 10% accuracy. Slide switch selects range; 18-position switch for value selection. Shpg. wt., 2 lbs.

Model Y-139. Net only ..... **$ 5.95**

Capacitance Substitution Box

$5.95

Makes it easy to find capacitor values needed in a circuit. Provides 18 standard values from .0001 mfd to .22 mfd. ± 20%. All values are 600 volt, except .15 and .22, which are 400 volt. 18-position selector switch. Shpg. wt., 2 lbs.

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Excellent design; range, 20 cps to 1 mc; less than .25% distortion; 600 ohm output. Ideal for hi-fi testing; offers the flat response of a lab standard. Shpg. wt., 16 lbs.

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- Tunes 540 kc to 31 mc
- Built-In Q-Multiplier
- Constant Running HF Oscillator
- Worthy of the Advanced Ham Operator
- Printed Circuit Bandswitch
- Printed Circuit Board
- 1.5 μv Sensitivity

A sensational communications receiver value with all the selectivity, sensitivity and features of high-priced commercial units. Uses printed circuitry throughout, including the exclusive new KNIGHT-KIT printed circuit bandswitch, for remarkably easy assembly. Covers 540 kc to 31 mc in 4 ranges; calibrated, electrical bandspread on 80-10 meter Ham bands; slug-tuned Hi-Q coils; continuous, VR tube-regulated B+ applied to HF oscillator lets you switch from standby to receive with no drift; built-in Q-multiplier peaks desired signal or nulls interference; delayed AVC; provision for crystal calibrator (below). Sensitivity, 1.5 microvolts for 10 db signal-to-noise ratio. Selectivity: variable from 300 cps to 4.5 kc at 6 db down. Exalted BFO injection. Controls: Main tuning, bandspread, band selector, Q-multiplier selectivity, Q-multiplier tune, null-off-peak, BFO pitch, RF gain, AF gain, BFO-MVC-AVC-ANL, off-stby-rec-cal, antenna trimmer, and phone jack. Cold-rolled 1/16" steel chassis. Handsome metal cabinet, 10 x 10 x 16½". (Less phones, 8-ohm loudspeaker and S-meter.) 23 lbs.

Model Y-726. Amateur Receiver Kit. Net..... **$104.50**

Y-727. S-Meter Kit for above. 1 lb. Net..... **$9.50**

knight-kit 50-Watt CW Transmitter Kit

Model Y-255

$38.95

Only $3.89 down

- Ideal for the Novice
- Pi Antenna Coupler
- Bandswitching—80 to 10 Meters

There's exceptional value in this very popular bandswitching transmitter kit. Compact and versatile, it's the perfect low-power rig for the beginning novice as well as the seasoned veteran. Has bandswitching coverage of 80, 40, 20, 15 and 10 meters. Rated at 50 watts—actually operates at up to 60 watts on 80 and 40 meters. Oscillator is efficient 6AG7; final is reliable 807. Crisp, clean, cathode keying of oscillator and final. Built-in pi coupler permits use with random length antennas. Has highly effective TVI suppression. Other features not usually found in transmitter kits at this low price include: Ceramic-insulated final tank capacitor; pre-assembled switches; pre-wound parasitic chokes; ceramic coil forms; coax connector; crystal and VFO socket on front panel; power take-off jack for accessory equipment. Meter reads either plate or grid current of final. Takes crystal or VFO without circuit changes. Cabinet interior and chassis are copper-finished. Size, 8½ x 10½ x 8¼". With tubes and all parts for easy assembly. (Less crystal and key.) Shpg. wt., 19 lbs.

Model Y-255. 50-Watt Transmitter Kit. Net only..... **$38.95**

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Complete with built-in power supply! Careful design and voltage regulation assure high stability. Excellent oscillator keying characteristics for fast break-in without clicks or chirps. Full TVI suppression. Has plenty of bandspread; separate calibrated scales for 80, 40, 20, 15, 11 and 10 meters; vernier drive mechanism. 2-chassis construction keeps heat from frequency determining circuits. Output cable plugs into crystal socket of transmitter. Output: 40v on 80, 20v on 40. With Spot-Off-Transmit switch for spot frequency tuning. Extra switch contacts for operating relays and other equipment. Attractive metal cabinet, 8¾ x 6 x 6". Ready for easy assembly. Shpg. wt., 8 lbs.

Model Y-725. VFO Kit. Net only..... **$28.50**

knight-kit 100 Kc Crystal Calibrator Kit

Model Y-256

$10.50

Crystal frequency standard at very low cost. Gives marker every 100 kc up to 32 mc. A "must" for marking band edges. Mounting flanges for installation in or back of receiver cabinet. Size only 1½x 1½x3". Requires 6.3 v. at 0.15 amp and 150-300 v. DC at 3-6 ma. Trimmer for zero-beating with WWV; On-Off switch. Complete with tube, crystal, all parts and easy-to-follow instructions. Shpg. wt., 1 lb.

Model Y-256. 100 Kc Crystal Calibrator Kit. Net only..... **$10.50**

knight-kit Amateur RF "Z" Bridge Kit

Model Y-253

$5.85

Measures standing wave ratio (SWR) and impedance of antenna systems; ideal for adjusting antenna systems for optimum results. Measures impedances from 20 to 400 ohms up to 100 mc; SWR to 150 mc. Any VOM may be used for null indicator. With coax input and output connectors. Meters both input and bridge voltage. Calibrated dial gives direct impedance reading; includes 1% precision resistor for precise calibration adjustment. With all parts and handy plasticized SWR chart (less meter). 2½ x 3 x 4½". Shpg. wt., 1½ lbs.

Model Y-253. "Z" Bridge Kit. Net only..... **$5.85**

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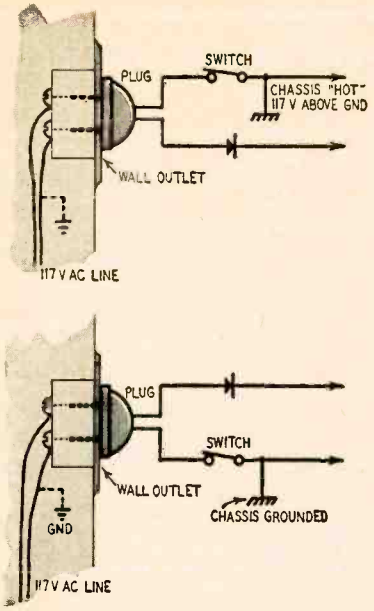


Fig. 2—With plug in one way, chassis is grounded; in other, 117 volts above ground.

(*Continued from page* 100)

most portable TV sets, the chassis is hot or directly connected to the line, and the metal cabinet is connected to the chassis through a capacitor–resistor network like that shown in Fig. 3. Without this network, large static charges might accumulate on the cabinet, giving anyone who touched it an unpleasant though not necessarily dangerous shock.

In a transformer set, the current from the electric line passes through the transformer's primary winding, which is carefully insulated from all other parts of the set, and through that winding only (see Fig. 4). The transformer insulation effectively isolates the secondary voltages from the line so the chassis ground is effectively separated from the line. The B-supply voltage in an ac set can be dangerous —particularly to persons with heart difficulties or with naturally damp skin —but is not so likely to be contacted accidentally because, to get a shock, one must contact two points of widely separated voltage in the receiver circuitry itself. An ac chassis is inherently "cold." Even ac equipment is not failure-proof. On rare occasions a capacitor breakdown may short one side of the line to the chassis or metal cabinet, making it hot. There are also some sets containing filament transformers or autotransformers that are not entirely isolated from the line, and so present all the hazards of transformerless equipment.

What to do about it

A number of ways to make electronic household equipment completely safe have been proposed. The Chicago authorities have suggested making a three-wire system (Fig. 5) mandatory for transformerless sets. It is standard practice for small hand-held tools and appliances, and window air conditioners. A third wire is attached to the metal shell of the appliance and runs to a pin on a three-prong plug. It has been urged that the three-wire attachment lead presents a new hazard. Most householders do not hesitate to replace or splice line cords, even of they will not touch anything else electrical. With a three-wire cord, confusion and the possibility of wrong or dangerous connections might result. In spite of that, the three-wire line seems the surest approach to safety in home electronic and electrical equipment. The plan has one weakness. Practically no homes have the necessary three-wire receptacles and though a municipality could no doubt enforce a ruling that no equipment be sold unless fitted with three-wire plugs, it could not as easily compel homeowners to install the necessary three-prong receptacles.

This should not prevent the individual life-loving home owner from having receptacles installed for his own electric and electronic equipment. It is comparatively simple to run a three-wire line for the average TV set. The third (grounding) wire may be attached firmly under a screwhead on the cabinet. The three-prong receptacle is not always so easy. The problem is to find a good earth to which it can be grounded. Most modern homes are wired with conduit, armored cable or a three-wire flexible cable with one conductor designed to act as the ground lead. In these cases installation is merely a matter of removing the two-conductor receptacle and replacing it with a three-conductor type. The third prong must be connected to the conduit, armor or ground lead, and tests made between it and a known good earth to make sure it is actually grounded.

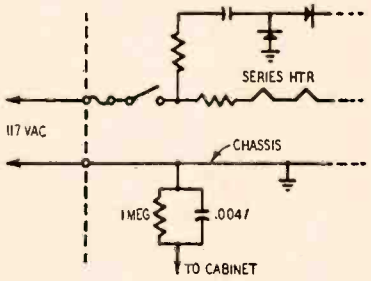


Fig. 3—A typical resistance–capacitance isolation network.

Some cheaper homes have been wired with a two-conductor flexible cable which makes no provision for grounding, and some older houses may be wired in the ancient knob-and-tube style, with the wires widely separated and run on porcelain standoffs or through porcelain tubes. These systems do not normally have a ground lead and installing one is likely to be costly.

Even worse are the cases where houses or parts of houses are wired with *ungrounded* armored cable. This does happen and is the reason why all three-wire receptacles should be checked after installation to make sure the grounds are really grounded.

An apparently simpler proposal is to use two-prong *polarized* plugs. You may not be aware of it, but the chances are 10 to 1 that the receptacle on the wall nearest you is polarized—one slot is wider than the other. The wide slot is connected to the grounded wire of the electric system (or should be). Used with a polarized plug (one prong larger than the other) this would seem to mean that a TV or radio set could be so hooked up that the chassis would stay at ground potential. But one serious drawback stands in the way of this easy-looking solution.

The polarized plug *would* make a chassis safe *if* it were connected to the grounded side of the line at all times. Unfortunately, many pieces of equipment, including most small radio receivers and some TV sets, have the line switch *between the set or chassis ground and the line*. When the switch is opened, the connection to earth is broken and the whole set becomes hot (see Fig. 6-a). If the switch is on the other side of the line (Fig. 6-b) so that the hot lead is disconnected when the switch is turned off, the equipment remains connected to ground and is safe.

Another suggestion is that an isolation transformer be used. This would presumably make the set safe, but in an awkward and expensive way. The suggestion presumes that the sets are inherently unsafe, which is not the case. The weight and bulk of an isolation transformer destroy the portability of a portable TV and the cost of a large isolation transformer is high ($15–$20).

The technician's role

A more fruitful immediate solution is to insure that nothing in done to a TV set (or other piece of electronic equipment) that will make it dangerous. When the sets come from the factory, they are presumably safe. How do they become otherwise?

Two things can make a hitherto normal piece of equipment dangerous. One is internal breakdown, such as the shorting of a capacitor between a hot chassis and cabinet. The other is external damage or improper servicing. A cabinet can be dropped so that items that should be separated come into contact or the same result may be produced by careless servicing or inexpert tinkering by unqualified repairmen. The metal-cabinet sets, in general, have a hot chassis carefully separated from the cabinet by insulating washers or strips. A capacitor shunted by a high-ohmage resistor is usually installed be-

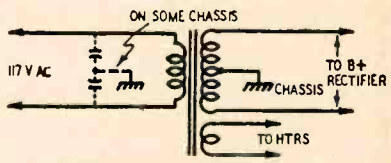
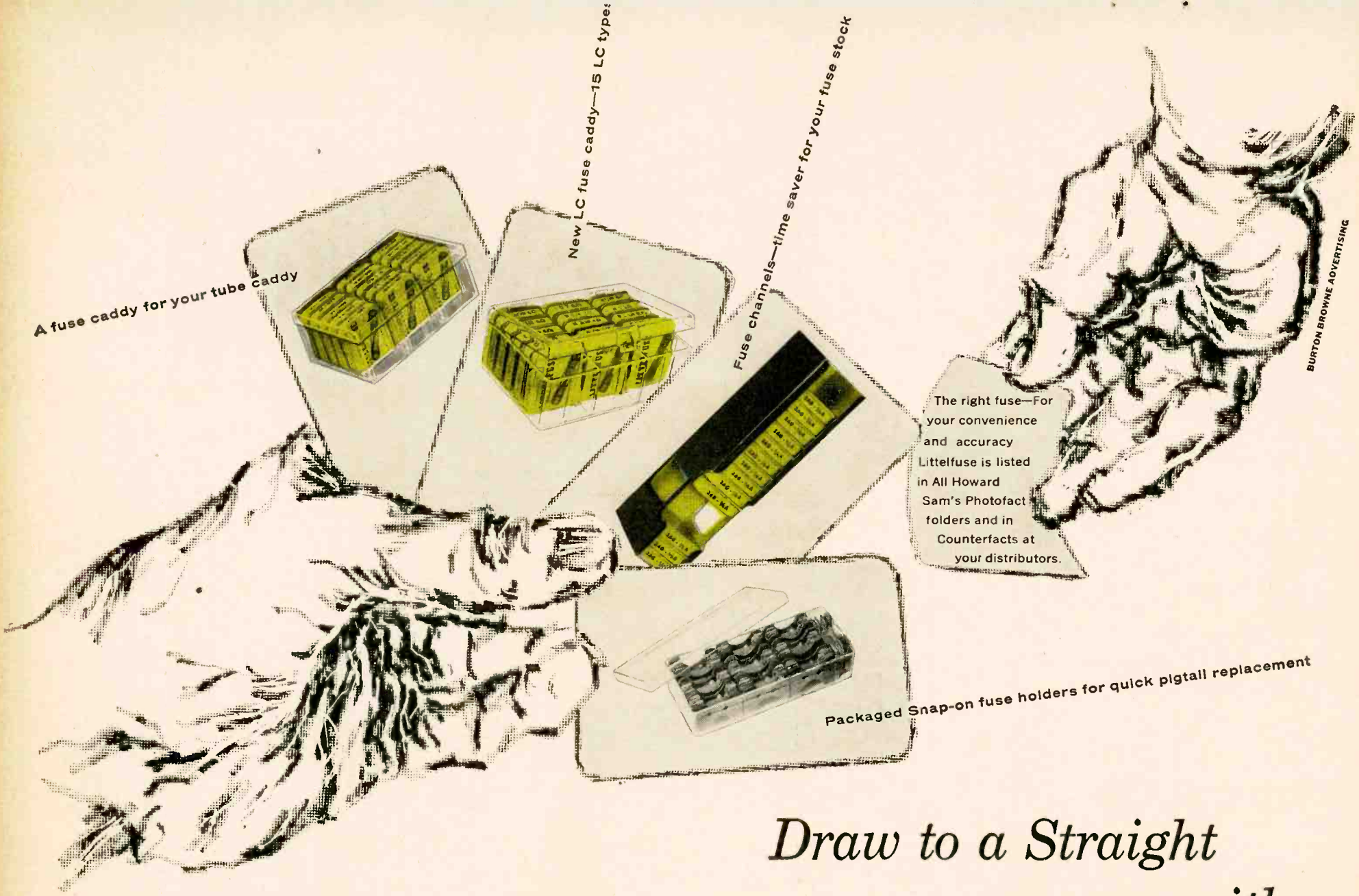


Fig. 4—Why a transformer set is safer.

Fig. 5—The 3-prong plug has a grounded terminal.



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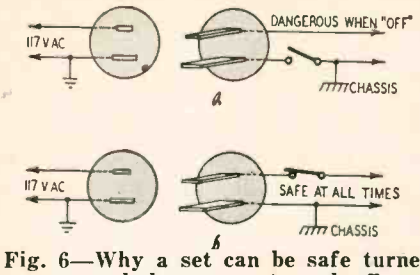

Fig. 6—Why a set can be safe turned on and dangerous turned off.

tween the negative terminal of the circuitry (normally the chassis) and the cabinet, to prevent static charges, as pointed out previously. The antenna leads may be entirely isolated from the rest of the circuitry, or may have a pair of capacitors or capacitors shunted by resistors. In the General Electric M3 —presumably the chassis involved in the Skokie accident—the arrangement is as shown in Fig. 7. Shorting of any of the capacitors can cause a hot cabinet.

More serious is the possibility of mechanical contacts. Where the chassis is held to the cabinet with screws inserted through tapped nylon inserts, a long screw may make contact with hot metal. Shorts may actually be introduced by tampering with antenna isolating networks.

One manufacturer recognized the problems of metal cabinets as long ago as the introduction of the 8-inch personal portable. Instructions to the service technician for replacing the chassis in the cabinet include:

Make sure the insulating boards have been placed in their proper positions. The boards are provided to prevent any thin metal object, which may fall or be inserted through the louvres, from coming in contact with high-voltage circuits *or from causing a short circuit to cabinet.* [Italics ours.]

More recent instructions—on current 17-inch portables—say:

The three insulating boards—one between the lower chassis and the printed circuit, another fastened to the bottom of the cabinet back and the third the disc around the fine tuning shaft must be replaced if removed for any reason. . . . A final check should be made when servicing the receiver, to insure that no loose metal object is shorting between the receiver chassis and the cabinet. (*RCA Service Data, 1957 No. T1*)

No similar warnings (other than the usual hot-chassis notice) have been found in other service data so far in-

Cause of the Skokie electrocution was a short through insulation to the 135-volt B plus lead of the television chassis, a jury of experts reported after examining the set. The connection caused a combination of direct current and the 120-volt ac supply to appear between the outside cabinet and ground, the jury stated.

Probable cause of the short was stated: "The jury believes that during the factory assembly the 135-volt direct current bus was accidentally wedged between the mounting bracket and the vertical holding control.

The probability is very great that the deceased died of shock from simultaneously contacting the TV set and the grounded metal trim of the kitchen counter top."

spected, but there is little doubt that most service manuals printed in the future will carry very definite warnings and information on proper precautions to be taken when servicing such sets.

Summary

It is possible and necessary to increase the TV and radio safety factor greatly by following a few simple precautions:

Make sure that the insulating medium provided by the manufacturer is not removed or damaged during servicing. If it is damaged, replace it.

After the set is installed in the cabinet, make a visual check, then finally a check from cabinet to a known ground with an ac voltmeter, *with the plug in both positions* in the receptacle and with the power switch *in both on and off positions.*

Make sure that isolating networks, especially in antenna circuits where they are more likely to be disturbed, are intact. The cabinet-ground test will check the capacitors in these networks.

The service technician or technical set owner may under some circumstances take further steps to insure safety:

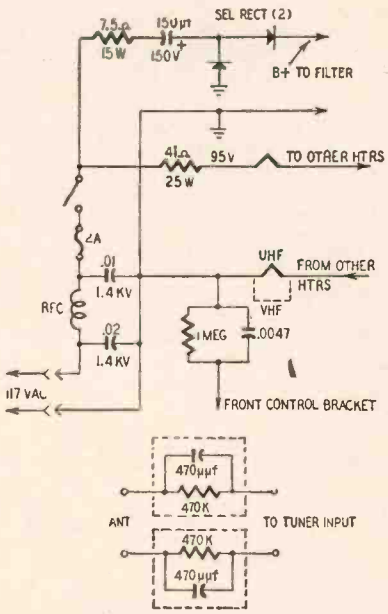

Fig. 7—Isolating networks in the General Electric M-3 chassis.

If the power switch is found to be in the hot side of the line, a two-prong polarized plug may be attached, making sure, of course, that the large prong is on the chassis side; if three-prong receptacles can be installed, a three-wire lead may be used to ground the cabinet.

Sets may be placed well away from grounded objects like radiators, bathtubs or pipes. They can also be situated well away from windows, where rain may drive in the back and temporarily short insulating boards.

Sets should be inspected immediately after any damage, such as may be caused by tipping over a portable TV stand.

Obviously, the usual procedures, such

as checking for frayed line cords, should be observed and the fire hazard should not be ignored. Check for, and replace, oversize fuses and warn against installations in poorly ventilated places.

The technician may also perform another service of considerable psychological value. On completing work on a receiver, he can give the owner a statement that the equipment has been tested and found free from shock hazard. This may be typed out on the bill. At the present time, such a statement will carry considerable reassurance to the owner and may even be of value to the technician if an accident should occur some time after the equipment has been serviced. END

REFERENCES

Cyrus Glickstein, "Don't Be a Shock Absorber," RADIO-ELECTRONICS, March, 1957, page 46.
Guy Slaughter, "Murder by Radio," RADIO-ELECTRONICS, March, 1950, page 44.

A BRUSH WITH DEATH

The greatest occupational hazard in TV servicing is the ever-present danger of a picture-tube implosion. Although it doesn't happen too often, most technicians know the hair-raising sensation when the neck of a tube cracks or snaps off.

This may happen while a chassis is being carried and the protruding neck is carelessly bumped against a door frame or in some cases during the installation or removal of a tube from a tight-fitting yoke.

In any event, the technician is usually in a precarious position and for several seconds can do little more than hold his breath and hope . . . as he listens to the tell-tale hiss of rushing air.

On one occasion, a near-victim was driving in a coupe with a 21-inch chassis and tube on the seat beside him. The speaker was resting directly behind him, near the rear window. At a sudden traffic stop the speaker fell forward and struck the picture tube.

Of course it was all over in a split second and the driver remembers nothing more than the boom of the implosion and the awareness of flying glass. When I saw him emerge from his car a few minutes later, his head was dripping blood and he staggered dazedly.

The inside of car was a shambles with broken glass everywhere, no one piece much larger than a half-dollar. The material damage was extensive: one yoke, one flyback transformer, eight tubes, one speaker, several items on the car's instrument panel and two windows. The latter, one on each side, were apparently shattered by the impact of the flying pieces of the ½-inch faceplate.

The remarkable thing is that the driver wasn't seriously injured. Within this area of bombardment he escaped with only a few superficial cuts, one being on the chin, only a fraction of an inch from the throat.—*Charles G. Buscombe*

How Far Can You Go in Electronics Without a Degree?

"Student" Fred Gunther in the IBM school

Fred Gunther has no degree. Yet, today, at IBM, Fred is a Technical Engineer working on America's biggest electronics project. His story is significant to every technician who feels that lack of formal training is blocking his road to the top.

Let's go back to 1950 and watch Fred Gunther, at 18, as he goes about the business of determining his life's work. Fred spent almost a year trying his hand at various jobs. None of these turned out to be the one that Fred wanted to devote his life to. So, still undecided about his career, Fred entered the Navy for a four-year hitch.

Fred learned something very valuable in the Service, as have many other men who eventually discover the electronics field. His aptitude tests revealed him as an excellent electronics prospect, and he received ten months' training in electronics fundamentals and radar. Upon his discharge in 1955, he was an Electronics Technician, First Class.

Something even more important to Fred's career occurred during his Service hitch. He began to hear such terms as "automation" . . . "data processing" . . . "electronic computer." "Then, one evening, while glancing through the paper," he recalls, "I spotted a story about *Project SAGE*."

What is Project SAGE?

SAGE means Semi-Automatic Ground Environment. It is part of America's radar warning system—a chain of defense that will ultimately ring our country's entire perimeter. At the heart of this system are giant electronic computers, which digest data filtered in from Texas towers, picket ships, reconnaissance planes, ground observers. The computers analyze this information for action by the Strategic Air Command and other defense units. These computers are the largest in the world. Each contains perhaps a million parts—occupies an entire city block. They are built for the Project by IBM.

Answering instructor's questions

Fred joins IBM

SAGE fascinated Fred, for it embodies the most advanced electronic concepts in giant computer work. And, when he learned that IBM would train him at full salary, plus a living allowance, to become a Computer *Units* Field Engineer, he seized the opportunity. Fred started his new electronics career in the IBM school, with twenty other technicians. He attended classes 8 hours a day. Courses consisted of some 20 subjects—computer circuitry and units, maintenance techniques—everything he would need to become a full-fledged Computer *Units* Field Engineer.

Assigned to McGuire AFB

His training completed, Fred was assigned in May, 1956, to McGuire Field, where the first of the giant SAGE computers is located. Here he assisted in the cable installation for this vastly complicated electronic giant. He helped to set up the computer, interconnect its many sections, check it out and make it ready for operation. Fred spent five months at McGuire Air Force Base, but his education was not yet completed.

Becoming a Computer *Systems* Engineer

"I like to think it was due to my interest and grade of work," Fred says, "but at any rate, last October I was invited to return to Kingston for further training—to become, in fact, a Computer *Systems* Engineer. Naturally, I was proud and pleased, for this training would give me a much greater range of understanding . . . make me more valuable to the company and myself . . . and give me a chance to assume actual engineering responsibility." Fred completed the

At the operating console of the computer

Computer Systems course. After several months of outstanding work in his new capacity, he received a *third* promotion—to Technical Engineer—in a field engineering liaison group.

What does the future hold?

What does the future hold for Fred Gunther, now that he has become a Technical Engineer? "It's hard to even set a goal in a field as rapidly moving as this," Fred says, "but with my IBM training back of me, the future sure looks good. I've advanced from Radar Technician to Computer *Units* Field Engineer to Computer *Systems* Engineer to Technical Engineer *in two years*—and received a valuable electronics education besides!"

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Practical COLOR Installation

Part II—Purity, degaussing and convergence are the key to Red and Fuzz discussion

By BOB MIDDLETON

NOW, before we get back to this degaussing routine," remarked Fuzzball, "which do you do first, purity or convergence?"

"From a practical standpoint, you should make up your mind right away which you are going to do," Red observed.

"So, how do I make up my mind?" asked Fuzzball helplessly.

"Maddening, isn't it?" Red grinned. "All you do is to start on the one that is out the farthest."

"That makes sense," Fuzz admitted, "but it gets confusing. One service manual I remember tells you to make good static convergence before and during purity adjustments — another tells you to make all the purity adjustments before going to the convergence controls."

Red stuck his tongue in his cheek. "If you listen to too many guys at the same time, you'll just make more business for the head-shrinker. In this racket you got to try to get the general idea of what it's all about."

"The way I understand it, then, is like this," Fuzzball mused, "if the convergence looks pretty decent but the purity is for the birds, I start to bring in the purity first. Then I touch up the convergence and ought to have it made."

"You're so right," agreed Red. "And of course, sometimes vice is versa. If the purity happens to look about right but convergence is cruddy, then you work on convergence to start with, and end with purity touchup, in case it seems like there is room for improvement."

"Likewise and furthermore," suggested Fuzz, "if they are both out quite a ways, you might have to work back and forth several times between them."

"Sometimes I feel like there is really some hope for you," Red remarked admiringly.

"OK, never mind the compliments," Fuzz muttered; "let's get back to degaussing."

Red inhaled a thoughtful swig of java. "Well," he said, "first you got to get a degaussing coil. Some of the screwdriver mechanics tell me you can use the ac field from a soldering gun —personally I wouldn't know anything about that."

"You got me fogged," protested Fuzz. "What's a degaussing coil?"

"Just a large air-core coil that you plug into the 117-volt ac line," Red explained. "They are stocked by some jobbers, or you can make your own."

"Could I make a degaussing coil?"

"Sure thing. Any country boy can do it. Just wind 300 or 400 turns of magnet wire—about No. 22 or 24—on a 12- or 18-inch circle and tape it up like a doughnut. Connect 8 or 10 feet of zip cord to the coil and you got it made."

"So how do I use it, in case the purity is bad on the picture tube?"

"That falls in the class of easy problems for easy boys," Red grinned.

"To listen to you," Fuzz protested sourly, "I would figure that I belong to the new generation of idiots."

"It's only one man's opinion," Red replied soothingly. "But seriously, the first thing you do is to remove the rim magnets from around the picture tube. In a Motorola set, you unsnap the magnets from their clips, and lay them aside while the tube is being degaussed. In an Admiral, you find the other type of rim-magnet arrangement—the rim magnets can be pulled back into iron cups or magnetic shunts. When the magnets are inside the shunts, there is no danger of demagnetizing them with the field of the degaussing coil."

"Suppose somebody forgets about the rim magnets?"

Red made a weak gesture. "As Confucius say, 'You have had it.' You will take so much magnetism out of the rim magnets that they won't do a job anymore."

"OK," agreed Fuzz, "I'll remember about the rim magnets. So how do I use the coil?"

"First try degaussing the tube from the front. Plug the coil into an outlet and hold it square in front of the screen for 20 or 30 seconds. Then back off slowly. When you are 6 or 8 feet away from the receiver, you can unplug the coil."

"Why this slow backing away before the coil is unplugged?" asked Fuzz with a puzzled look.

"Well, when you unplug the coil, there's going to be a spark at the contacts and a surge through the coil. It could leave the tube magnetized worse than when you started. You have to get far enough away that the surge won't affect the tube."

"Should the set be turned off?" asked Fuzz.

"Doesn't have to," replied Red, "although it could be called good practice. If you have the set on, you'll get a color pattern on the screen that's out of this world, in case you're the curious type."

"Then I recheck the purity?"

"Yep. Usually, the first treatment does it. In some cases, the tube or the tube shield or the chassis itself gets magnetized in a spot where the first treatment doesn't get it."

"What do I do when the ball bounces in that direction?"

"Well, then you have to get the degaussing coil down around the sides of the tube, and maybe under the chassis, too. But when you are working back on the tube, be sure to remove the beam magnets, lateral corrector magnet and purity magnets while you're using the coil. If you demagnetize them and have to come back to the shop for replacements, the boss will chew you out but good."

"I see where you got to use the coil with discretion," Fuzz admitted.

"You said a mouthful," Red agreed. "Just get careless once and lay the coil

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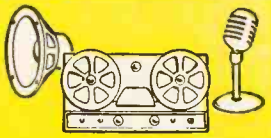

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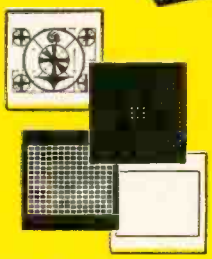

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near a meter, and you're in hot water. That meter will read low and can't be used until it goes back to the factory for repair."

"How does a picture tube get magnetized, anyhow?" Fuzz asked.

"Lots of ways. Some guys forget and use magnetized tools around a color set. If you get screwdriver-happy, you'll have a degaussing job right away. Sometimes a guy forgets and lets a PM speaker get close to the picture tube. Some meters have an external field that causes trouble if the meter is rested on the tube or shield. Then, there are cases that you just can't tie down—the set has been running OK but the purity gradually gets out and can't be adjusted unless a degaussing job is done."

"I reckon I ain't too sharp, but I'm hep," Fubb remarked. "Then what comes after the purity adjustments?"

"Can't figure whether you're bragging or complaining," Red replied. "But we ain't quite through with this purity deal yet. In most cases, the green and blue fields will come in OK after you get good red purity. You will find cases though where you may have to compromise a little in purity adjustments for the three fields."

"How do you compromise?"

"Well, you work back and forth between the three fields and always favor the red as much as possible. The customer will be most critical of the flesh tones because the actors carry the action and their faces are the center of attention. That's why you should balance the purity in favor of the red field, when necessary."

Fuzz pulled a bottle of aspirins out of his pocket and handed it to Red. "Have two," he offered; "they're small."

"It isn't really that bad," Red replied. "There's headaches all right, at the start, but when you get enough practical experience this color setup is a breeze."

"What else should I know about the purity adjustments?" asked Fuzz.

"That's about it. As a final check, balance up the three screen controls for a neutral gray raster and see if there is any tinting anywhere on the screen. If you see any you will know that you slipped a little somewhere along the line. Sometimes, when the tinting is very minor at this point, you can make the final purity touchup on the gray raster without going back to the individual color fields."

"Then we get with the convergence," Fuzzball suggested.

"Well, this is where you come to the pièce de résistance, as you might say. For the first few days, you're going to figure that color TV is a comedy of errors, and wonder if you have all your buttons."

"I'm listening."

"OK. It's easy enough to get good convergence in the center of the screen by adjusting the three beam magnets and the lateral corrector. Getting convergence at the top and bottom and

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Using the degaussing coil on a color TV installation.

sides of the screen is a horse from a different garage—this is where the dynamic convergence controls come in."

"So I turn on the white dot generator now."

"Reet. And make blame sure that the generator is synced in at 15,750 cycles."

"Why is that so important yet?" Fuzz asked.

"Simply because the horizontal phasing coils are turned to resonance with the horizontal sweep frequency, as I will explain. Obviously, if your white dot generator is locking in a hundred cycles or so off frequency, you will mistune the horizontal phasing coils—you can converge the picture tube but, when you tune in a black-and-white program, the tube will be out of convergence on the left- and right-hand sides and the customer will complain about rainbow fringing."

"I see what you mean. Then I'll go bats doing the dynamic convergence all over again."

"That's it," Red agreed. "A guy could end up in a padded cell."

"So how can I be sure the white dot generator isn't a white elephant generator?"

"Well," said Red, "there are several ways. Some generators have horizontal sync and some don't. If the generator doesn't have sync, you have got to supply sync from a black-and-white station transmission—the instruction book for a generator of this type explains how to do this."

"But," suggested Fuzz, "if the dot generator has its own sync, I have nothing to worry about."

"Not if you use your head for something besides a hat rack," agreed Red. "You will find that some generators provide a crystal-controlled sync oscillator and you have nothing to check out. Other dot generators use a vfo sync oscillator with a control on the instrument panel for setting the sync frequency."

"Is it a job to set the sync to the right frequency?" asked Fuzz.

"It's easy enough," Red replied, "if you watch the screen pattern while you're adjusting the sync frequency. All sets have at least a trace of 60-cycle hum in the circuits and when the vertical sync is zero-beat with the power line, there is no writhing or movement in the dot pattern. But, if the vertical sync is not zero-beat with the power-line frequency, you'll see more or less snaking in the pattern."

"Clue me in here," Fuzz protested. "We started talking about setting the horizontal sync frequency in the generator and now you talk about the vertical sync rate."

"It's simple enough," Red explained. "The horizontal sync and vertical sync in this type of generator are locked together—if one is right, the other is correct too."

"I got you now, Red. The station operates its own vertical sync in step with the power-line frequency, I heard somewhere."

"You heard right," he agreed.

"What size dots are best?" Fuzz asked next.

"Frankly, I can't answer that one," Red admitted. "So much depends upon the particular situation and personal preferences. On some of these color sets. you have to make some or all of the convergence adjustments from the rear, using a mirror in front on the screen."

"That's where large dots will come in handy," Fuzz suggested.

"As a matter of fact, you may not be able to see small dots at all in a mirror, unless you darken the room like the inside of a cow. You better have a pretty good mirror, too."

"Guess though, if I had a helper along in a case like that, he could tell me how the pattern looks from in front," Fuzz remarked.

"Only after you have both had plenty of experience," Red shot back. "Otherwise you will find out quick that you are not talking each other's language."

"Small dots would give you a more accurate check on convergence, wouldn't they?"

"They'd tend to," Red agreed. "Don't forget too, that it will be a cold day in July when you get a picture tube 100% converged. The trick is to know when to stop."

"When would that be?" Fuzz asked.

"Well, as a general rule, if you can't see any misconvergence when you are 5 feet back from the screen, you probably have convergence about as close as you are going to get it."

"Suppose the customer complains, though, about not having 100% convergence?"

"We have an almost irresistible urge to shoot him right at the beginning," Red advised him. "I generally put his name on the stink list, and tell him I'm all booked up the next time he calls."

"Not to get off this fascinating subject of customer beefs," Fuzz said, "but I been hearing a lot about white crosshatch for convergence. What's the scoop?"

"Well, I like it for at least certain parts of the job," Red replied. "However, I can get along very nicely with white dots only. Seems to be partly a matter of opinion, I would say."

"I know that we have juggled with at least a dozen dynamic convergence controls," Fuzz remarked. "Where do I start?"

"We covered the beam magnets and the lateral corrector for center-screen convergence," Red replied, "and the main thing to keep in mind here is that these static convergence controls, as they are called, produce exactly the same motion of a color dot at any point over the entire screen."

"Then the dynamic controls cause nonuniform dot motions," Fuzz suggested.

"That's what they do. The first rule is to keep the three color dots converged at all times in center screen while working the dynamic controls to bring in the dots around the edges of the screen."

"I smell something here," Fuzz announced. "Do you mean that the dynamic adjustments will interact with the static adjustments and throw the convergence out at center screen?"

"You are so right," Red replied. "Convergence is a matter of continual back-and-forth adjustments. That's one of the reasons why it eats up so much time."

"Clue me in a little more on these dynamic controls."

"Well, you have the dynamic group for vertical—usually six controls. Then you have the dynamic group for horizontal—again usually six controls. In some cases you may also have a couple of yoke balancers for final touchup."

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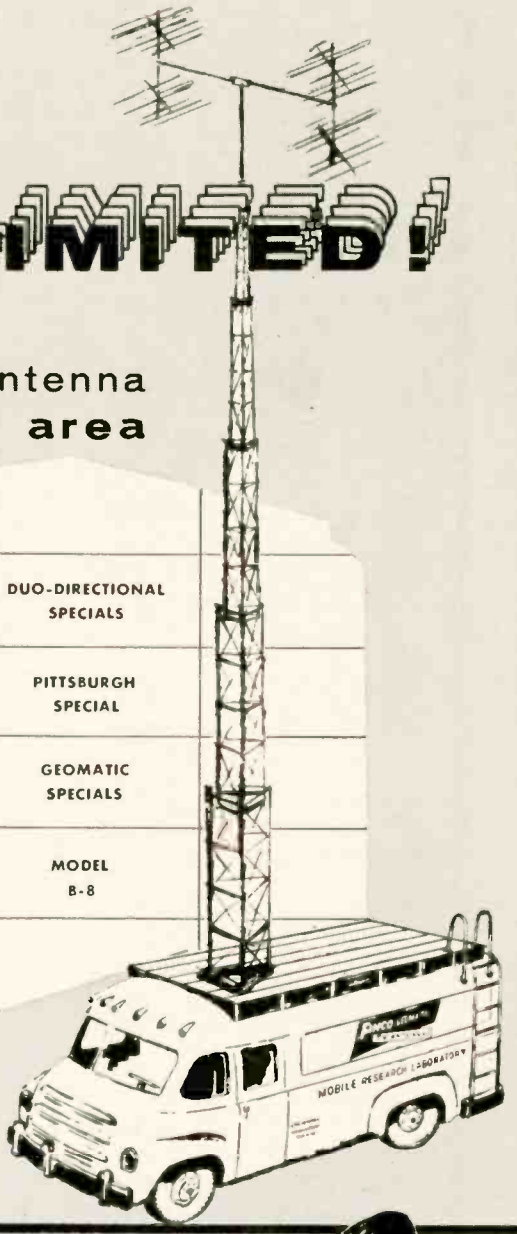
MODEL B-7	FRONT-TO-BACK SPECIALS		



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Form No. 20-199

TELEVISION

"Which do I start in with first?"

"It's customary to start vertical dynamic convergence first. You pick out a column of dots down the center of the screen and start making vertical dynamic adjustments to converge this column of dots—forget the others."

"Why do we work on just the center column of dots?"

"Simply because convergence at the left- and right-hand sides of the screen is affected much more by the horizontal controls, and you will go all around the mulberry bush if you pay any attention to them at this point in the procedure."

"I see," said Fuzz. "How about filling me in on the vertical controls?"

"Well, we have them grouped into red, green and blue controls. We have a tilt and an amplitude control for each color—total of six."

"They interact with each other?"

"Unfortunately, yes. You will seldom be able to make a final adjustment once and for all on any one of these controls," Red observed.

"Now, judging from the names, I guess the tilt controls will make the column of color dots slant one way or the other."

"You're partly right," Red agreed, "but you're partly wrong, too. The red and green tilt controls produce some slanting or tilting of the dot column, but the dot motions are complex and there is more than tilt in the movement. Moreover, the blue tilt control has no tilting action whatsoever—it changes only the relative spacing of the blue dots."

"This is intriguing," Fuzz commented. "Do you figure that color TV will ever get off the ground?"

"It is off the ground, buddy," Red replied somewhat sharply. "I can play the violin, too. You and I are up against the maintenance of color sets in the field right now."

"I ain't giving you any static, Red," Fuzz apologized; "I'm confused."

"Everybody gets confused in this racket until they get some practical experience. You remember the first black-and-white set you worked on."

"Amen," Fuzz grunted.

"Now to get back, the amplitude controls adjust the amount of parabolic current flowing through the convergence coils, and the tilt controls adjust the amount of sawtooth current in the coils."

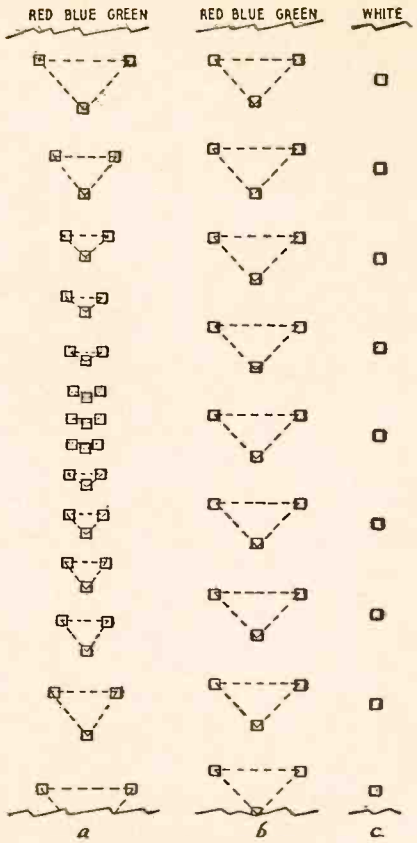
"What does that mean in English?"

"Practically, what you do is to work back and forth on the amplitude and tilt controls to get the red and green dots in parallel columns, because they can then be brought into a straight single vertical column with the beam magnets."

"What about the blue dots?" asked Fuzz.

"We don't have to even look at them, if we don't want to, while we are lining up the red and green dots. In fact, some techs cut off the blue gun during this time."

"You mean that the blue dots will come in OK once the red and blue dots are straightened up?"



Vertical dynamic convergence of one line of dots: a—pattern when starting; b—red, blue and green dots lined up in parallel columns; c—convergence completed, only white dots can be seen.

"Right. The blue dots always line up straight in a vertical column because of the mounting of the convergence pole pieces. And since the green and red dots must line up straight in a vertical column when they are adjusted to be parallel, we don't have to worry about the blue dots to start with."

Fuzz scratched his head a moment. "So it looks like the final adjustment will be work with the blue vertical amplitude and tilt controls to bring them into convergence with the yellow dots."

"That's the general idea," Red agreed. "Remember, you have to touch up the beam magnet adjustments while you are doing this. You will also find that every time you make a considerable adjustment of the blue controls, you will probably have to go back and make a little touchup on the red and green controls."

"I'm kind of shook up," Fuzz announced, "but I'm still game. What next?"

"That pretty much ties down the vertical convergence until after the horizontal convergence has been made. Then you will probably have to retouch the vertical controls."

"Before we go ahead," Fuzz suggested, "I think we owe ourselves another coffee."

Red held up two fingers. "Garçon, draw two."

TO BE CONTINUED

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TV Service Clinic

conducted by

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PICTURE analysis is one of the most useful tools in troubleshooting color TV receivers. Every distortion in picture reproduction has a reason behind it and, if you are on your toes, a lot of time which would otherwise be wasted in hit-and-miss approaches can be saved.

Here are some of the more basic elements of color picture analysis:

Horizontal rainbows

Each rainbow shows that the color subcarrier oscillator is 60 cycles off frequency. Thus, a picture with one horizontal rainbow shows that the color subcarrier oscillator is running 60 cycles above or below 3.58 mc.

A picture with two horizontal rainbows shows that the oscillator is running 120 cycles above or below 3.58 mc.

Let's consider the single horizontal rainbow. If the oscillator is exactly 60 cycles off frequency, the rainbow will stand still. But if the oscillator frequency is slightly less than 60 cycles, the rainbow drifts downward. On the other hand, if the oscillator frequency is slightly higher than 60 cycles, the rainbow drifts upward. Here's why:

When the oscillator is exactly 60 cycles off frequency, the oscillator returns to its starting phase at the beginning of each vertical scan. In other words, the rainbow repeats itself exactly at the beginning of each vertical scan—the rainbow stands still.

But when the oscillator frequency is slightly lower than 60 cycles, the rainbow is a bit incomplete at the end of the vertical scan and is completed only after a portion of the next scan has been completed—the rainbow thus drifts down the face of the picture tube.

If the oscillator frequency is slightly greater than 60 cycles, the rainbow develops faster, and more than completes itself in one vertical scan. For this reason, the rainbow drifts up the screen.

As the oscillator frequency goes up, the rainbow drifts up faster and faster until we cannot see it any more and the color seems to have dropped out of the picture—when red, green and blue flash past our eyes at a speed greater than the persistence of vision, the colors blend into a gray.

When the oscillator frequency becomes still higher and approaches 120 cycles, we see two rainbows drifting down the screen. At exactly 120 cycles above 3.58 mc, the two rainbows stand still. A slight increase in oscillator frequency, and they start to drift upward.

Thus, by counting rainbows and observing their drift, we can quickly determine how many cycles the oscillator is off frequency, and whether it is higher or lower than burst frequency.

Match Gonset line

What is the best way to match 450-ohm Gonset line to 300-ohm ribbon? One manual says to split the Gonset line, tapering it down to the 300-ohm line over a span of 30 inches or more. This is difficult and slow.—R. L. B., Bluefield, W. Va.

This is a good question (and we like 'em!) because it brings out some of the practical considerations in impedance matching which are sometimes overlooked. In the first place, you are working with a SWR (standing-wave ratio) of 1.5 to 1, on the basis of nominal impedance ratings. This is splitting the old hair a bit thin, for the following reasons:

1. Some 300-ohm ribbon line does have a characteristic impedance very close to 300 ohms. But, on the other hand, some of the stuff measures much higher or much lower. If you want to be sure of what you are trying to match to what, better get a really good sweep generator and check the lines

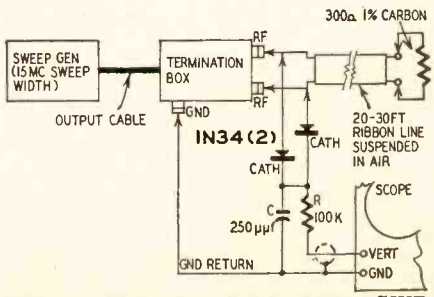

Fig. 1—Method of checking SWR. Ground return lead carries rf currents and must be kept very short.

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The Turntable That Changes Records

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The arm is a one-piece, spring-damped, counter-balanced unit which will take any standard high fidelity cartridge. It is free of any audio spectrum resonances. It permits the last record to be played with the same low stylus pressure as the first. Between the top and bottom of a stack of records there is a difference of less than a gram in tracking pressure as compared with 4 to 8 grams on conventional changers. Vertical and horizontal friction are reduced to the lowest possible level. These qualities, found only in the Collaro Transcription Changer, insure better performance and longer life for records and styli.

In its superb performance, the new Collaro Continental, Model TC-540, meets the rigid requirements for high fidelity equipment. Here, for the first time in a changer is professional quality at a record changer price. The Continental is $46.50. Other Collaro changers are priced from $37.50 up. (Prices slightly higher west of the Mississippi.)

In addition to the new tone arm, the Collaro Continental features include: 4 speeds, manual switch for turntable operation; wow and flutter specifications — 0.25% RMS at 33⅓ RPM — superior to any changer in the world; automatic intermix; automatic shut-off after last record; heavy duty 4-pole, shaded pole induction motor; heavy rim-weighted balanced turntable; muting switch and pop-click filter for elimination of extraneous noises; jam proof machinery; pre-wiring for easy installation; attractive two-tone color scheme to fit any decor; tropicalization to operate under adverse weather and humidity conditions; easy mounting on pre-cut board or base; custom testing at the factory for wow, flutter, stylus pressure and correct set down position.

FREE: Colorful new catalog describes complete Collaro line. Includes helpful guide on building record collection.

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with a series demodulator probe (see Fig. 1) against precision (1%) carbon resistors. You may possibly be surprised when you find out what you are trying to match to what.

2. Even if you find that you are really concerned with matching 300 ohms to 450 ohms, how about the SWR in the rest of the system? That is, if you sweep each terminated section of the system, do you find SWR's in the order of 1.2 to 1, or perhaps more like 3 to 1 or 5 to 1? It is only logical to make certain that we are not swallowing a camel, while gagging at a gnat. Fig. 2 shows the extremes of patterns encountered in SWR tests.

When the trace touches the zero-reference line, as in Fig. 2-b, the SWR is infinite. That is, any peak voltage divided by zero is infinite.

You will obtain this pattern when the end of the line is open or when it is dead shorted. However, the phase of the null shifts, of course, along the base line for a short, as compared with an open.

To measure SWR, we divide the maximum voltage (or current) by its minimum value, as shown in Fig. 3, taken from the AARL Handbook. When the minimum is zero, we have an infinite SWR.

When you are working on a very long section of line, the loss is appreciable. This can also be measured. Short the end of the line and then note the voltage by which the pattern *fails* to touch the zero-volt reference line. This amount is *double* the line loss.

On short lines, such as 20 or 30 feet, we can't even see the loss, and we forget about it. The pattern is given purely in terms of VSWR (voltage standing-wave ratio).

A dc scope is as useful as a zero-volt reference line from a scope because the resting position of the beam with no signal applied shows us the zero-signal level, which can be drawn on the screen with a wax pencil.

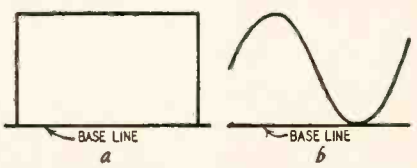


Fig. 2—a, Rectangular pattern shows perfect match of line to load; b, sine-wave pattern touching base line shows complete mismatch—dead short or wide open.

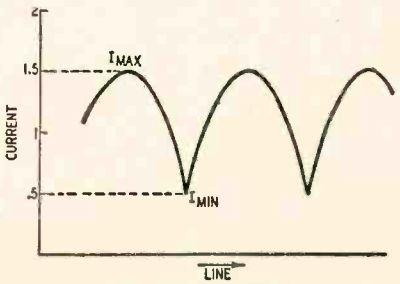
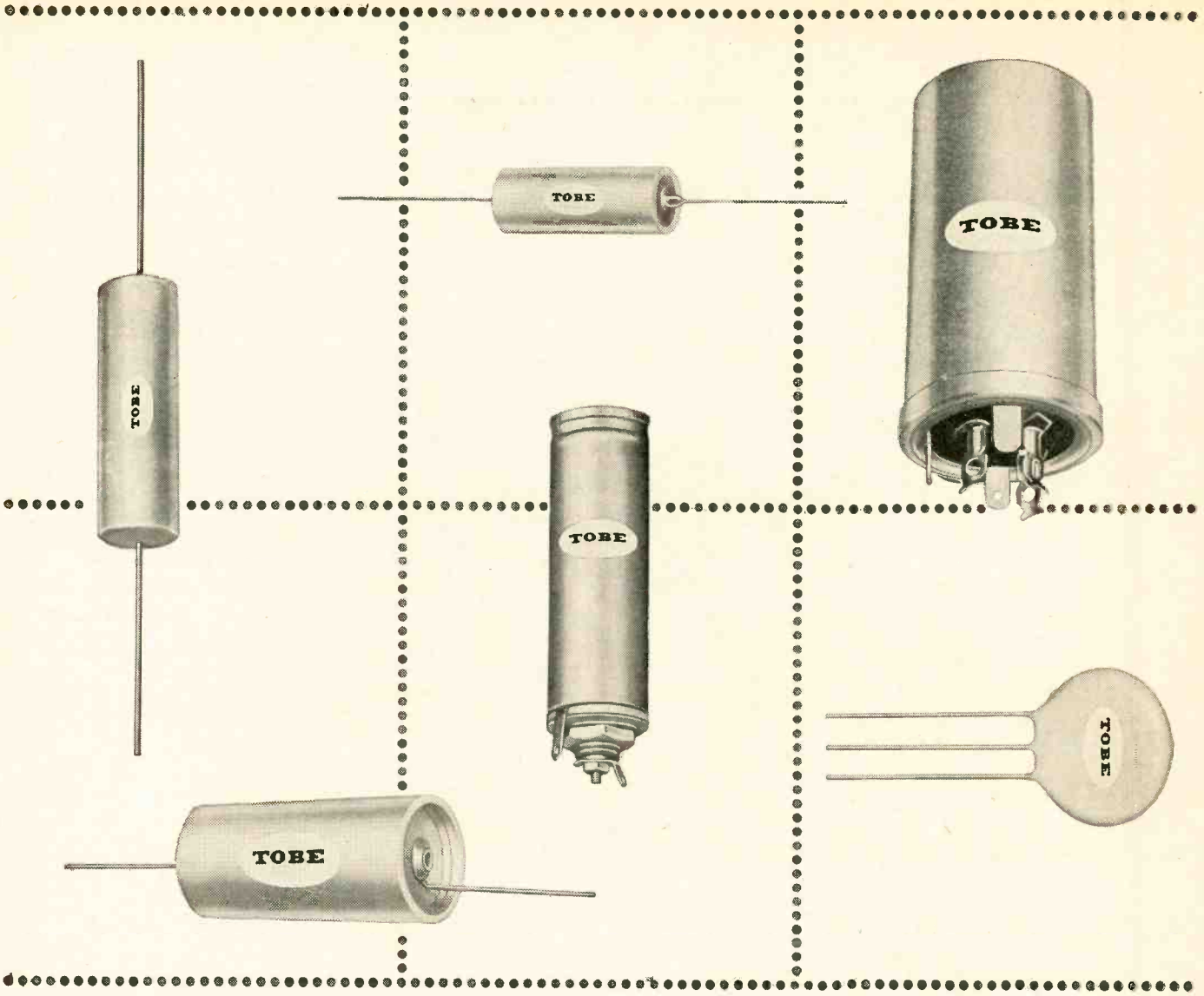


Fig. 3—Measuring SWR: I_{max} is 1.5 and I_{min} is 0.5, so SWR equals I_{max}/I_{min} = 1.5/0.5 = 3 to 1.



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TELEVISION

The center frequency of test depends on the frequency you are interested in. It might be channel 2 or 13 or 75. The sweep width of the generator should be sufficient to throw a maximum and a minimum on the screen. Otherwise, the tuning dial of the sweep generator can be rocked a little back and forth, to run both onto the pattern.

If we find that this 1.5-to-1 mismatch is our camel, it is quite possible to bag the beast. The method of matching the 450-ohm line to the 300-ohm line depends upon the particular channel or channels to be accommodated.

In case several channels are to be received, the instruction to split the Gonset wire line and to graduate the spacing down to that of the 300-ohm ribbon is the most practical solution.

However, if only one channel is to be received, you can make up a quarter-wave matching section which is mechanically more convenient than a tapered line.

The impedance of the matching section should be 365 ohms, which can be obtained by using No. 12 wire spaced 1 inch between centers. The length of the matching section must be equal to a quarter wavelength of the picture carrier on the desired channel.

For general tests, I have found the RCA WR-59 sweep generator hard to beat. The output is acceptably flat, the output cable is terminated with a center-tapped load which greatly facilitates use of the double-ended demodulator probe, and there is enough output voltage on the high channels that you can really work with it.

SWR and impedance-matching tests are difficult or impossible with many sweep generators which are highly touted by their manufacturers. One of the hidden faults to be guarded against is the presence of spurious frequencies in the output which can vitiate the test. For example, if we are checking an rf tuner for match on channel 7, and the sweep generator has strong spurious outputs on channels 2 and 13, our test is little more than a farce.

Few technicians seem to realize how essential a really good sweep generator is for the accomplishment of any serious test work.

High B plus

I replaced the focus-coil circuit in an Olympic 766 with an equivalent resistor and PM focus control to correct a condition of too high voltage from the B-plus power supply. This did not have any effect on the voltage, which still remains about 70 volts too high. The resistor is a variable wirewound type and, no matter where the slider is set, the voltage remains the same.

Lifting the B-plus lines off the bleeder also has no effect on the B-plus voltage. Is the trouble in the power supply?—A. J. K., Milwaukee, Wis.

The fact that you can lift the B-plus lines off the bleeder with no effect on the supply voltage suggests that the bleeder is open. If the bleeder has con-

tinuity and normal resistance, there must be some change (at least a little drop) in the voltage value when the bleeder draws current from the supply. I would suggest that you check the bleeder for an open circuit before proceeding further.

Long-range reception

My problem is I am trying to receive channels 9 and 11 at a distance of 105 miles from New York. Here in Philadelphia we have a powerful station on channel 10. I can receive 10 without any antenna at all. Hence, the chief problem is to keep channel 10 from interfering with the weak signals on 9 and 11. Should I use a double-stacked traveling wave or a 10-element Yagi cut to 9 and 11? Also, is a booster really helpful, or does it just boost the noise?—V. D., Philadelphia, Pa.

You may find that you will have difficulty in trying to receive channels 9 and 11 from New York with any type of antenna since you are receiving 10 without an antenna. Adjacent-channel traps may be insufficient in this case, and you may have to enclose the chassis in a screen box.

Any unbalance in the lead-in can also be very troublesome in a case like this, and you may find it advisable to use shielded 300-ohm ribbon lead. The outer braid of the lead-in is grounded to the screen box.

A double-stacked traveling-wave antenna would ordinarily be a good choice, although in this particular situation its high gain on channel 10 could work against you. The fact that 10 is not in line with 9 and 11 in your location does give you a certain advantage in the front-to-back ratio of the traveling-wave antenna. An experimental installation would be required to determine if the available rejection would be adequate.

A Yagi cut to 9 and 11 can be designed to have a deep dip through 10 and, if used with shielded ribbon lead and possibly a screened chassis, would seem to be the most conservative selection in your particular situation.

A booster will give you a definite advantage if it is installed at the antenna and if the booster itself has a low noise figure. The cascode type of booster is one of the types with low noise. Any booster installed at the receiver end of a long down lead will have to contend with the line noise, which may be appreciable. To make certain that you are getting the maximum signal-to-noise boost, it is advisable to make the installation at the antenna terminals.

Vertical nonlinearity

I have a Crosley model H-21COWH receiver that has a bright horizontal stripe moving up across the picture. It is almost ½ inch wide and other than this the entire picture is fine. I have replaced the vertical linearity control but this did not help. All capacitors and resistors have been checked

and none are bad. I also replaced the vertical output transformer but this gave no improvement in the linearity. Varying the linearity control changed the width of the horizontal line a little, but not nearly enough. The output of the vertical oscillator looks good on my oscilloscope and so it appears that the trouble is in the vertical output stage. But I am at a loss as to what the trouble might be.—T. F., Orlando, Fla.

The symptoms you describe point very strongly to 60-cycle interference in the vertical output stage. I assume that you have replaced the 12BH7 output tube and we can most likely eliminate heater–cathode leakage as the cathode of the compressed lines or nonlinearity. The vertical movement of the bright horizontal line is due to the fact that your local power line is not synchronized with that of the transmitted sync pulses. This trouble is not unusual in this chassis, and in a synchronous area the horizontal bar will remain stationary.

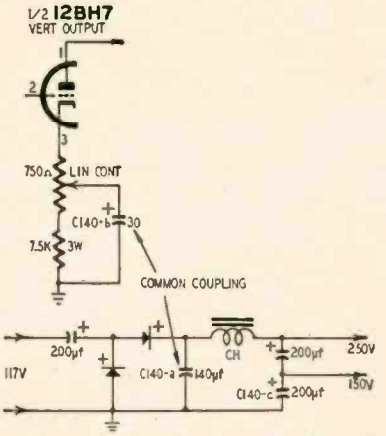

Fig. 4—Leakage between units of a multiple-section capacitor in half-wave doubler and video cathode bypass causes 60-cycle interference and one white bar.

The cause of the trouble is the common coupling between sections a and b of C140 (Fig. 4). Section a introduces a power supply component into the vertical sweep output circuit. This condition can be corrected simply by clipping the lead from C140-b and connecting a new 30-μf capacitor rated at 150 volts. As long as you are making this change, if your area is subjected to appreciable variations in ac line voltage, use a larger capacitor of about 80 μf. This will minimize changes in vertical linearity at the top of the picture caused by line-voltage fluctuations.

END

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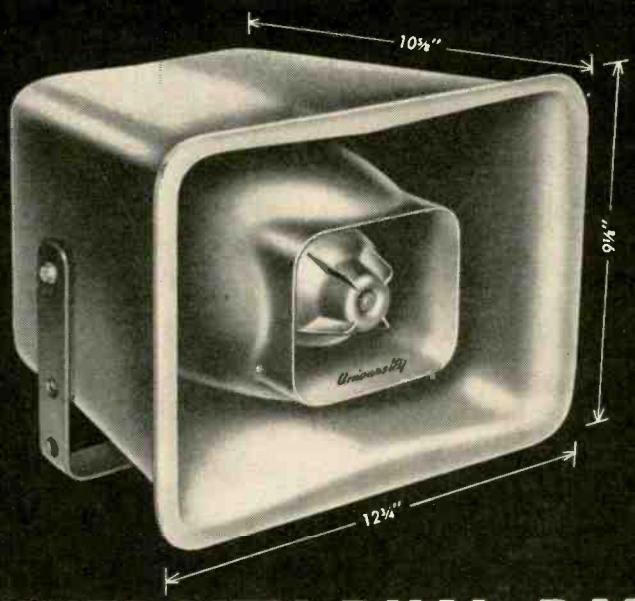

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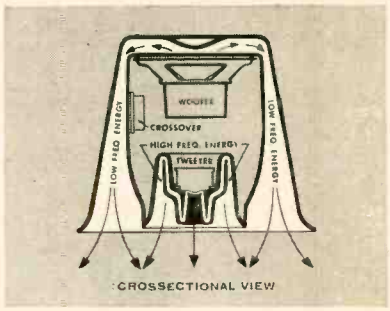

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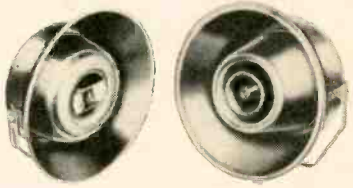
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MODERN FLYBACK CIRCUITS

A better knowledge of how the three main types operate can simplify some of your service problems and eliminate others

By JESSE DINES*

THE several variations of high-voltage and horizontal deflection systems used in TV receivers include the rf, isolation-transformer, autotransformer and direct-drive arrangements. All of these (except the rf) perform the same basic functions—production of sawtooth sweep current for the horizontal yoke coils, boost voltage for the horizontal output and other stages, high voltage for the second anode of the picture tube, filament voltage for the high-voltage rectifier. Flyback systems may also be designed to provide any, or a combination, of the following: agc pulses, afc pulses, horizontal blanking pulses, horizontal linearity control, picture width control, horizontal centering. All functions of the system occur simultaneously.

The rf supply (high-voltage system) was used extensively with 10- and 12-inch picture tubes prior to the advent of the 630 chassis. In this system an rf oscillator supplies energy to a separate transformer which produces the high voltage for the picture-tube second anode. The disadvantages of this system are the interference created (due to oscillator radiation) and the relatively great number of component parts. This led to its early extinction.

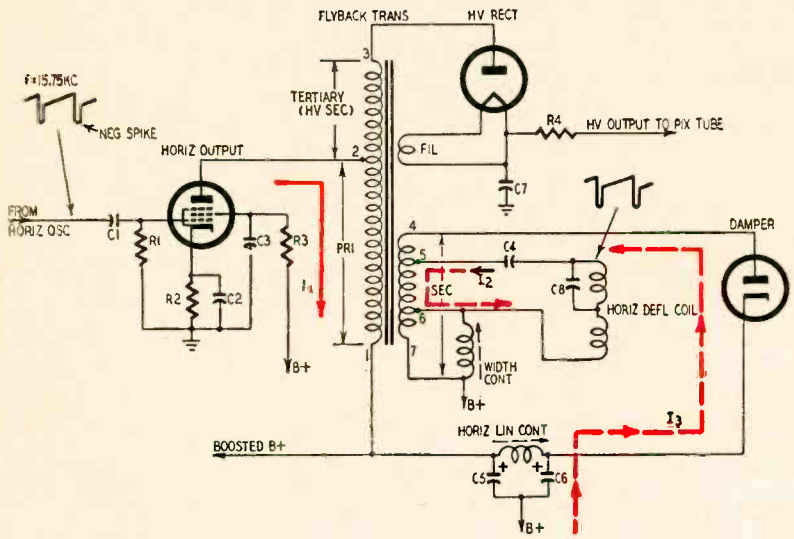

Fig. 1—Typical flyback circuit using isolation transformer.

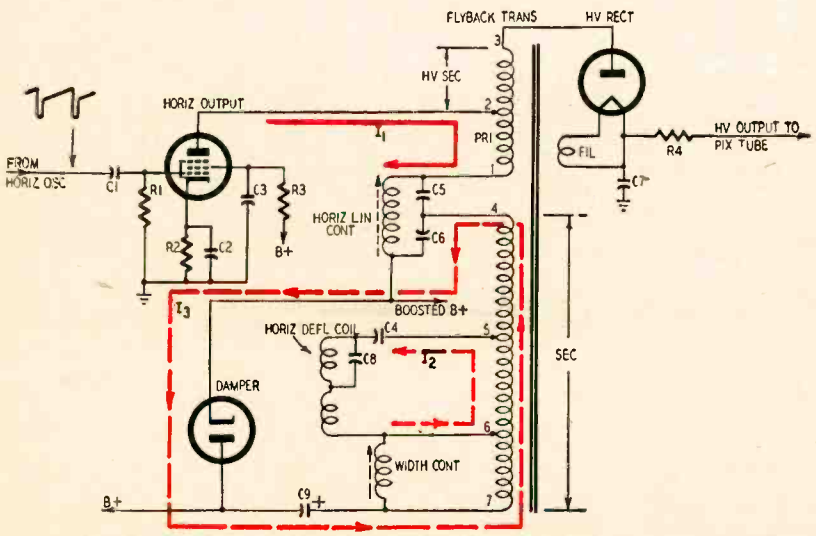

Fig. 2—Horizontal sweep circuit using an autotransformer.

Isolation type flyback

This circuit (Fig. 1) made its appearance with the 630 chassis and is still used in some of the very newest TV sets. The horizontal output tube supplies voltage pulses to the flyback transformer. The flyback transformer matches the relatively high impedance of the horizontal output tube with the low impedance of the horizontal yoke and provides additional windings and taps to connect other components such as the width coil. Pulses appearing across the 1–3 winding are rectified by the high-voltage rectifier tube which supplies a high dc voltage for the picture tube. The horizontal yoke provides sweep current for deflection. Spurious oscillations which occur in the yoke circuit are removed by the damper tube. The width and linearity coils control picture width and horizontal linearity, respectively.

*Author *Servicing TV Sweep Systems* (H. Sams).

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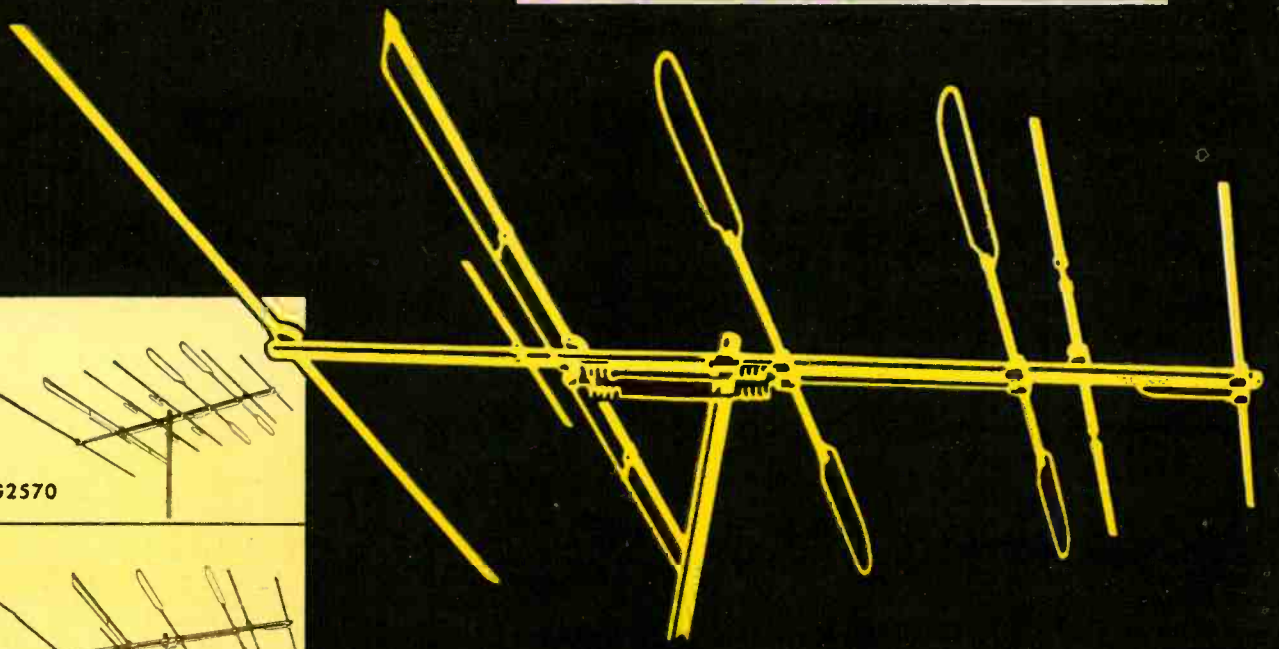

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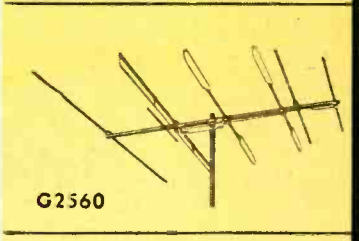

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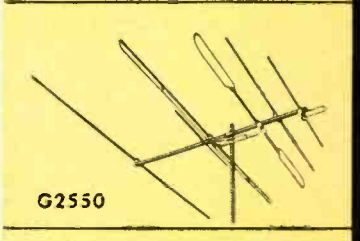

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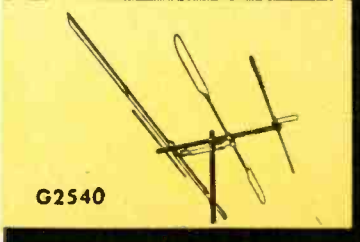

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C1–R1 form the input coupling network and C2–R2 the cathode bias network for the horizontal output tube. C3–R3 are the screen grid coupling capacitor and dropping resistor, respectively. C4, C5 and C6 are the yoke dc blocking, resonant (with linearity coil) and boost capacitors, respectively. C7–R4 form the filter network for the rectifier tube.

During the latter two-thirds of the sweep portion of the input to the horizontal output tube, the tube conducts and current I_1 flows in the primary of the flyback transformer. The sawtooth yoke current I_2 develops due to transformer action. The negative spike of the input signal cuts off the horizontal output tube sharply and the entire flyback circuit, since it is not being loaded down now by the tube's conduction, breaks into oscillation at 70–90 kc. The first negative half-cycle of oscillation appears across the secondary and is transferred back to the 1–3 winding; it is rectified and used to obtain the high-voltage output of the system.

The next positive half-cycle of oscillation (as well as all other positive halves) appearing across the secondary causes the damper tube to conduct (I_3), charging boost capacitor C6 with the indicated polarity. In about one-third of the trace time C6 charges to the peak voltage appearing across the secondary. The damper cathode becomes positive enough, with respect to its plate, to cut the tube off. After one-third of the horizontal trace the horizontal output tube conducts and the cycle repeats.

The boost voltage which appears from pin 1 of the flyback to ground results from the charge across C6 and the B-plus voltage in series with it.

The linearity coil and C5 resonate at about 15,750 cycles. This alters the instantaneous plate voltage of the horizontal output tube which, in turn, affects the horizontal linearity of the picture. The width coil is a power-absorbing device. That is, its inductance (variable) changes its impedance and the current flowing through it. The greater the current flow through it, the less the current available for the flyback system the narrower the picture width; the converse is also true.

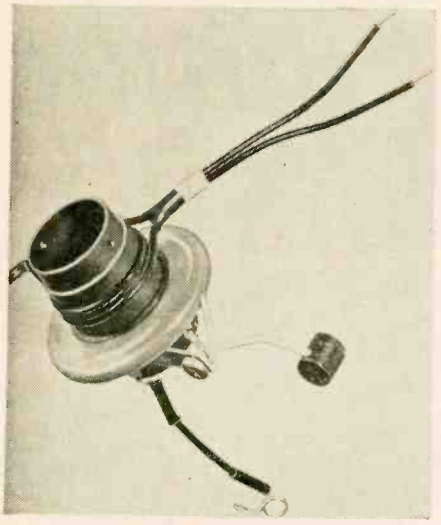
Autotransformer flyback

The basic circuit is shown in Fig. 2. In comparing this with the isolation type it is seen that both circuits are practically identical. (The same symbols and pin numbers are used for the corresponding component parts.) In fact, it would appear at first glance that the only difference is that the 4–7 secondary winding in Fig. 1 has simply been repositioned so that it lies directly below the primary winding. However, the basic difference is that in the autotransformer the B plus is applied to the damper tube plate instead of directly to the secondary winding. (This is necessary to permit I_3 flow through the damper tube, as shown.)

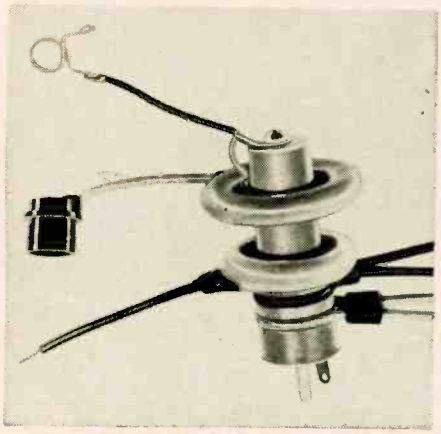
C9 is added in the circuit to permit the ac conduction of I_3 and to prevent dc from being applied directly to the 4–7 winding of the flyback. Boost capacitor C6 charges as shown. The boost voltage appears from the damper cathode to ground, which includes the charges across C6 and the B-plus supply (and C-9) added to each other.

Current I_3 flows from pin 7 to 4 of the flyback and in Fig. 1 (the isolation type circuit) it flows from 4 to 7, making the polarity across the winding opposite for both types of circuits. This does not alter the operation of the flyback circuit, as was explained previously, but merely makes the waveforms and polarity of the autotransformer secondary winding 180° different from that of the isolation type.

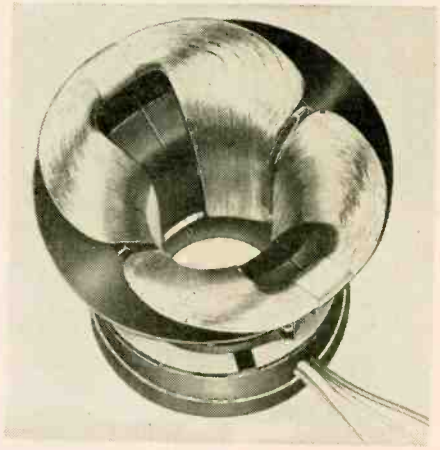
The advantage of the autotransformer sweep circuit over the isolation type is its greater operating efficiency, by virtue of the closer coupling between windings and the increased turns ratio between primary and secondary (for the same given number of transformer turns). For this reason, practically all

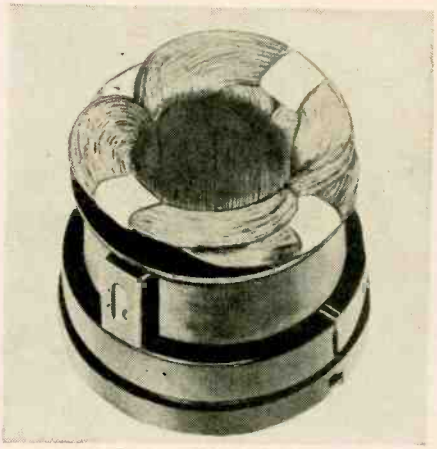


Air-core flyback transformer.



Ceramic-core flyback transformer





—Photos courtesy of Ram Electronics

Deflection yokes: above—90° type; below—70°. Note the considerable difference in the angle of flare.

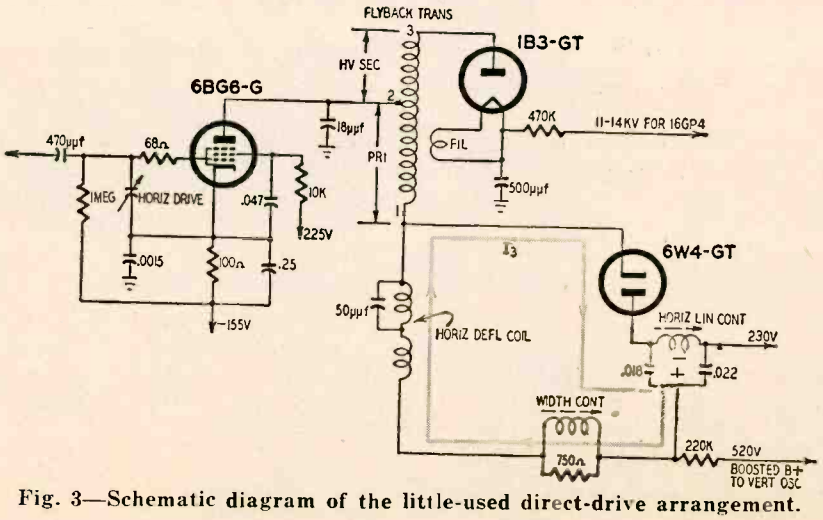


Fig. 3—Schematic diagram of the little-used direct-drive arrangement.

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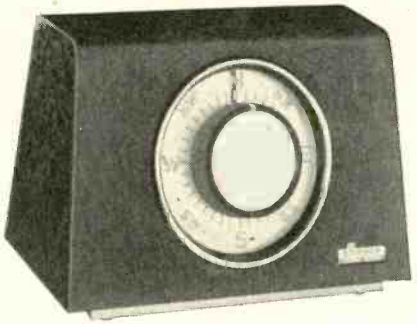

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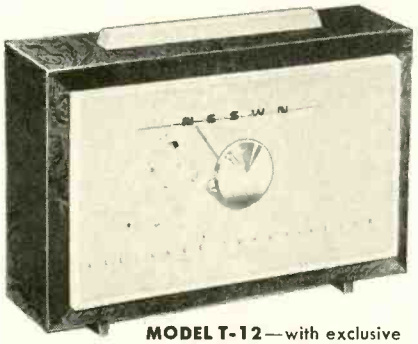

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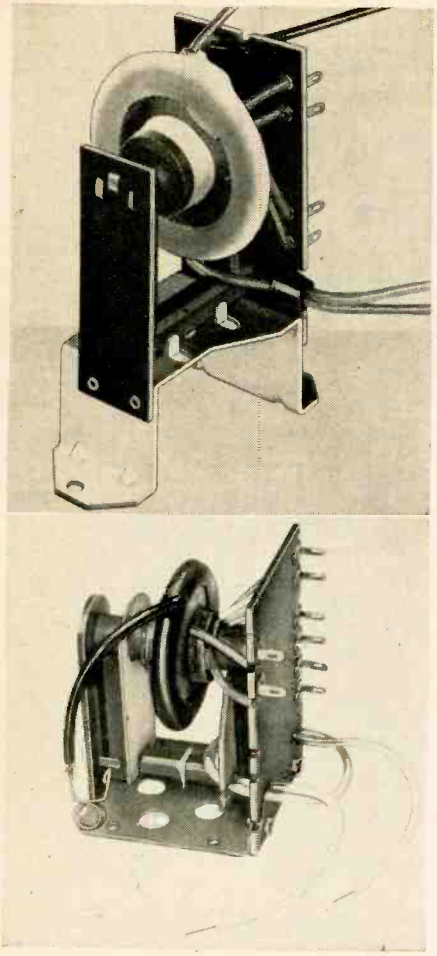


Horizontal output transformers (flybacks): above—90°; below 70°.

of the newer flyback circuits contain an autotransformer.

Direct-drive circuit

Several years ago, the direct-drive system was employed in the chassis of many set manufacturers. Although many TV sets contain such a circuit it is practically extinct in the newer sets because of its tendency to break down. This circuit was designed to produce optimum efficiency while using a minimum number of component parts.

A typical direct-drive circuit, used in Emerson chassis 120124, is shown in Fig. 3. The most distinguishing feature of the circuit is that the flyback transformer has only three terminals and one tap point. The horizontal yoke winding, since it is in series with the 1–2–3 flyback winding, takes the place of an additional secondary winding. In other words, it is equivalent to the 4–5–6–7 secondary winding shown in Fig. 2, making the direct-drive circuit equivalent to an autotransformer type flyback circuit. In Fig. 3, the damper tube is effectively connected across the yoke and the width coil, in series with the yoke.

The conduction of the damper tube is indicated to show how the .022-μf boost capacitor develops its 290-volt charge. The 520-volt boost, thus, is formed by the charge across the boost capacitor and the 230 volts of B plus.

The horizontal yoke inductance of this system is very high (30 mh) since it actually takes the place of the flyback transformer winding which normally also has a high inductance. The inductance value is the same as that of winding 1–2. Thus, winding 1–2 provides approximately 2.5 kv peak-to-peak across it, as well as the yoke. From terminal 2 of the flyback to ground, there is developed, therefore, 2 × 2.5 or 5 kv, voltage needed to develop 11–14 kv at the output of the high-voltage supply.

The flyback transformer used in this particular system is an air-core type. This is one of the first direct-drive flybacks used. Later types employ a circular ceramic core, permitting its overall size to be reduced considerably. The air-core type requires many more winding turns from terminals 1 to 2 to obtain the necessary impedance and, therefore, its dc resistance is much greater than for ceramic-cores.

The direct-drive system is highly efficient. Its design is based upon its inherent distributed and stray capacitances. Thus, lead dress must not be disturbed when servicing such a circuit. The circuit is designed so that the retrace time (about 5-6 μsec) is very low, thus helping to achieve its high efficiency.

The 90° flyback circuit

This designation refers to the deflection angle of the picture tube. The sweep components must be designed to work with such a picture tube. Originally, 90° tubes were 24 and 27 inches. However, some 10-, 17- and 21-inch tubes have been included recently.

There are no noticeable mechanical distinctions between 70° and 90° flybacks whether they be isolation or autotransformer types. As a matter of fact, they may even be interchanged, provided they meet all other design requirements. Electrically, more winding turns are used for the 90° flyback to obtain a greater high-voltage output and thus its dc resistance is higher than those of the 70° flyback. However, there are exceptions to this rule.

The winding flare of the 90° yoke is much greater than that of the 70° unit. The greater flare is necessary to provide sufficient deflection to cover the entire picture-tube screen with good edge-to-edge focusing. Also, the horizontal inductance of the 90° yoke (over 20 mh) is much greater than that of the 70° type (usually less than 20 mh, except for direct-drive systems). Although the magnetic field of the 90° yoke is used to better advantage because of its flare, the field has less effect on the gun beam since the distance between field and beam is much greater. To compensate for this and, at the same time, to obtain more magnetic energy the yoke inductance is made greater. (The energy of an inductor is directly proportional to its inductance.)

The width and linearity coils used in the 90° system are the same as those used for 70°. However, the former more often uses horizontal output tubes such as the 6CD6 and 6CU6 and damper tubes such as the 6AX4 and 6AU5 to

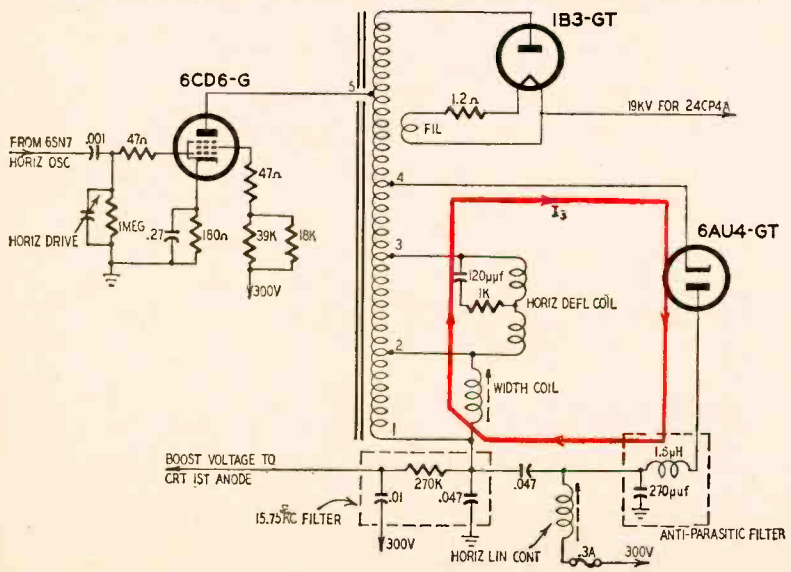
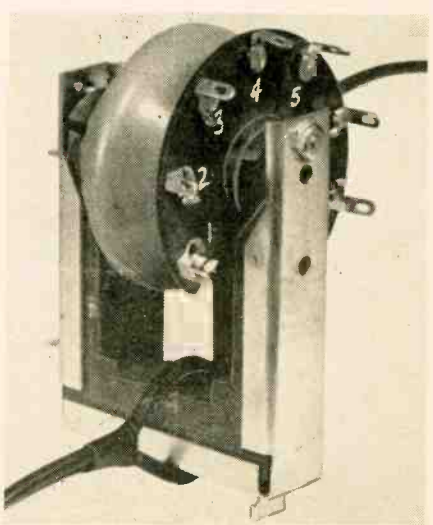
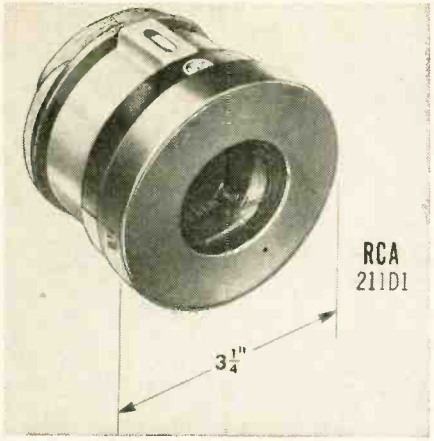


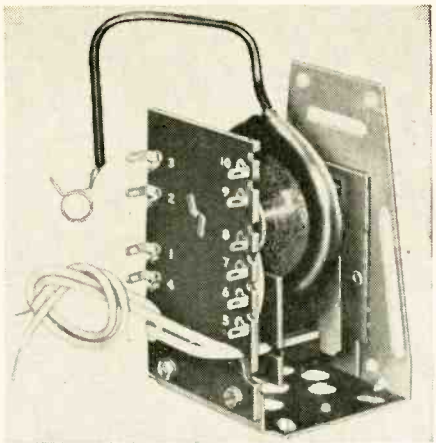
Fig. 4—Typical 90° deflection circuit used in the RCA chassis KCS89.



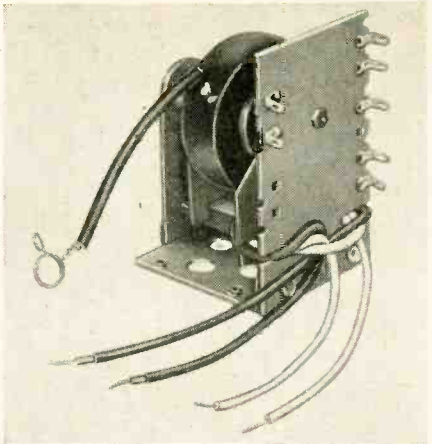
Merit model HVO-57 horizontal output and high-voltage transformer.



The RCA general-purpose model 211D1 70° cosine deflection yoke.



RCA's 232T1 universal 70° horizontal output transformer.



The RCA 228T1 70° horizontal output transformer, for voltages to 15 kv.

withstand the greater currents and peak voltages which prevail in this system.

In practically every case the 90° system uses an autotransformer flyback. A typical 90° circuit, used in the RCA chassis KCS89, is shown in Fig. 4. Unlike the 70° autotransformer circuit in Fig. 2, the flyback transformer is one continuous winding and the linearity coil is connected to the bottom of the flyback instead of in between a split winding. This does not alter the circuit operation (as was explained previously) since the linearity coil serves the same function — to vary the instantaneous plate voltage to the horizontal output tube plate. The advantage of the linearity coil arrangement in Fig. 4 is that it is not subjected to the high peak voltage which appears across the damper cathode, thus making it less susceptible to breakdown.

The damper current I_3 is indicated in Fig. 3. It charges the .047-μf boost capacitor which is in its path. The boost voltage, therefore, appears from pin 1 to ground, which is the average charge across the boost capacitor (290 volts) plus the 300-volt B-plus supply. The boost voltage is fed to the C-R tube first anode to obtain proper focusing. The 15,750-cycle filter is, therefore, inserted between the boost voltage supply and the first anode to prevent 15,750 cycles from causing intensity modulation of the electron beam.

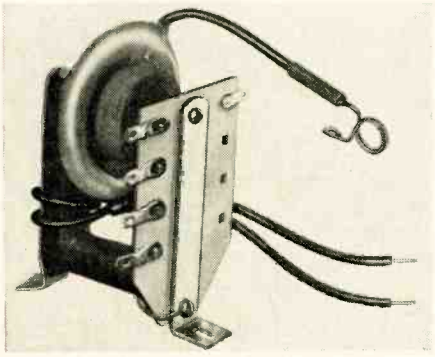
The linearity coil does not have a resonant capacitor (C5 in Fig. 2) since the stray distributed capacitances of the coil as well as the other capacitances in the circuit provide the needed capacitance. A 1.5-μh choke and a 270-$\mu\mu$f capacitor, connected in the 6AU4 plate circuit, form an antiparasitic filter to prevent the higher harmonics developed in the flyback circuit from entering the 300-volt B-plus supply.

High-voltage circuits

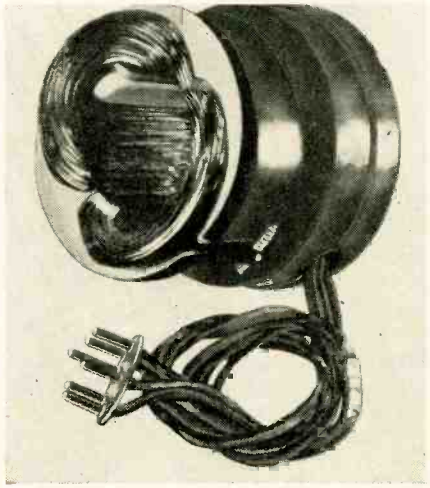
Many of the early TV sets used multiple high-voltage rectifier systems, doublers in particular. A few of the newer sets, such as Sylvania chassis 1-387, also use doublers. Tripler, quadrupler and even quintupler circuits are used in projection sets to obtain very high voltages, in the order of 30 kv. However, since these are limited in their use, only the operation of the doubler circuit is discussed.

The basic doubler circuit is shown in Fig. 5. The operation of V1, R1, C1 and C2 is that of a single rectifier. When positive pulses appear at the plate of V1, it conducts (I_1), charging up C2 as shown. Between positive pulses C2 discharges (I_2) as indicated and charges C1. R1, in series with C1, prevents the latter from losing too much of its accummulated charge. After several cycles, C1 and C2 are charged to the full value of E. From point X to ground (between flyback transformer pulses) E exists, by virtue of the charge across C1. When the positive pulses from the flyback appear, another E voltage is superimposed on the already-existing one across C1, thus making the voltage from point, X to ground approximately 2E. The voltage has thus been doubled.

V2 and C3 operate in the following manner: The V2 filament is effectively connected to point X since the plate resistance of V2 is very small when it conducts during positive pulses. Therefore, C3 charges (I_3) as shown and after many pulses it is charged to the full 2E value. The charge of C3 discharges C1 (since it lies in the I_3 current path). However, C1 once again regains its E charge between positive pulses. Actually, the high-voltage output is about 2 kv less than 2E, due to the inherent losses (such as loss in voltage by the drop across V1 and V2 during their conduction and the voltage drop across R1) in the circuit. END



Stancor's A-8254 flyback transformer.



The Merit MDF-79 deflection yoke.

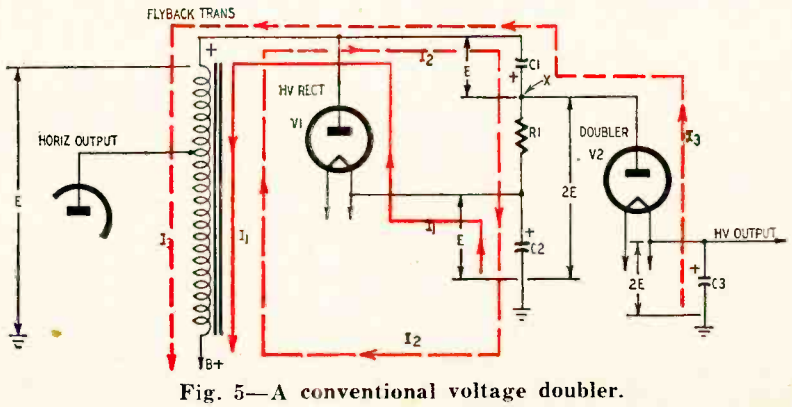


Fig. 5—A conventional voltage doubler.

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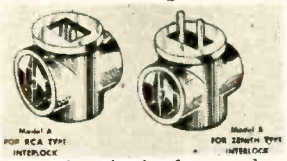

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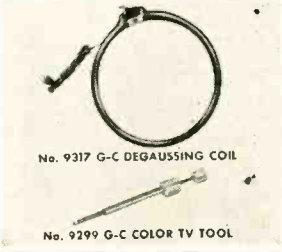

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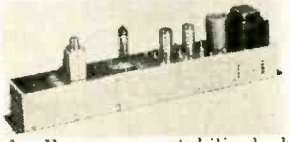

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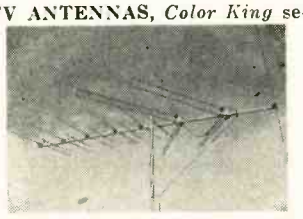
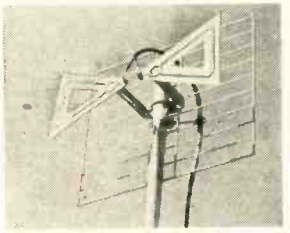


UHF ANTENNA, *model 3011.* Bowtie type using air dielectric.



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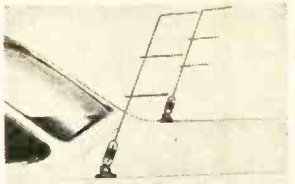

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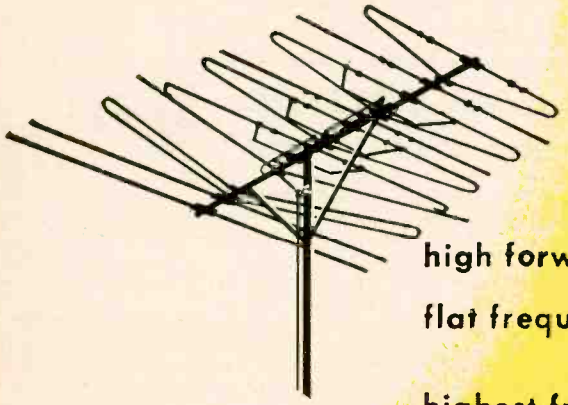

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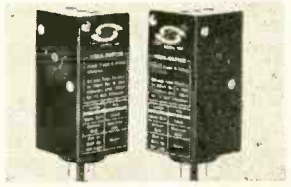
TUBE TESTER, *model 301.* 2 controls to set. Checks for

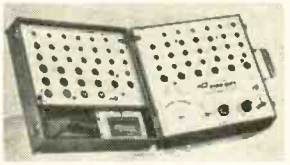
shorts, leakage and quality. 4½-inch meter. Oak carrying case.—**Electronic Measurements Corp.**, 625 Broadway, New York 12.

TUBE-TESTER ADAPTER, *model VB-2, Vibra-Dapter.* For checking 3- and 4-prong vibrators. Tube-tester set for 6AX4 or 6SN7 when checking 6-volt vibrators; 12AX4 or 12SN7



for 12-volt vibrators.—**Service Instruments Corp.**, 171 Official Rd., Addison, Ill.

TUBE AND TRANSISTOR TESTER. *Model 630, Dyna-*



Quick. Tests each section of multiple tubes for mutual conductance, shorts, grid emission, gas content and life. Instantaneous heater-continuity check. Pin straighteners mounted on panel. Checks leakage current and forward gain ratio of all types of junction, point contact and barrier transistors.—**B & K Mfg. Co.**, 3731 No. Southport Ave., Chicago 13, Ill.

SCOPE PREAMP, *model SPR-100.* Increases selectivity by 40

db. Flat response from 10–25,000 cycles. Hum and noise output less than 5 mv.—**Jerrold Electronics Corp.**, 23rd & Chestnut Sts., Philadelphia 3, Pa.

MOLDED TRANSFORMERS for

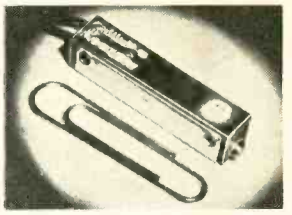
airborne applications. 10 sizes, 0.2–1.5 pounds. Available for standard or high-temperature use.—**United Transformer Corp.**, 150 Varick St., New York 13, N. Y.

REPLACEMENT TRANSFORMERS. *P-3049* (illustrated) exact

replacement for Motorola power transformer 25C737472. *P-2865* replaces Philco 32-8512; *P-2868* replaces Philco 32-8586; *P-2683* replaces Philco 32-8575 and *P-2871* replaces Philco 32-8635.—**Merit Coil & Transformer Corp.**, 4427 No. Clark St., Chicago 40, Ill.

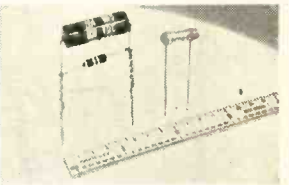
FILAMENT TRANSFORMERS. 6 new models: *21F13; 21F25; 21F28; 21F29; 21F30* and *21F31.*—**Thordarson-Meissner Mfg. Co.**, 7th & Belmont Ave., Mt. Carmel, Ill.

PRECISION POTENTIOMETER, *Padohm.* Screwdriver-adjusted. 100–20,000 ohms. 10%



tolerance.—**Clarostat Mfg. Co. Inc.**, Dover, N. H.

TUBE-R-CAP. Resistor–capacitor unit takes up space of tubular capacitor alone. *CC20:* 500-volt capacitor 400 μμf–.00215 μf; resistance tolerance 20% below 1 megohm. *CC25:* 500-volt 970 μμf–.005 μf; resistance tolerance 20% below 1

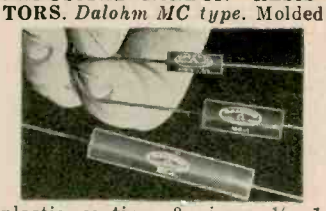


megohm, 30% over 1 megohm.—**Centralab**, 900 E. Keefe Ave., Milwaukee 1, Wis.

CARBON RESISTORS, *Hi-Stab.* In molded, noninsulated, hermetically sealed, ceramic-encased types. Deposited carbon. High stability.—**Erie Resistor Corp.**, 639 W. 12 St., Erie, Pa.

NEW DEVICES *(Continued)*

DEPOSITED-CARBON RESISTORS. *Dalohm MC type.* Molded



plastic coating. 3 sizes: ½, 1 and 2 watts. — **Dale Products Inc.,** Box 136, Columbus, Neb.

TURNTABLE, *model 1/S-3.* 4 speeds. Neon stroboscope. Magnetic speed adjustment. Rim

drive, capacitor type, 4-pole motor—**Intersearch Inc.,** 7 Arcadia Place, Cincinnati 8, Ohio.

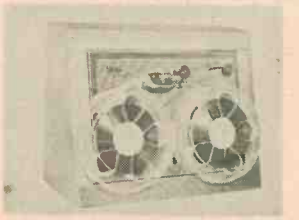
STEREOPHONIC RECORDER, *Stericorder.* Records and plays back sterophonic sound. Hysteresis synchronous motor, 2 VU meters, cueing and editing

facilities and 2 self-contained independent channels of preamplification and power amplification.—**Superscope Inc., Audio Electronics Div.,** 780 Gower St., Hollywood 38, Calif.

TAPE RECORDER, *model 1960.* 2 speeds, 3¾ and 7½ inches

per second. Dual-track recording. Fast forward and rewind. Weighs less than 15 pounds.—**Telectrosonic Corp.,** 35-16 37th St., Long Island City, N.Y.

CASES. *Model 400* (illustrated) holds any Viking tape deck and



can be used vertically or horizontally. *Model 401* for amplifier or preamp.—**Viking of Minneapolis,** 9600 Aldrich Ave. So., Minneapolis 20, Minn.

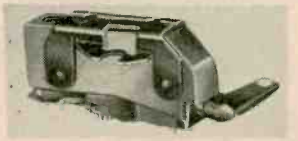
MAGNETIC TAPE. Scotch brand *no. 131 Low-Print.* Reduces print level by 8 db and increases high-frequency response.— **Minnesota Mining &**

Mfg. Co., Dept. A7-236, St. Paul, Minn.

PHONO CARTRIDGES. *Climatite, model 120TS (illustrated):* 3-volt output, 30–11,000 cycles. *Model 118TS:* 0.75-volt output, 30–13,000 cycles. *Model 124TS:* 3-volt output, 30–11,000 cycles. *Soundflo:* plug-in cartridge-needle combination. *Model 89TB:* 1.3-volt output, 30–15,000

cycles. Crystal mike *model M-332:* 30–15,000 cycles. Output level —57 db.—**Astatic Corp.,** Conneaut, Ohio.

PHONO CARTRIDGE, twin-lever ceramic. 30–15,000 cycles. Dual needles. 1-mil stylus for 33⅓ and 45 rpm; 3-mil for 78



rpm.—**Shure Brothers Inc.,** 222 Hartrey Ave., Evanston, Ill.

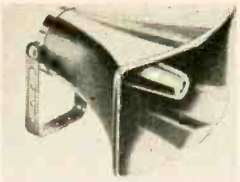
PHONO CARTRIDGES. Series VR-II Magnetic variable reluctance. Frequency response:

20–20,000 cycles. Tracking pressure: 4 grams. Electrostatic shield. 7 models: 4 single-stylus and 3 dual-stylus types. Diamond or sapphire styli.—**General Electric, Specialty Electronic Components Dept.,** W. Genesee St., Auburn, N. Y.

REMOTE-CONTROL UNIT, *Duo-Master,* for TV sets can also be used for monitoring tape recordings. Single-wire hookup. Provides remote tuning of picture, sound and station selec-

tion.—**Tech-Master Corp.,** 75 Front St., Brooklyn, N.Y.

WIDE-ANGLE PROJECTOR, *model CLH.* Omnidirectional swivel mounting enables projector to be rotated 360°. Air column length 4½ feet. Horn cutoff 120 cycles. — **University**



Loudspeakers, Inc., 80 S. Kensico Ave., White Plains, N.Y.

TRANSISTORIZED MICROPHONE, *model 505T*. Built-in transistor amplifier. No batteries, extra power supplies or

circuit changes needed. Transistor-powered by available current normally used by carbon mike unit.—**Shure Brothers, Inc.**, 222 Hartrey Ave., Evanston, Ill.

BINAURAL PREAMP. *Model SA-25*. Kit or factory-wired. Dual-channel preamp drives its own 25-watt amplifier in conjunction with any present am-

plifier. Response 20 – 20,000 cycles. Equalization controls. 2-position low-cut and high-cut filter.—**Arkay**, 120 Cedar St., New York, N.Y.

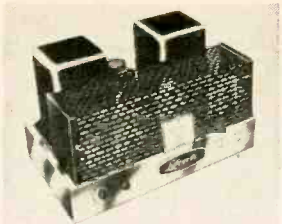
PREAMPLIFIER. Includes dip-soldered printed-circuit board

with factory-mounted components. Dc filaments. Frequency response ±0.5 db, 6–60,000 cycles. 6 inputs. Feedback type tone control. **Dyna Co.**, 617 No. 41 St., Philadelphia 4, Pa.

HI-FI AMPLIFIER, *model M-60*. 60 watts, 7–70,000 cycles ±1 db. IM distortion less than 1% at 60 watts. Harmonic distortion less than 1% from 20–20,000 cycles. Sensitivity, 1.5

volts rms for full output.—**MusiCraft**, 48 E. Oak St., Chicago, Ill.

70-WATT AMPLIFIER, kit *(KT-400)* or *wired (LA-70)*.



20–20,000 cycles ±1 db at full output. Uses 2 KT88's, 1 6AN8, 1 GZ34 and a selenium rectifier. Meter for bias and balance adjustment. — **Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N.Y.

HIGH-FIDELITY AMPLIFIER, *Mark III*. 60 watts, 16–24,000

cycles ±0.1 db. KT88 for power output.—**Dyna Co.**, 617 No. 41 St., Philadelphia 4, Pa.

BINAURAL FM-AM TUNER,

kit *(KT-500)* or *wired (LT-50)*. Separate AM and FM sections. 20–20,000 cycles ±0.5 db. Harmonic distortion less than 1% on FM, less than 1% on AM for 80% modulation. — **Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N.Y.

HOOKUP WIRE. Conforms to MIL Spec 16878-B. Plain vinyl

or vinyl with nylon jacket. 16–26 gauge. 10 solid and 9 striped colors.—**Belden Mfg. Co.**, 4647 Van Buren St., Chicago 80, Ill.

CLUTCH FACING KIT. Corrects slipping manual tuner on pushbutton-tuned auto radios. Contains cleaning swabs, sol-

vents and spare clutch facings. —**Colman Tool & Machine Co.**, Amarillo, Tex.

DUAL CONTROLS. Concentric controls snap together to assemble a custom dual-concen-

LEEDS & NORTHRUP MICROMAX RECORDERS

Strip type recorder used for controlling and recording wide variety of processes. Used originally for temp. range of 350-550° C. but may be changed for other applications. Operates on Wheatstone bridge principle using AC galvanometer movement. Original cost several times our low price. Removed from demilitarized equipment which in many cases was new. Sold as used but guaranteed, or money back if not satisfied. Ship. wt. approx. 165 lbs.

$179.50 ea.

SYNCHROS, SELSYNS, AUTOSYNS!!! At money-saving prices!!! LARGE QUANTITY 20,000 in stock 110 v. 60 cycle Units

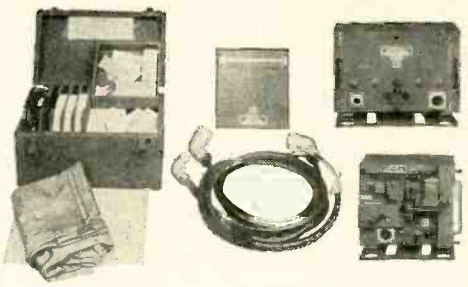
Navy Size & Type	Approx. Weight (lbs.)	Approx. Length (Inches)	Approx. Diameter (Inches)	Price Used
5F	5	6.0-6.8	3.4-3.6	$5.00
5G	5	6.0-6.8	3.4-3.6	5.00
5DG	5	6.0-6.8	3.4-3.6	5.00
5CT	5	6.0-6.8	3.4-3.6	5.00
6G	8	6.4-7.5	4.5	7.50
7G	18	8.9-9.2	5.8	10.00
7DG	18	8.9-9.2	5.8	10.00

110 V. 400 Cycle Units

Size & Type	Approx. Weight (lbs.)	Approx. Length (Inches)	Approx. Diameter (Inches)	Price Used
5F	5	6.0-6.8	3.4-3.6	$3.50
5G	5	6.0-6.8	3.4-3.6	3.50
5DG	5	6.0-6.8	3.4-3.6	3.50

CT—Control Transformer: D—Differential Motor: DG—Differential Generator: F—Motor (Follower): G—Generator. Mfg. by Bendix, Ford Instrument Co. and General Electric. Specify. Bendix, Ford & GE in stock

RC-58-B FACSIMILE SET $59.50 ea.



Brand new, complete, ready to operate by connecting to 12 V. DC source. Spare parts included with ample supply of ink and paper. Transmits and receives and prints, signatures and copy. Ideal for loan offices, banks or other businesses where signatures must be verified, etc. Use two sets together with 2 wires telephone line or radio carrier between. Cost Gvmt. approx. $6000. Your price, in original packing, only $59.50 ea. Ship. wt. approx. 300 lbs.

M-1 SERVO UNIT FOR BEAM ROTATION

Unit has self-contained hydraulic pump actuated by 27 V.—11 Amp. 1/5 hp. motor which pumps oil into either side of hydraulic piston giving better than a 100 lbs. torque to cable drum. Unit is reversible by actuation of either of two self-contained solenoid hydraulic valves. Connect by cable around antenna beam for any desired rotation speed. Greater adaptability than any other surplus device on the market. Ship. wgt. 37 lbs. Brand New—Only a few, order early.

Price.....$7.95 ea.

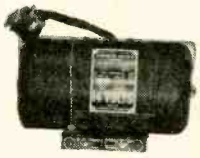
M-1 ODOGRAPH Over $5,000 Value $89.50

See Nov. 1944 Electronics for Full Description

This is a survey instrument for automatically drawing a map of the terrain over which the jeep or other vehicle to which it is attached traverses. These instruments mfgd. currently by Monroe Calculating Machine Co. and sold in excess of $5,000. Our surplus purchase allows passing on these machines at this value. Order early, only 200 in stock. Units have been rebuilt by Corp of Engineers, U.S. Army and guaranteed good condition. Ideal for prospectors, oil companies, power line and farm use. Nothing else needed for operation except vehicle. Many are using the compass unit for automatic pilots, on boats—many, many applications. A real machine. Ship. Wt. approx. 300 lbs.

Our Price .....$89.50 ea.

Brand New 12 V. Dynamotor



DM-40. Input: 12-14 V 3.4 A. Output: 172 V. —138 Ma. An ideal dynamotor to adapt to mobile uses on the new 12 V. cars. Don't pass up this buy even if your intended uses are not immediate. Size 6¾" L. x 3½" dia. 4" lead with 6 pin Jones plug. Ship. wt. 7½ lbs.....$2.75

We are not going out of business or losing our lease— but compare this list of prices & items anywhere

Due to lower prices on these items we cannot accept orders unless total amount is $5.00 or more

a. BC-604 Transmitter—10 tube 20-27.9 MC. F3 converts easily to 10 meter. For 12 or 24 V. DC use (no dynamotor supplied) complete with tubes. Size 18"x12"x10". Excellent condition. Shipping wt. 100 lbs. ea. Price $6.95 ea.

b. Metal locator—famous SCR 625 mine detector for finding treasure, pipes, and lost articles. Complete in carrying case ready to operate with batteries Case size 28¼"x16"x8¼". Ship. wt. 55 lb. Used. Price $29.50 ea. Batteries $4.25 per set.

c. Receiver R-1/ARR-1—two stage RF range, 235 to 248 MC. Ideal for conversion to preselectors, ham 220 MC convertor, etc. Complete with tubes in compact aluminum case 10"x3½"x3". Insulation on input coil has been broken by Army for demilitarization. Easily repaired with cement or replacement. Shipping wt. 4 lb. New. $1.25 ea.

d. Coaxial relay—operates on 12 or 24 V. Ideal for your mobile transmitter receiver equipment. Ship. wt. 2 lb. New $1.25 ea.

e. TS 9 Hand set—telephone type with switch in handle. Ideal for your mobile equipment. $2.95 ea.

f. 30 Amp Battery charger—cost gov't $300 ea. Mfg. by Ward-Leonard. Charging rates up to 30 amps on 12-30V battery combinations. Operates from 110 V DC. Size 20" wide x 20" high x 10" deep. Complete with metal spare parts box, spares, and cord. Ship. wt. 145 lb. In original wood box. New. Price $10.00 ea.

g. PE-237 Vibrator Power Supply—$5.95. 6, 12, 24 V. Non-synchronous vibrator type. Input 6 V. 36 amp., 12 V. 17 amp., or 24 V. 9.5 amp. DC Output: 525 V. DC .095 amp. 1105 V. DC 4.2 Ma., 6.5 V. DC 2 amp., 6 V. DC ½ amp., 1.35 V. DC 450 Ma. Higher current drain may be obtained with no ill effect. This power supply has been successfully used for powering the BC 604 Xmtr. Steel brown crackle case. Size 20¼"x11"x10". Ship wt. 119 lbs. Excellent to new condition. Vibrator not incuded.

h. J-47 Telegraph Key $1.00 Brand new Signal Corps surplus key in original packing. Ship. wt. 2 lbs.

i. 200 KC Crystal in DC-15A holder for ART-13 or calibration monitors. $1.00 ea.

j. Freq. crystals 100—$4.95 Kit of 100 brand new crystals worth $3.50 to $12.50 ea. All mounted in various holders. Plenty of ham band frequencies in assortment. Ship. wt. 4 lb.

k. Camp stove or portable sports heater—Evans blue flame heater originally used for keeping engines warm in Arctic climates, but ideal for camp cooking or heat for ice fishing, tents, etc. (Not recommended for confined or poorly ventilated bldgs.) Burns kerosene or gasoline. Size 10" dia. x 12" high with bail type carrying handle. Cost Gov't many times our low price. Shipped in original packing. Ship. wt. 47 lbs. $4.75 ea.

l. OVA-1 Test Signal Generator—$17.50. This signal generator was used to provide a test signal of constant frequency for operation and alignment of IF amplifier stages in the CG-46 ACQ type receivers. The generator covers the range between 150-250 megacycles. Amplitude modulated square wave output is obtained at frequencies of .1, 1, 10, and 100 kc depending on the position of the freq. mod. pulse switch. A 15 Mc. signal is also provided by a second osc. stage. Power is supplied by internal 115 V. 60 cycle AC supply connected to source by cord provided. Brand new with instruction book. Ship. wt. 62 lbs. $17.50.

m. 357 Marker Beacon Receivers—$2.95. Contains sensitive relay and tubes, operates on 75 MC. Ideal for radio control.

n. T-26 Carbon Mike—$1.95. Chest mounted switchboard type, leaves hands free for mobile work. Uses F-1 W. E. microphone element.

o. 115 V. 400 cycle Inverters $4.95 ea. New. 24 V. DC input-115V 400 cycle output inverters for numerous ADF, radar, and other electronic items. Size 9"x6"x4½". Ship. wt. 12 lbs.

p. 1-KW Plate Transformer—$8.95. Brand new—Arma II V. Contains two 400 V. CT. 1.25 amp. windings which may be series or parallel connected. 110V. 60 cy. Pri. Size 9½"x9"x8". Ship. wt. 100 lb.

q. Edison 37½AH 6 V. Batteries—$17.50 ea. Iron-Nickel Alkaline type consisting of 5 type B2H cells.

r. AN/ART-4 Dual Target Transmitter—$3.95 dual transmitter one on 55.5 mc, others on 56.75 MC built into a 6 ft. x 30 ft. plastic screen. Shipped in original box. Ship. wt. 75 lbs.

s. Torque Amplifier 110V AC—$7.50. Works like the power steering on a car—light movement of input shaft is transmitted to output shaft in direct ratio with torque being added by 110 V. 1/40 H.P. motor which is part of unit. Size 12"x7½"x5⅜. Shipped in original box. Ship wt. 45 lbs.

t. 30 Amp. DC Ammeter—$1.00. New—3" round panel type 0-30 Amps., DC, white face, black scale, Mfg. by Hoyt, Ship. Wt. 2 lbs. ea.

u. DM-42 Dynamotor—$9.50—12-14V. DC Input-515 and 1030V. output @ 260 ma. continuous. Size 12½"x7"x7". Ship. wt. 30 lbs.

v. 110V to 28V Transformer—$5.00. 110V. 60 cycle pri. 28V. 8 amp. secondary transformer for building your 24 volt charger or DC supply. New. Ship. wt. 10 lbs.

w. BB-54-2V. 34AH Battery—$1.95. New. Plastic case storage battery, size 5⅜"x4"x3", Shipped dry charged. Ship. wt. 5 lbs.

x. Mallory AC Capacity selector—$1.50. MSS-100 capacity selector for determining correct replacement motor starting capacitors. Fraction of jobbers price—New—Ship. wt. 3 lbs.

y. Golf Car Motor—$4.50. Storage battery operated reversible motor—1¾ H.P.—12 to 24 V. DC. Speed to 6000 RPM. Measures 4⅛" dia. x 9" long ⅝" spline shaft. NEW Ship. wt. 13 lbs.

z. 100 amp 6V. Leece-Neville Alternator and Rectifier for police car or other automobile or boat use where high charging currents are needed. Used but guaranteed. Ship. wt. approx. 100 lbs. $45.00 ea.

OIL CAPACITORS: All New

2x1 mfd.	600V. Aerovox 24C16	$2.50/dozen
4 mfd.	600V. Sprague 23C16	3.50/dozen
3x2 mfd.	4000V. Tobe 30C16	7.50/dozen
12 mfd.	15000V. GE Pyranol 35C16	2.50 each

Variable Condensers: All New

100 mmfd. midget variable Bud MC 1265 Reg. $2.45 price—Special $1.00 ea. $7.50/dozen. Defiance Replacement type ganged, all 6 models $2.75 for 6.

ESSE RADIO CO. 42 WEST SOUTH ST. INDIANAPOLIS 25, IND.

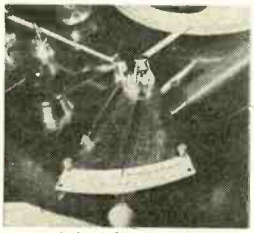
REMIT SHIPPING CHARGE AND INSTRUCTIONS WITH ALL ORDERS. OTHERWISE ORDER WILL BE SHIPPED EXPRESS COLLECT. ALL ITEMS GUARANTEED TO YOUR SATISFACTION OR MONEY REFUNDED IF RETURNED PREPAID WITHIN 10 DAYS OF RECEIPT

tric control. A variety of combinations.—**P. R. Mallory & Co., Inc.**, 3029 E. Washington St., Indianapolis, Ind.

LONG-NOSE PLIERS, *no. 208-6-NC.* For wiring by cut, hook

and crimp method. Replaceable cutting blade. Self-opening coil spring.—**Mathias Klein & Sons**, 7200 McCormick Rd., Chicago 45, Ill.

TAPE TENSION GAUGE. Imported from West Germany,

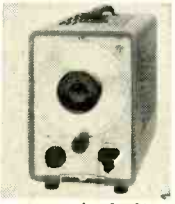


this precision-built instrument measures the tension of tapes in tape recorders. All movable parts are mounted on ball-bearings.—**American Elite Inc.**, 7 Park Ave., New York, N. Y.

VARIABLE INDUCTORS. Subminiatures, 1¼ x 34/64 by 34/64 inches. *AF-87* (illus-

trated): 30–500 cycles, 400-cycle peak. *AF-88:* 50–1,000 cycles, 800-cycle peak.—**Burnell & Co. Inc.**, 45 Warburton Ave., Yonkers 2, N. Y.

AUDIO SWEEP OSCILLATOR, *model 207A.* 20–20,000 cycles.



±4% accuracy, including warm-up drift and component aging. Designed for motor drive.—**Hewlett-Packard Co.**, 395 Page Mill Rd., Palo Alto, Calif.

STEREOPHONIC RECORDER, *model 601-2.* 7½ ips, 30–15,000

cycles. Separate record, playback, microphone and line input amplifiers.—**Ampex Corp.**, 934 Charter St., Redwood City, Calif.

INDICATOR SWITCH, *Pan-i-Lite.* For low-voltage indicating and switching applications. 6, 12 and 28 volts. Blue, red, green, white or yellow. Mounts in ¾-inch hole.—**Alden Products Co.**, 117 N. Main St., Brockton 64, Mass.

RADIO-CONTROL UNITS. *Model F-249* (illustrated): crystal-controlled, single-channel transmitter. 1-mile range, with

27.255 crystal and tube; *F-208:* matching receiver, 3 x 2¼ x 1½ inches; *F-327:* motor-driven, electric servo mechanism, single-pulse operation, electronic return to neutral.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

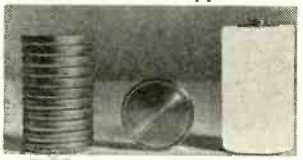
TELEPHONE PICKUP COIL, *model HP-61.* Transcribes tele-

phone conversations with recorder or makes messages audible with amplifier. ⅝-inch diameter, 2⅜ inches long. With 6-foot shielded cable terminated in standard phone plug.—**Microtran Co. Inc.**, 145 E. Mineola Ave., Valley Stream, N. Y.

ANTENNA-MATCHING COILS, for RCA TV sets. *No. 1213* (center) replaces coils with

X-shaped cross section. Nos. 1214 (left) and 1230 (right) replace 2 hollow-core coil sizes.—**Colman Tool & Machine Co.**, Amarillo, Tex.

NICKEL-CADMIUM BATTERY, rechargeable. For miniature and subminiature applications.



Available in 1.2-volt 0.25-ma-hour and 1.2-volt 0.5-ma-hour sizes.—**Gulton Industries Inc.**, 212 Durham Ave., Metuchen, N. J.

POWER SUPPLY, *model R-10.* Dc output variable from 200–325 volts at 100 ma. Regulation better than .07% from zero to full load. Ripple less than 200 microvolts rms at 115 volts ac. Ac output, 6.3 volts, 3 amps. Ac input 105–125 volts, 60 cycles.—**L. E. E., Inc.**, 625 New York Ave., N. W., Washington 1, D. C.

All specifications given on these pages are from manufacturers' data.

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

Audio Follies
Bargain Sampler of Indecent Proportions
Cook L-XX

If Emory Cook set out to produce a hi-fi sampler to end all samplers, he may well have succeeded. Certainly no previous sampler comes close to offering so complete a sampling of a catalog or such a variety of sound.

There are 15 selections here from 15 Cook records, starting with very real trains, proceeding through steel bands, calliopes, carousels, a variety of unusual instruments such as the zither, cimbalon and pedal harpsichord, the more familiar organ (but in Cook's awesome realism), the orchestra and finally calypso and hot jazz. Many of these I have reviewed previously, but this recording may well be superior to the originals because it is pressed by the new Microfusion process.

The claimed superiority of this process seems to be realized. Surface noise is at a new low—though the material is not immune to electrostatic noise and, therefore, needs treatment for it. Cook claims, also, that the material is stiffer and, therefore, the high frequencies are not as likely to be wiped off. In any event the high highs are extremely sharp and the transient response very notable, indicating a wider and cleaner bandwidth. On all accounts, as a sampler of Cook's peculiar genius, hi-fi sounds and the new process, this is recommended without any reservations.

Fiesta in Hi-Fi
Hanson and Rochester Symphony
Mercury MG-50134

Here are four pleasant and colorful works by four contemporary American composers all based on familiar folk songs: McBride's *Mexican Rhapsody*, Nelson's *Savannah River Holiday*, Mitchell's *Kentucky Mountain Portraits* and Vardell's *Joe Clark Steps Out*. The music is both melodic and rich in orchestral color with a spectacular bass, tremendous drums and a variety of high highs. The recording is truly Olympian with tremendous crescendos—so tremendous that in spots even the best pickups may be overdriven if tracking and pressure are not optimum. Thus, it provides a very real challenge and test. But on those systems that can take it and dish it out, the effect will be sufficient to pop vest buttons with pride.

Hi-Fi Fiedler
Fiedler and Boston Pops
RCA Victor LM-2100

A very felicitous combination of music most people—even newcomers to music—will enjoy and brilliant sound that will nicely prove the value of high fidelity. The works are Rimsky-Korsakov's *Coq D'Or*, Rossini's *William Tell* and Tchaikovsky's *Marche Slave*. Between them they provide a little of everything from sharp high highs to thundering tympani. The balance is exemplary; though the recording is live, definition is excellent, and with the best pickups there will be no noticeable distortion. It will sound good on any hi-fi, but on the best it should provide a complete illusion of listening to a live concert in a seat 75 or 100 feet from the stage.

HONNEGER: *Pacific 231*
Rugby
and other works
Scherchen conducting Philharmonic Symphony of London
Westminster XWN-18486

Pacific 231 is the now famous musical impression of a locomotive which offers as fine fare for a first-rate (and test for poor-to-middlin') hi fi as there is on records. This version is particularly outstanding for the good double bass, very low drums, definition, clarity and the overall awesomeness of the performance. *Rugby* is a rather similar musical impression of a Rugby game. *Mouvement Symphonique* has been described as *Pacific 231* coming back. *Prelude to the Tempest* is even more awesome to my ear than 231 with its thunderous drums and buzzing strings. The other shorter works are of an earlier period. Here is a pretty good anthology of Honneger music and, for those who can tolerate it, excellent material for system testing—especially of definition and dynamic capability—as well as notably realistic samples of various instruments—particularly string bases and drum—and some remarkable tonal effects.

TCHAIKOVSKY: *Nutcracker*
(Excerpts)
Fiedler and Boston Pops
RCA Victor LM-2052

This version contains not only those most familiar excerpts usually performed as the *Nutcracker Suite*, but other less familiar portions of the original ballet. The music provides fine showoff and demonstration material particularly rich in the high percussives. The recording is outstanding with a brilliant liveness, realistic balance and very clean throughout.

KABALEVSKY: *Comedians' Suite*
Colas Breugnon Suite
Horlick conducting Paris Conservatory Orchestra
Schuechter conducting Philharmonia of London
MGM-E3506

The *Comedians' Galop* from *The Comedians* by this contemporary Russian composer has become a great pop favorite. Here is the full suite of excerpts from the original ballet. While the other sections are not as exciting as the *Galop*, they are all interesting in tone coloration and pleasant to listen to. The less familiar *Suite from Calus Breugnon*, an opera, possesses equal interest and even more spectacular sound material, particularly a fine bass, heavy drumming and big climaxes. The recording is one of MGM's very best with a fine balance, liveness and exceptionally clean.

The Deutschmeisters Take a Holiday
Deutschmeister Band conducted by Herrmann
Westminster WP-6044

There are bigger brass bands than the Deutschmeister and there are records of bands playing more demanding music, but no other band plays with such an authentically Viennese sentimen-

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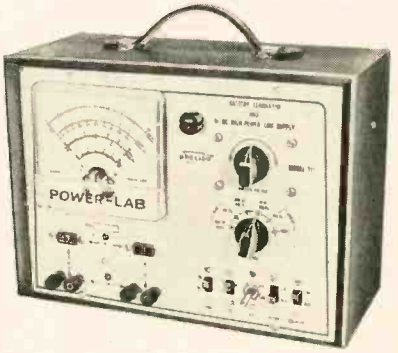
- **A DC HIGH CURRENT AMMETER**
- **AN AGC BIAS BOX**



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Here is a tester that actually checks a tube for its applications, not whether it is just good or bad. On the Model 111, GM and Emission are checked separately. It is the first and only device that measures 600-mil tubes on a meter. Sweeps from 0 through the normal testing range when making measurements, which gives an average evaluation for the tube over an extended range of operation. Connects test voltages to each tube element. Uses a single rotary switch to check each element against every other element for shorts, whether they're hot or cold. Measures tube bias directly on a meter. Features a no-backlash roll chart. Includes provisions for testing all prong types. Cathode-Ray tubes may also be checked with the use of an adaptor. An exceptional instrument for the shop, one that has won an impartial independent scientific survey hands down.

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tality or sounds more like brass bands used to sound in that golden era of brass bands 50 and more years ago. Here they are again with eight engaging concert marches, waltzes, polka, etc. The drum is big and untrickily beats a big beat, the snares play the typically Teutonic cliches, the brasses have that real Continental plaintiveness. There are just enough instruments to give the music full color, but not so many that any choir is drowned out. The recording is extremely good and the definition especially is outstanding.

SURINACH: ***Second Symphony***
TURINA: ***Rhapsodia Sinfonica***
Winograd conducting Philharmonia of Hamburg
With Sandra Bianca, piano
MGM E-3510

Somehow or other the blend of modern and Spanish is far more palatable than straight modern. In any event, it produces in these works some interesting sound, well punctuated with percussion and accentuated by some big peaks. Surinach is more modern than Turina, yet sounds more Spanish in this particular work. Even those who ordinarily dislike modern music may find both these works engaging The recording is one of the best of this orchestra and presents the music to very good advantage.

HOVANESS: ***Anahid***
Alleluia and Fugue
Tower Music
Surinach conducting MGM Orchestra
MGM E-3504

I have previously reviewed several recordings of this very individual American composer. This one gives a pretty good review of his three periods: *Alleluia and Fugue* goes back to his more conventional early days, *Anahid* is from his Armenian period and *Tower Music* from his more recent neo-Archaic period. The three works are fairly representative though not the most remarkable of his unique style. There are plenty of unusual effects, including a bass solo and considerable percussion. I do not know why some of it was cut so high, however, with the result that in spots even solitary trumpets are ragged.

BRAHMS: ***Symphony No. 1***
Munch and Boston Symphony
RCA Victor LM-2097

The first movement of this great symphony is almost a concerto for tympani, and a very fine showing they make in this recording. No comment is necessary about the music and everybody has his own preference as to its interpretation. The recording is clean, spacious and live enough to yield an appropriately romantic quality. Definition is good enough and the overall sound at a moderately loud level yields a fine presence. Not at all spectacular from a hi-fi point of view but an outstanding example of the way a fine hi-fi recording can enhance great music and yield an experience of it almost as good as a live performance.

LECLAIR: ***Concerto for Flute, Strings and Harpsichord***
HAYDN: ***Concerto for Flute and Strings***
PERGOLESI: ***Concerto for Fluto Traverso***
Camillo Wanausek, Flute
Pro Musica Chamber Orchestra of Vienna
Vox PL-10-150

The flute is one of the most felicitous of all instruments on a fine hi-fi system and this recording provides three very fine examples of music written especially for it, beautifully and very cleanly recorded. Incidentally, if you live in an area where there are lots of birds, play this next spring when they are in their best voice and you'll attract a choir of flute-lovers and imitators.

SHUBERT: ***Death of Lazarus***
Winograd conducting Philharmonia of Hamburg
With vocal soloists
MGM E-3526

This was intended to be the first act of a full-length opera, but only the first act was finished. It was not performed until very recently and

won some acclaim not only for its intrinsic musical values but for its Wagnerian effects as well. This recording presents it complete and is the first performance on American records.

BACH, K.P.E.: *Concerto for Four Viols*
MASCHERA: *La Capriola*
GABRIELI: *Canzone*
TOMOSINI: *Suite for Violetta*
Ensemble Marius Casadesus
Westminster XWN-181-30

Four composers of the 16th, 17th and 18th centuries are represented here with chamber works performed on ancient string instruments by a group which has specialized in recreating this music as authentically as possible. Especially interesting to me was the way four viols in the Bach concerto's second movement manage to sound like an organ. Thanks to the fine recording, the contrast of the viols to our modern violins is well and flatteringly presented. You don't have to be a musical antiquarian to enjoy this music either.

VIVALDI: *Concerto for Two Trumpets in C*
Concerto for Two Trumpets in E Flat
Concerto for Oboe and Strings in D Minor
Concerto for Oboe and Strings in F
Winterthur Symphony Orchestra
Concert Hall CHS-1242

Except in brass band music, the trumpet is seldom allowed to take the spotlight. Here a pair of them is given the opportunity to showoff both the capability of the instrument and the virtuosity of its players in very pleasant music and a very fine recording which presents the trumpets at their best and a very fine test of mid-range and tweeter coloration. Assuming the pickup tracking is good, the tone should be clean and sweet throughout, brassy but without stridency. The oboe is about a half octave higher in range and offers a contrast in tone. This one is unusually sweet and mellow.

COPLAND: *Piano Concerto 1926*
Leo Smit, piano; Radio Rome Symphony conducted by the composer
BLOCK: *Four Episodes for Chamber Orchestra*
Scherman conducting
Radio Zurich Symphony Orchestra
Concert Hall Society CHS-1238

This is an early Copland, seldom heard nowadays, in which he employed jazz idioms. It will be especially interesting because it is conducted by its composer and because it shows only traces of the style so characteristic of his later works. The Block *Episodes* are very interesting chamber music with an oriental flavor in spots—modern but most people would find the modernisms unobjectionable. The recording is excellent except that it is overcut in spots and will drive some pickups into distortion.

VERNON DUKE: *Souvenir de Monte Carlo*
ROBERT COBERT: *Mediterranean Suite*
Surinach conducting
MGM Chamber Orchestra
MGM E-3497

An opportunity to savor hitherto unperformed music. Duke is a Russian-born contemporary American composer who has scored Broadway shows and some popular songs, including *April in Paris*. He has also written serious music (at first under his patronimic Dukelsky) which shows very few traces of Broadway or pop music. *Souvenir de Monte Carlo* is a ballet composed about ten years ago but never produced. Cobert is a clearly promising young American composer who here receives the first performance of his works. Neither of these is at all hard to listen to. Both have some excellent percussion. The recording is excellent. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14th St., New York 11, N.Y.*

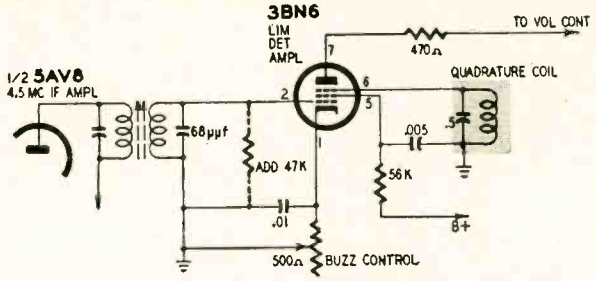
Technotes

CROSLEY AT-10M

Complaint: excessive buzz, most pronounced on strong and medium signals.

The set employs a gated beam tube as FM detector, limiter and first audio amplifier. For minimum buzz the alignment of the preceding 4.5-mc if coils must be on the button. A high hiss developed whenever alignment was attempted, showing that the stage was oscillating at an ultrasonic rate.

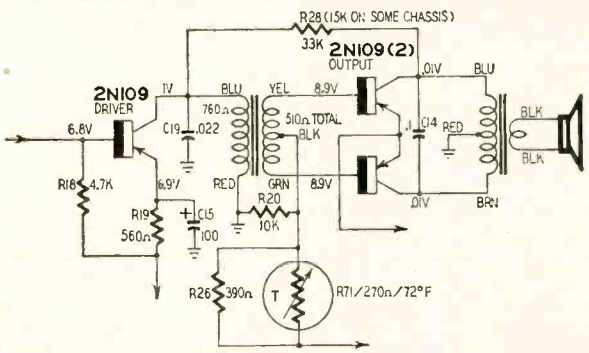
As a cure, the secondary of the if transformer feeding the 3BN6 was shunted with a resistor as shown in the partial schematic. The highest value that would permit alignment was 68,000 ohms. To insure a permanent cure, a 47,000-ohm resistor was installed with no noticeable loss of volume. (The added resistor acts as a damper to kill the oscillation.)—*J. R. Vought*



DUMMY TUBE

Not long ago, trying to find which tube had an open heater in a transformerless Motorola VT-71, I had an unusual experience. As a substitute for other tubes, I was using a 6AG5 which had a cathode-to-heater short and which had the cathode pins cut off. Soon I found the bad tube — a 6AU6 limiter. And, much to my surprise, the audio operated loud and clear! With a limiter tube without cathode pins! Only when the audio control was fully advanced, could any audio disturbance — a 60-cycle hum — be heard. Evidently the cathode, shorted internally to the heater, was reaching ground through the heater string. And bias must have been correct because there was no noticeable distortion on normal audio levels! — *B. W. Welz*

RCA TRANSISTOR PORTABLE



In model 7-BT-10K a 33,000-ohm resistor R28 has been added from the collector of the driver to the collector of one of the output transistors as shown in the diagram. This introduces negative feedback, improving audio response and cutting distortion.

Other components are changed in value as follows: R19, from 1,000 ohms to 560; R20, from 12,000 ohms to 10,000; C19, from .0047 μf to .022. The affected components are shown in the partial schematic.—*RCA Victor and Victrola Service Tips*

FRONT-END FAULT

We were demonstrating a new color bar generator on an early Sylvania 15-inch receiver. The receiver gave good results on color TV programs. The generator looked very bad with incorrect hues for all bars except black and white. No setting of the color phasing control served to produce correct hues.

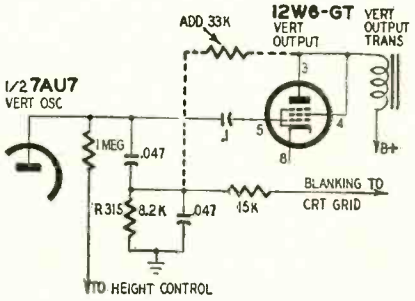
We then considered the possibility of the tuner having poor response on the channel for which the generator was set (channel 3). There was no possibil-

ity of switching channels, since the generator was fix-tuned. Another color receiver was not available for a cross check.

We did have a spare tuner and wired it into the receiver. This solved the problem, all colors came through properly both on a channel-5 program and on channel 3 with the generator. Another example of the fact that tuned-circuit response is considerably more important for color reception that for black-and-white.—*Robert G. Middleton*

COMPRESSION

A Truetone TV model 2D1530B showed compression of scanning lines at the top of the picture. Tube changes and linearity-control manipulation would not remove the bunching.



The condition was remedied by feedback to the vertical peaking resistor from the vertical output transformer. As the diagram shows, a 33,000-ohm resistor was connected from the hot side of the peaking resistor (R315) to the plate (pin 3) of the vertical output tube. Value of the resistor may have to be a little higher or lower for different sets of the same model.—*Peter Milliano*

ADMIRAL TUNERS

Poor performance in Admiral all-channel tuners may be due to improper lead dress. The lead between the uhf antenna terminals and the uhf tuner doubles as a quarter-wave trap at the mean frequency of the low vhf channels and a three-quarter-wave trap at the mean frequency of the high vhf channels. The lead must be dressed away from any metal, particularly the metal brackets of the rear kinescope mount. If the lead is found doubled up or looped it should be straightened out. —*Warren J. Smith* END

"Plenty of B plus, but no B minus!"

Technicians' News

TEXAS ELECTRONIC FAIR

The Texas Electronics Association (TEA) held its fifth annual clinic and Fair on Aug. 2, 3 and 4, at the Texas Hotel in Fort Worth, Tex. Total attendance was more than 450, out of a total registered membership of over 500.

The opening night was highlighted by a banquet. After the invocation, the guests were addressed by Tommy Thompson, of the Fort Worth City Council, representing the Mayor; Bill Inman, president of TEA, and the Honorable Robert S. Calvert, Comptroller of the State of Texas. Keynote speaker of the evening was Hal F. Bersche, of RCA, who spoke on "The Future of Independent Service in Electronics."

The second day's features included addresses by John Bennett, general manager of Philco's factory-supervised service program, and J. A. Milling, president of Howard W. Sams, Inc. Mr. Bennett's talk dealt with "Etiquette for Servicemen" and Mr. Milling discussed "Selling Service."

After a coffee break the technicians heard talks by Cecil Lightfoot, of Texas Instruments Co. on "Transistors and Their Effect in the Service Industry" and on the "TV Orphan," by Irv Tjomsland (see RADIO-ELECTRONICS, July, page 103) of Triad Transformer Corp. Then the group was addressed by Robert K. Cannell, service manager of V-M Corp., on "Servicing Tape Recorders." After lunch John Thompson of G-E Distributor Sales Tube Division spoke on "Service Can Be Profitable." "Color Alignment and Convergence" was discussed by Verne Ray, editor of Howard Sams' *PF Reporter*.

Management seminars during this period covered "Independent vs Captive Service" by Dick Fenick of Tung-Sol Tube Co. and "Basic Needs of the Modern TV Shop" by E. W. Merriam, of Sylvania, followed by an open discussion period.

On the closing day the first address was by Ed Meagher of CBS-Hytron on "An Eye to the Future." Technical personnel heard talks by Al Coumont of Sprague on "Ceramic Capacitors and Their Application" and the day was ended with a panel discussion of various technical problems. James Palmer of TEA moderated the panel consisting of Bill Renner, Ed Meagher, Irv Tjomsland, Bob Hodges, Cecil Lightfoot, Gordon Gow, Al Coumont and Clint Walter.

During the talks several interesting facts were brought out, including the

successful effort by TEA and its members to kill a licensing bill brought up in the Texas Legislature during the past session, but whose principles were considered incorrect by TEA members.

The business sessions closed with talks on "Advertising and Promotional Aids" by Wm. J. Nagy of Philco; "Accident Reduction Made Effective" by Bill Leonard of the National Safety Council and "Developing a Store's Personality" by Al Robertson of Oklahoma City.

NEW GUILD FORMED

A state organization of independent radio–television service groups was created at a recent meeting held in Cambridge by delegates from six Massachusetts cities. The group is chartered as the Electronic Technicians Guild of Massachusetts (ETGM).

Elected president of the new group was Nicholas A. Averinos, Colonial Radio & Appliance Co., South Weymouth; vice president, Gilbert P. Clark, Centronics Co., Newton; secretary, Lawrence J. McEvoy, technician, West Newton; treasurer, Albert N. Giddis, TV service manager, Lowell; assistant to the president, Remo DiNicola, South Shore Television Services, Quincy.

LETTER TO THE FTC

The following letter was sent by the National Alliance of Television & Electronic Service Associations (NATESA) to the Federal Trade Commission:

"Gentlemen:

"We note with growing concern the tremendous pressure being exerted upon your commission to authorize 'Pay-as-you-see TV.' It appears that those who are pushing the hardest are huge, interlocking combines which would profit immensely from authorization of *captive* broadcasting. It appears that exclusive rights to movies, sporting events, etc., are tied up by these people and that manufacturing facilities are also already within these combines.

"With such potential monopoly so evident in other phases touching upon 'Pay-as-you-see TV' and in view of the fact that should authorization be forthcoming, control of the operation of *all* sets would become vital to the operators, it becomes crystal clear that the monopoly would be extended to include service and maintenance of TV sets.

"The independent TV service people, of whom there are roughly 120,000, have pioneered and developed the service business at great cost and sacrifice. They are *little*, little businessmen and cannot easily afford the cost of defending their rights against huge corporations. Further, they have learned from many years of contact with set owners that by and large, the public is happy with TV broadcasting as now practiced, even though they may not be completely satisfied.

TECHNICIANS' NEWS *(Continued)*

"Small service businesses are good for the American economy in both peace and war. With the rapid development of bigness in all phases of business, we believe service *is* the last frontier of free enterprise and that it must be preserved.

Sincerely,
Frank J. Moch
Executive Director"

ASSOCIATION MAGAZINE

The first issue of the SRTT IPET has appeared. It will be produced and distributed monthly as the official publication of the Society of Radio and Television Technicians, Inc. of California (SRTT). IPET means: for the *I*ndependent *P*rofessional *E*lectronic *T*echnician. The magazine is mailed free each month to members of SRTT and nonmember radio and TV dealers in the San Fernando Valley and the adjoining territory.

GUILD HITS DISTRIBS

Long Island, N. Y., electronic parts distributors were blasted for indiscriminate consumer sales by the Radio & Television Guild of Long Island (RTG). A report in the *Guild News*, the association's monthly journal, listed distributors accused by the guild of indiscriminate sales. Also listed were distributors who would not sell to a consumer under any circumstances.

This action was taken after persistent reports from members indicated that existing guild shopping policies required strengthing. Long Island service dealers have strongly objected to the number of parts jobbers selling to defense plant employes.

The *Guild News* noted that, if the more than 200,000 defense workers of the region make an average annual purchase of $5 in parts from distributors, more than $1,000,000 in retail sales would be routed from normal retail outlets.

RTA–PASADENA NEWS

Recent meetings of the Pasadena Radio Television Technicians Association (RTA) have seen a group of informative speakers, due to the efforts of Cecil Parker and Bill Yatty, program chairmen.

Bernard H. Linden, of the Los Angeles FCC office, presented a full discussion on interference problems with a description of the makeup and activities of the Cooperative Interference Committee, and the local FCC office.

At another meeting Miss Lillian Dionne, representing the Pasadena Office of the Social Security Administrations, covered all aspects of social security from both employer and employe viewpoints with special reference to the problems of service technicians and dealers.

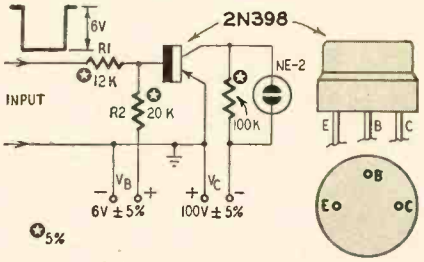
Another interesting talk was given by W. W. Cotie of the Hickok Instrument Corp. Mr. Cotie discussed tube testers and answered questions concerning his firm's test instruments. END

New Tubes & Semiconductors

Among the month's releases are two transistors. One of these is accompanied by a diagram showing its use in a neon indicator circuit. A tube-based silicon rectifier, a multiunit seven-pin miniature and a stacked rectifier also appear.

2N398

A germanium alloy-junction transistor of the p-n-p type. Made by RCA and specifically designed for use in high-voltage, on–off control applications, particularly neon indicator, relay puller, incandescent-lamp driver and direct-indicating counter circuits of electronic computers.



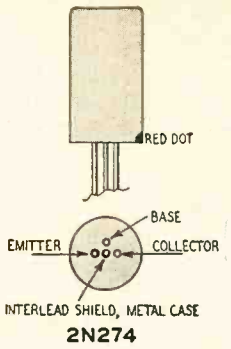
A typical neon indicator circuit is shown in the diagram. An input of −6 volts lights the lamp by overcoming the transistor's cutoff bias and causing the 2N398 to conduct heavily (saturate), grounding the lamp through the low collector-to-emitter resistance. With 0-volt input, the 2N398 is cut off by the base bias circuit (V_B, R2, R1) and acts like an open switch due to the high collector-to-emitter resistance.

Maximum ratings in switching service are:

V_{CB}	−105
V_{CE}	−105
I_E (ma)	100
V_{EB}	−50
I_E (ma)	100
Dissipation at 25°C (mw)	50
at 55°C (mw)	10
Ambient temperature operating °C	55

2N274

A drift transistor of germanium p-n-p type. Specifically designed for use as a rf amplifier in very compact military and commercial equipment and in entertainment type receivers operating at frequencies covering the AM broadcast band and up into the short-wave bands. An important design feature is the use of shielding to minimize interlead capacitance and coupling to adjacent circuit components. It is provided by a fourth lead situated between the collector and emitter leads and internally connected to the insulated metal envelope. The RCA 2N274 is



2N274

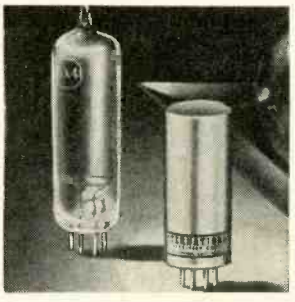
hermetically sealed and has flexible leads.

Maximum ratings for class-A rf amplifier service are:

V_{CB}	−35
V_{EB}	−.05
I_C (ma)	−10
I_E (ma)	10
Collector dissipation for ambient temperatures up to 71°C (mw)	35

S6X4

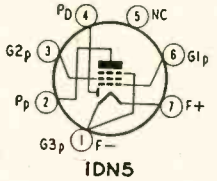
A tube-base-mounted silicon replacement for the 6X4. Directly interchangeable with the 6X4, it has a maximum dc output of 85 ma, an input voltage



of 400 rms and a maximum peak current of 225 ma. Maximum peak inverse voltage is 1250. Voltage drop at 70 ma is 6 volts. It is made by International Rectifier.

1DN5

This diode–remote-cutoff-pentode is a seven-pin miniature type with a 1.4-volt .05-amp coated filament. Designed for use in battery-operated portables, it performs the combined functions of AM detection and af amplification. It is manufactured by RCA.



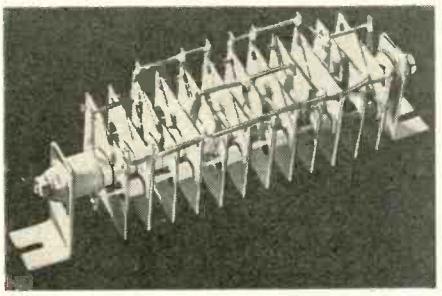
1DN5

Typical operation, pentode unit, as a class-A1 amplifier:

V_p	67.5
V_{g2}	67.5
V_{g1}	0
R_p (megohms)	0.6
g_m (μmhos)	630
I_p (ma)	2.1
I_{g2} (ma)	0.55
Maximum rating, diode unit:	
I_p (ma)	0.25

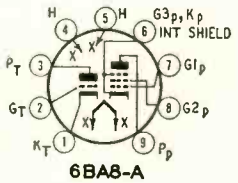
Rectifier stacks

A new line of 170°C silicon rectifier stacks has been announced by G-E. More than 200 standard models, completely wired for various uses, are included. A typical example is the 12-fin stack shown in the photo. This model is rated at 280 volts rms, input and 250 volts dc, output. Current rating at 25°C is 9 amps; at 170°C, 3 amps.



6BA8-A

A general-purpose multiunit tube of the nine-pin miniature type containing a medium-mu triode and sharp-cutoff pentode. The pentode unit is especially useful as a video amplifier tube. It may also be used as a reactance or agc amplifier tube. The triode unit can be used in low-frequency oscillator and phase-splitter circuits. Made by RCA, the 6BA8-A is designed with a 6.3-volt 600-ma heater having a controlled warmup time.



6BA8-A

Its characteristics as a class-A1 amplifier are:

	Triode Unit	*Pentode Unit*
V_p	200	200
V_{g2}		150
V_{g1}	−8	0
Cathode-bias resistor (ohms)		180
μ	18	
R_p (k ohms)	6.7	400
g_m (μmhos)	2,700	9,000
I_p (ma)	8	13
I_{g2} (ma)		3.5

Other types

A miniature twin-triode with separate cathodes has been released by Amperex. Type 7062 is designed as a plug-in replacement for the 5965.

A 6198-A Vidicon has been announced by RCA. It is a small camera tube intended primarily for industrial television applications.

A high-power high-vacuum diode has been introduced by IT&T. Designated the F-7030, it has a maximum peak inverse voltage rating of 25 kv.

Two uhf beam-power tubes with ceramic metal seals have been announced by RCA. They are the 6816 and 6884. END

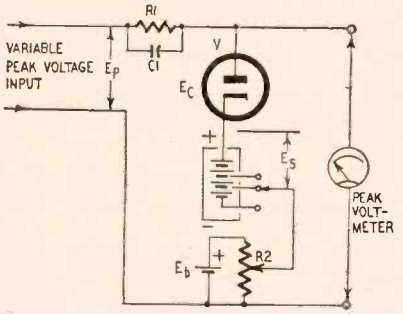
Patents

CALIBRATION CIRCUIT FOR PEAK-READING VOLTMETER

Patent No. 2,765,442

Mason A. Logan, New Providence, N. J. (Assigned to Bell Telephone Labs, Inc., New York, N. Y.)

This circuit is a convenient setup for calibrating a peak-reading voltmeter. The voltage source is one that has the same general waveform as that which the meter is to measure. Network R1–C1 (see diagram) has a time constant equal to that of the meter. Therefore, waveform distortion is eliminated.



To prepare the calibration circuit, E_b is first adjusted to cancel diode contact potential E_c. Then E_s, the standard voltage, is set to the desired value. Now E_p is increased and, when its peak voltage is equal to E_s, the meter deflection will cease to rise. At this point V begins to conduct and shunts current out of the meter. If, as presumed, E_s is known so is the peak of E_p and the voltmeter may be calibrated.

Note that the voltage across the meter is lower than E_s (or the peak of E_p) due to the voltage-dividing effect of R1, C1, so this network must be taken into account.

ALERTING DEVICE

Patent No. 2,744,194

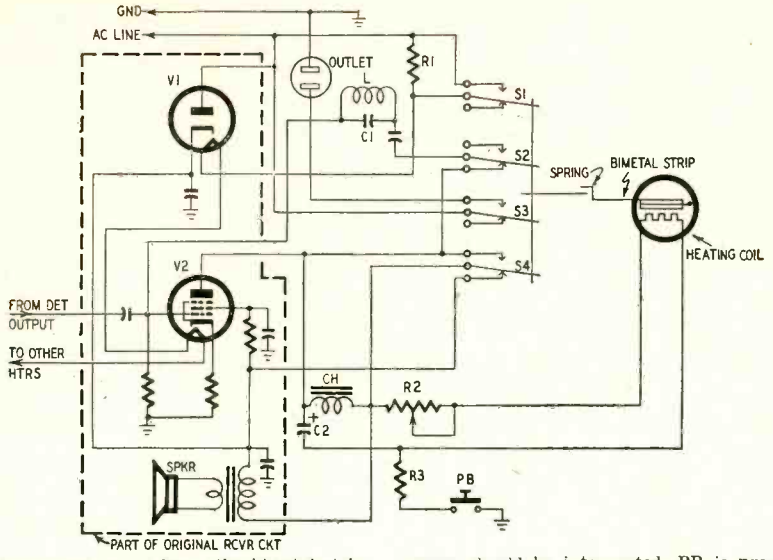
Martin Auerbach, Flushing, N. Y.

This is an adapter for a broadcast radio that can be tuned to any nearby station. Radio and adapter are energized at all times, but during standby periods power consumption is very low. In case of an air raid or other emergency, the broadcast station transmits a predetermined steady tone which operates the adapter, switching the radio to full gain and sounding an alarm.

The adapter includes a pair of plugs for insertion into the rectifier and power tube sockets of the radio. These tubes (see diagram) V1 and V2, are removed from the radio and plugged into corresponding sockets of the adapter. No soldering is necessary. The adapter also contains a line outlet for a warning light or audible alarm and an adjustment knob.

The heart of the adapter is a bimetallic strip which is heated by the alerting signal. This strip is spring-loaded so even slight bending causes it to trigger the multi-pole switch. This switch (S1 to S4) is shown in its standby position.

With S1 as shown, series resistor R1 reduces heater current to the radio. This saves power during standby when full radio amplification is not necessary. S2 feeds the output of V2 back to its grid through L–C1. This degenerative network is tuned to the warning tone, so this is the only frequency that does not incur degeneration. It is the only frequency that is fully amplified during this time. The speaker is shorted by S4 which connects CH and C2 to pass the steady



tone into the coil which heats the bimetal strip, triggering the alarm.

On receipt of an alert signal, S1 shorts R1, and the radio is set for full gain. S3 energizes the ac outlet to set off any desired visual or audible alarm. S4 shorts out CH and places the loud speaker across V2.

This adapter appears fool proof unless the power should be interrupted. PB is provided to periodically check the circuit. When momentarily depressed, dc from the power tube flows into the heating coil and R3. If the alert device is operating properly, the bimetal strip should be triggered in about 30 seconds. R2 is used to adjust input to the heating coil. A knob on the front panel resets the device.

IONIC SPEAKER

Patent No. 2,793,324

Michael N. Halus, Palo Alto, and Stanley W. Holcomb, Mountain View, Calif. (May be used by the U. S. Government without payment of royalties.)

Corona is something to be avoided in TV sets, but here it is the basis of operation. The ionic speaker is an efficient device for converting audio currents into sound. It does this by generating an intense stream of ions (or corona) which cause the air to expand and contract in accordance with the audio currents. Having no mechanical parts, the ionophone is efficient and without resonant frequencies.

This invention (see Fig. 1) is an improvement

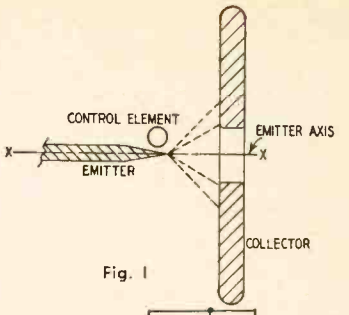


Fig. 1

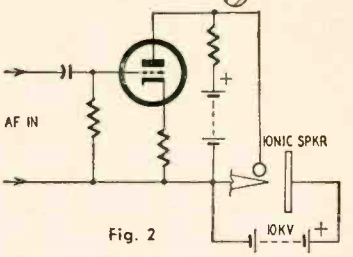


Fig. 2

over previous types. There are three elements: an emitter, a metallic rod with pointed end; collector, a circular metal ring with opening at its center; a control element wire (whose cross-section is shown as a small circle). A high voltage is impressed between emitter and collector to set up a corona discharge. The ion stream must not be too intense or an arc will occur.

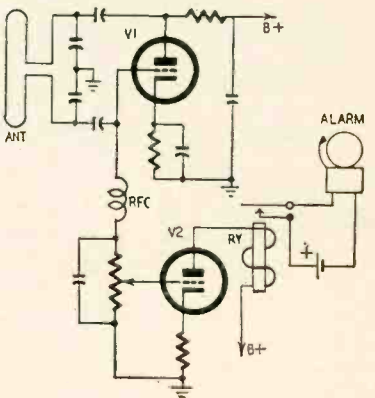
Fig. 2 shows how to connect the ionic speaker to an audio output tube.

ANTI-SHOPLIFTER DEVICE

Patent No. 2,744,060

Thomas F. Thompson, Eugene, Ore. (Assigned to Richard B. Thompson, Dale Belford and Oliver D. Olson)

This invention protects against theft of merchandise from department stores and similar shops. A tiny resonant circuit is concealed within the price tag of each article. If the article is stolen and carried through an rf field generated for the purpose, it affects an oscillating circuit which sets off an alarm.



The diagram shows a grid-dip oscillator (V1) which generates a field around its antenna. The latter may be a loop placed near the counter of the store cashier. Each shopper must pass through this field. If he or she is carrying stolen merchandise through the field, its resonant circuit reacts on the dip oscillator. There is a reduction of grid current to V1, lowering the bias on V2. The latter tube passes more current, energizing the relay and setting off an alarm.

The oscillator frequency may be as high as 5,000 mc. At such frequencies the resonant circuit may be a conductor about 1 inch long. END

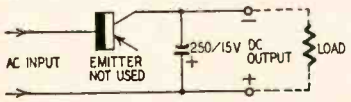
RAINEX VS RADAR?

Vatican City Latinists bemoan that Latin is continuously being pushed to the rear. They claim Latin is by no means dead and their scholars keep adding modern terms. Sample: *Radio-electricum instrumentum exploratorium* (radar).

try This one

TRANSISTOR RECTIFIER

Everyone knows that a junction transistor is made up of two rectifiers, but few have tried it for rectification purposes. Actually, the base-collector junction is very efficient when used as an ac rectifier.



The circuit is shown in the diagram. The transistor is any high-power p-n-p transistor, such as a 2N256 or 2N301. Load currents and voltages are shown below. In these tests the transistor junction was compared with that of a low-voltage (25-volt) *selenium* rectifier.

Ac volts	*Load (ohms)*	*Load Current (ma)* *Transistor*	*Selenium*
12	12.5	600	500
10	8.	600	520
6	8.	350	280

If you find yourself without a high-current rectifier for a sudden experiment, try a transistor. Even a damaged unit may still be suitable as a rectifier. For example, it is quite possible that a dead short may occur between emitter and base, without affecting the other junction. Under this condition, it is still possible to use the collector-base junction.—*I. Queen*

CUT CONTROL SHAFTS

New subminiature controls used in transistor equipment have ⅛-inch-diameter shafts. These shafts can be cut to length in less than a second using an AMP type screw-cutting and terminal tool.

Insert the shaft into the 8-32 or 10-32 screw-cutting opening and squeeze. The shaft will cut off clean as a whistle without any burrs or distortion. — *Edwin Bohr*

PAINTING ETCHED PANELS

Repainting electronic equipment with control markings etched on the metal panel is quite a problem. Many shun this type of work because of the time spent in "picking" the recessed letterings, which are usually numerous. Here is a simplified method of repainting this type of panel with a minimum of effort and with simple and inexpensive equipment.

To start with, you will need a paint sprayer or a hand type insecticide sprayer with a good pump. This is imperative if you want a fine spray finish. You will also need a stiff brush, a few sticks of writing chalk, paint thinner

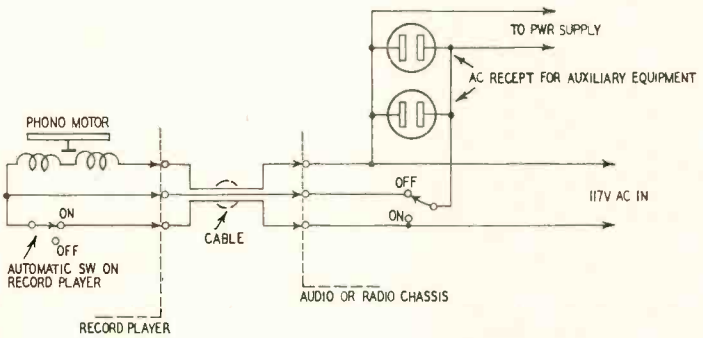
and of course quick-drying enamels of the desired shades.

In repainting etched panels, start with the etched letters. Give the inside of the letters a thin coat of the desired color using a stiff brush to apply the paint. Use jabbing strokes. Next, wipe off paint smears on the panel's surface with a rag wet with paint thinner. Do not use too much thinner or you will flood the etchings. Allow the paint to dry completely (this is absolutely necessary) before you tackle the whole panel surface. If quick-drying lacquer or enamel is used in the operation, the repainting can be completed the same day. Here's where the real problem comes in. How do you prevent paint from smearing the nice job you made on the etched lettering? Very simple! Get out those sticks of blackboard chalk and, with the panel laid flat on a table, rub particles of chalk into the etched letters to fill the depressions completely. Wipe off excess chalk that gets on the panel's surface, being careful not to scratch out the chalk that is in the etchings. Now you are ready to spray.

Fill up the sprayer with the desired paint and spray it on the whole panel surface. Allow the paint to dry completely. When dry, restore the markings by picking them with a stiff brush. The thin paint coating breaks loose easily under the pressure of the stiff brush. The loosened particles of chalk may then be blown out of the depressions and clear, neat letters remain. —*Jesus N. Ongchua*

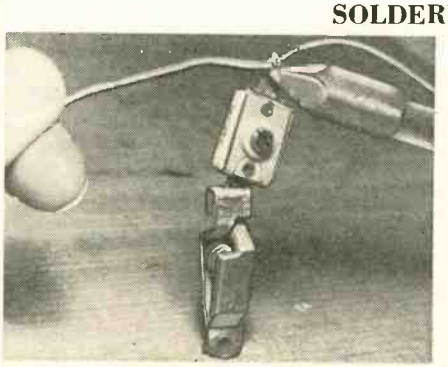
NOVEL AUDIO SWITCHING

Many record players (both manual and automatic) have a switch that opens the line circuit at the end of the last record. By substituting an spdt switch for the normal spst line switch on your amplifier, radio or tuner this equipment can be automatically turned off at the end of the last record. The diagram shows the hookup.



The record player is controlled at all times by its on–off switch. When the amplifier or radio line switch is off, the equipment can be turned on by closing the switch on the record player. Throwing the radio or amplifier line switch to ON makes the equipment independent of the switch on the record player. A three-conductor cable and polarized connectors are recommended for making connections between the record player and audio chassis.—*John E. Meyer*

SOLDERING VISE



Ever wish you had a third hand to hold small parts when soldering? Make a small vise for the purpose from a test clip and a woodscrew. Clip off the wire supports at the rear of the clip, remove the screw and pinch the rear projection flat. Hacksaw the slot in the woodscrew 1/25 inch deeper, insert the back of the clip into the slot and solder it in place. Screw the vise into a pilot hole drilled in a convenient spot on the top of your workbench.—*John A. Comstock*

CRYSTAL-PICKUP TEST

Checking crystal phono and microphone cartridges is quick and simple when a bridge type capacitor analyzer is used.

Disconnect the leads from the cartridge and clip test leads to the terminals. Set the capacitor checker's range selector switch to the 10–5,000-$\mu\mu$f range and balance the bridge with the tuning eye or other indicator just as you would when checking a capacitor. Now, gently pluck the phono needle or thump the mike cartridge with a finger while watching the balance indicator on the tester.

If the crystal is good, the indicator flickers or deflects violently as the generated voltage and change in capacitance unbalance the bridge. On the other hand, little or no variation will be noticed if the crystal is defective. —*Paul Mitnaul* END

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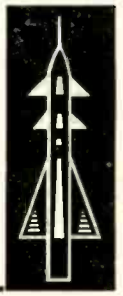

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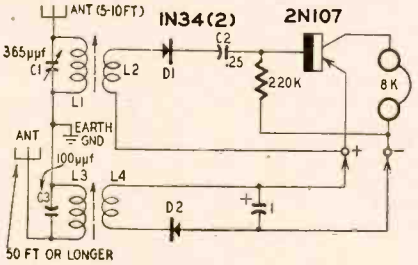
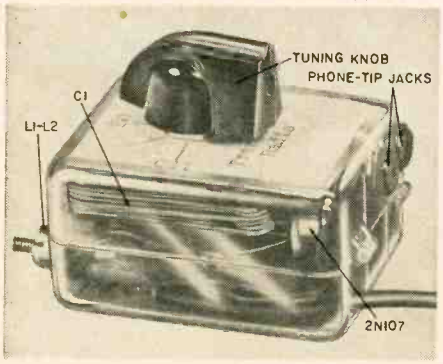


The diagram shows the circuit of my signal-powered transistor receiver. In the set shown in the photo the "battery" circuit is separate and is connected to the receiver through a cable. A strong local signal is picked up by tuned circuit L3–C3 and coupled to D2 and rectified to provide "battery" voltage for the transistor amplifier. L3–C3 should be tuned to the frequency that provides the maximum voltage across the 1-μf filter capacitor. On strong signals the voltage will be between 0.4 and 0.8. If the strongest signal is below about 800 kc, increase the value of C3 to 200 or 300 $\mu\mu$f.



The receiver portion of the circuit consists of tuned circuit C1–L1, diode D1 and a 2N107 transistor as an audio amplifier. C1 may be one of the 365-$\mu\mu$f midget tuning capacitors used in transistor circuits. C2 couples the detector to the 2N107 amplifier. The phones should have an impedance of at least 8,000 ohms to provide an acceptable match to the transistor.

Coils L1 and L3 are ferrite-core

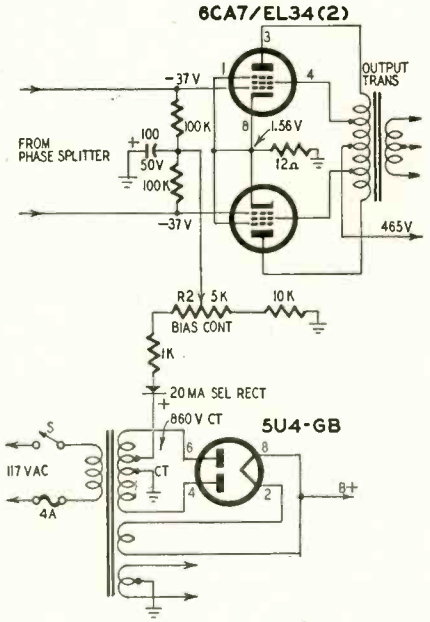
antenna coils. L2 consists of 50 turns of fine wire wound close to the grounded end of L1, and L4 has approximately 75 turns of fine wire wound close to the grounded end of L3.

This set uses two antennas and a common ground. The antenna for the "battery" circuit should be at least 50 feet long and as high as practical. In many areas the other antenna need not be longer than 5–10 feet.—*M. E. Quisenberry*

DYNA BIASET

A novel method of obtaining an accurate bias adjustment is incorporated in all new Dynakit amplifiers. Called *Biaset*, it insures top performance of the completed amplifier and eliminates the need of high-quality meters to make accurate bias settings.

The bias adjustment using the Biaset technique results in the same setting that would be obtained by adjusting the amplifier for minimum distortion.



The circuit is seen in the diagram. When bias is correctly set, the total cathode current of the 6CA7/EL-34's is 130 ma. This current, flowing through the precision 12-ohm resistor R1, produces a voltage drop of exactly 1.56 dc. As 1.56 volts is the voltage furnished by a D type flashlight cell, any fresh cell of this type acts as an accurate reference standard for bias adjustment.

The method of setting the bias is to measure the voltage output of a D type cell and note the meter reading. Then place the meter across R1. Plug in the rectifier and almost immediately there will be a current flow which will cause a meter deflection.

As the rectifier warms up, the reading. rises. The bias control (R2) should then be adjusted until the meter reading is the same as that across the dry cell. There may be some drifting as the tubes heat, but this will stabilize in 15 to 30 minutes, after which no further adjustment is necessary.

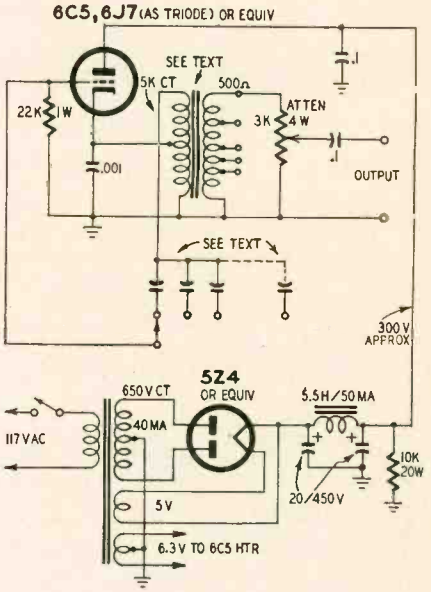
Although the setting is semiperma-

nent, resetting the bias at times of tube replacement or similar repair or maintenance work will preserve peak performance and keep distortion at an absolute minimum.

SIMPLE AUDIO OSCILLATOR

This easily built audio test oscillator uses a minimum of parts, has enough output to test speakers and can be connected to high or low impedance circuits.

The cathode of the oscillator tube connects to the center tap on the primary of an audio transformer and is bypassed to ground by a .001-μf capacitor. The transformer has a 5,000-ohm center-tapped primary and 500-ohm secondary. I used a Stancor A-3800. The oscillator is capacitance-tuned by switching capacitors in the grid circuit. A 2-μf paper unit produces oscil-



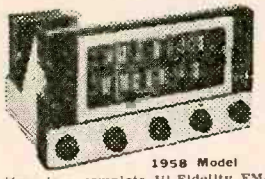
lations at around 20 cycles and a 500-$\mu\mu$f unit changes the frequency to around 20 kc. The frequency selector switch may be a 12- or 17-position rotary type such as the Mallory 32112J or 32117J, respectively. Use a soft-iron sheet-metal shield between the oscillator and power supply if both are on the same chassis.

This oscillator can be calibrated with the aid of a calibrated generator and an audio amplifier. Connect both outputs to the amplifier input and trim the tuning capacitors for zero beat. For example, if you want 400 cycles at a particular switch position and a .05-μf capacitor produces a 450-cycle signal, bridge small capacitors across the large one until the frequency is correct.—*W. M. Finley, Jr.* END

SHOCKING ERROR

On my first job
Didn't use good sense or
I'd never have touched
That high-voltage condenser!
—*Phyllis Barlow*

Hi-Fidelity AM-FM Radio



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1958 Model

Here is a complete Hi-Fidelity FM-AM radio made by one of the top manufacturers. This set is ideal for custom installations. Built-in 14-Watt Hi-Fidelity push-pull amplifier. Separate bass and treble controls. built-in AM and FM antennas, phone jack, output jack for tape recorder. Frequency Range 20-20,000 cycles ±2db. Output trans. tapped for 3.2, 8 and 16 ohms. This 11 tube set comes complete with crystal and magnetic phono inputs, including a 12" RCA extended range speaker. Size 12½x7½x7½. Amplifier, Pre-amplifier, AM-FM tuner — ALL ON ONE CHASSIS. Schematic Diagram on Request.

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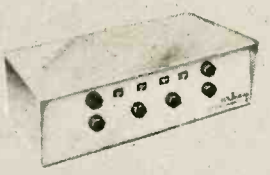
Arkay "Miracle Ear" sensitivity on AM gives 3mv. for 20 db. quieting: Bandwidth — 8 KC: freq. resp. 20-8,000 cycles: adj. cathode follower output.

ST-11

Kit $47.95 Wired $69.95

SP-6



SP-6—Dual channel, preamp with cathode follower outputs. Can be used with tape deck, mag. phono, tuner, or aux. equipment. The construction of the SP-6 allows for use as a conventional pre-amp. Features include 6 position func. switch: Simultaneous volume control: Loudness control: Bass control ± 16 db. @ 60 cps: Treble control ± 16 db. @ 10,000 cycles: 3 position Hi-filter and Lo-filter: Freq. response ± .5 db. 20 to 40,000 cps. Sensitivity—tape, 4 mv. for .5 volt output—phono, 6 mv. for .5 volt output—tuner and aux. .3 volt for .5 volt output: DC fil.: Built-in power supply:

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MODEL SA-25—dual channel pre-amp drives a monaural 25 watt Linear Williamson amp. with your present amplifier for unsurpassable realism of Binaural sound.

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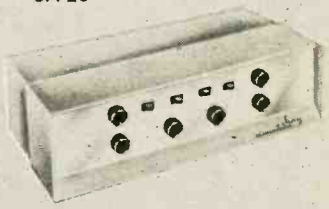
SA-25



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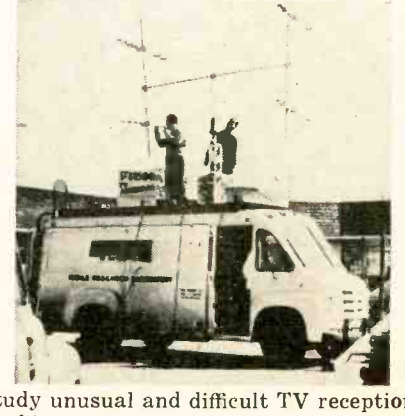
various sections of the country who have performed outstanding community service. The trophy shown and a $500 check for the winner's favorite charity or public service will be the prize for each winner.

Finney Co., Bedford, Ohio, developed a mobile research laboratory unit to



study unusual and difficult TV reception problems.

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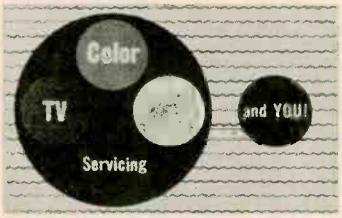


Color TV Correspondence Course for men with previous radio–TV training.

Charles M. Odorizzi, executive vice president—sales and services of RCA, was elected a member of the board of directors.

Sterling C. Spielman, director of electronic engineering for the Government and Industrial Div. of Philco Corp., Philadelphia, was appointed director of engineering for the division.

Albert Coumont (left) and **Kenneth Price** were named regional sales supervisors for Sprague Products Co., North Adams, Mass. Coumont was formerly

assistant to the president and is well known in the industry having served for four years as service coordinator for RETMA (now EIA). Price was previously Midwestern field engineer for Sprague Products and before that was on the engineering Staff of Radio Condenser Co.

Goodwin Mills, general manager of Knight Electronics Corp., Chicago, manufacturer of Knight Kits, was elected vice president of the company.

Bruce Fritz, sales manager of Lincoln Radio & Television Corp., Chicago, was elected vice president.

Jack W. Merritt (left), sales manager of the Photofact Div. of Howard W. Sams & Co., Indianapolis, was named sales manager of the new Electronic Distributor Div. **Walton G. Wilson**,

who joined the company in 1955, has been promoted to sales manager of the Industrial Service Div., succeeding Joe H. Morin, who recently became general sales manager.

Richard W. Griffiths was appointed director of sales for the Components Div. of Litton Industries following recent consolidation of the division and U. S. Engineering, a Litton subsidiary. Production, engineering, administration and sales functions are now centered in one Los Angeles location. He had been with Graybar Electric.

Alfred P. Petrusky, sales service manager of the Sylvania Radio Tube Div. in Williamsport, Pa., was promoted to manager of marketing, research—electronic products, with headquarters in New York.

Robert Black was appointed to the new position of Government contracts manager with Astron Corp., East Newark, N. J. He comes to the company from Servo Corp. of America.

George Mucher, Jr. joined the Distributor Sales Div. of Clarostat Manufacturing Co., Dover, N. H. He is the son of George Mucher, executive vice president—engineering activities.

Donald G. Haines, manager of the Chicago office of the Electronic Applications Div. of Sonotone Corp., was elected chairman of Chicago's IRE section.

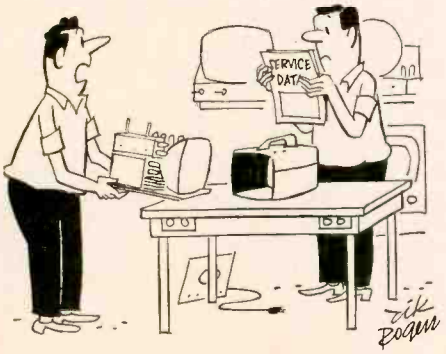
Arthur M. Liebschutz joined RCA as administrator–planning and entertainment, Semiconductor Div., Somerville, N. J. He had been manager of sales in the Selenium Rectifier Div. of Federal Telephone & Radio Corp.

Richard Deutsch, sales engineer for Channel Master Corp., Ellenville, N. Y., was promoted to chief sales engineer.

Allen S. Johnson was appointed sales manager of Cletron Inc., a division of Cleveland Electronics, Cleveland, Ohio, for its line of loudspeakers, speaker kits, hi-fi enclosures and related equipment. He has been active in sales and management with Westinghouse, Colonial Radio, Thompson Products and Webcor.

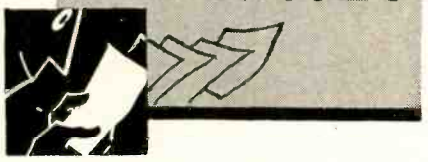
Reginald G. Schuler joined Brush Electronics Co., Cleveland, Ohio, as general engineering manager. He comes to the company from Badger Meter Manufacturing Co.

Sprague Products Co., North Adams, Mass., recently received its fourth Friends of Service Management Award from NATESA at that group's conference in New Orleans. Sidney L. Chertok (left), sales promotion manager for Sprague, is shown accepting the award from Harrol O. Eales, NATESA West Central vice president. END



"Does it say how to get it back in the case?"

technical Literature



TRANSFORMER GUIDE

Assembled with the technician in mind, *Catalog TV-57* describes a comprehensive line of replacement transformers and coils for TV applications. An alphabetical listing indicates the correct replacements for many TV sets.

Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

ELECTRONIC ORGAN

A two-color 16-page illustrated booklet describes an electronic organ you can build and details the 24 kits that make up the completed organ.

Schober Organ Corp., 2248 Broadway, New York 24, N. Y.

REPLACEMENT GUIDE

This revised replacement guide for substitution of germanium for selenium rectifiers in TV sets lists all American-made sets built since 1953 in which seleniums can be replaced by germanium rectifiers.

General Electric, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

GENERAL CATALOG

Green Sheet lists new and surplus test equipment, communications receivers and transmitters and parts.

Barry Electronics Corp., 512 Broadway, New York 12, N. Y.

DECIMAL EQUIVALENTS

A three-color wall chart of decimal equivalents with decimals running down the center of each column with 64ths to the right and 32nds and 16ths to the left. Guide lines connect each decimal with its equivalent fraction. 16 x 23 inches and 4 x 8½ inches.

John Hassall, Inc., P.O. Box 2242, Westbury, N. Y. Attn: Mr. Brewster.

CAPACITORS

Illustrated 24-page *Catalog 5701* offers a variety of ceramic, electrolytic, metallized paper and paper-oil replacement capacitors.

Tobe Deutschmann Corp., 2900 Columbia Ave., Indianapolis, Ind.

BAFFLES

A complete line of loudspeaker baffles and housings is described in an eight-page brochure, *No. P-100.* Included are wall, ceiling and portable models; hi-fi enclosures, accessories.

J. J. Powers Co., 1317 S. Fifth Ave., Maywood, Ill.

MEASURING TIME INTERVALS

Data File 112, Time Interval Measurements and How to Make Them, describes time-interval meters, the measurement of pulse width and elapsed time, and timing relay operations.

Beckman/Berkley Div. 2200 Wright Ave., Richmond, Calif.

EIA STANDARDS

Five new standards have been published: *RS-189: Encoded Color Bar Signals,* from *Standards Proposal No. 524; RS-192: Definitions and Dimensional Characteristics of Quartz Crystal units,* from *Standards Proposal No. 528,* a revision of *TR-112-A; RS-193: Designation System for Cathode-Ray Tubes,* from *Standards Proposal No. 540,* a revision of *ET-111-A. RS-194: Microwave Relay System Towers,* from *Standards Proposal No. 537; RS-195: Mechanical Characteristics for Microwave Relay System Antennas and Passive Reflectors,* from *Standards Proposal No. 538.*

EIA, Engineering Dept., 650 Salmon Tower, 11 W. 42nd St., New York 36, N. Y. RS-189, 30c; RS-192, 50c; RC-193, 25c; RS-194, 40c; RS-195, 50c.

NEW PRODUCTS

What's New With the Electron . . . 1957, is a listing of this manufacturer's new products for 1957. Klystrons, ceramic tetrodes, ceramic triodes and other special types are covered.

Eitel-McCullough, Inc., San Bruno, Calif.

BATTERY CONNECTORS

New 32-page catalog *GB6* contains information on battery-power and heavy-duty connectors for industrial and allied applications.

Cannon Electric Co., 3208 Humbolt St., Los Angeles 31, Calif.

KNOBS AND DIALS

A versatile line of standard instrument and control knobs, dials and assemblies made from thermosetting plastic is featured in *Catalog 106.*

Kurz-Kasch Inc., Standard Parts Div., Dayton 1, Ohio.

PRECISION RESISTORS

Comprehensive data on construction, types, winding techniques, winding forms, impregnation, terminals and characteristics of wirewound precision resistors is presented in illustrated *Bulletin D-1b.*

International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. END

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

Books

MARINE RADIO TELEPHONY, SC-34. Radio Technical Commission for Marine Services, c/o FCC, New Post Office Building, Room 6120, Washington 25, D. C. 5½ x 8½ inches, 48 pages. 60c (1–25 copies), 50c (over 25 copies).

Over 50,000 boats and ships carry radiotelephone equipment. Unfortunately many users do not understand how best to use radiotelephone to carry on their business, exchange vital information relating to navigation and management and, above all, for *safety.* This educational booklet describes proper us of the radiotelephone. It is prepared by the Radio Technical Commission for Marine Services (RTCM), an association of manufacturers, transportation groups and government agencies.

The handy guide lists calling, working and distress frequencies; summarizes radio rules and recommends procedure in case of emergency. To assure safe, as well as happy sailing, a copy should be aboard.—*IQ*

SERVICING COLOR TV, by Robert G. Middleton. Gernsback Library, 154 W. 14th St., New York, N. Y. 5½ x 8½ inches, 224 pages. Soft cover $2.90, hard cover $4.60.

With color television becoming more common, the service technician has been given a new and more difficult job. Color receivers are more complex and circuit action more critical than in monochrome sets. This book is written for the technician who is going to *repair* color receivers, rather than the man who wants to understand their fundamental principles of operation. It translates the theoretical approach, issued by the manufacturers, into an integrated, practical servicing technique that applies to all color sets.

Nine chapters cover all phases of color servicing. Numerous illustrations showing partial schematics, waveforms and screen patterns appear throughout. Some of the topics covered are: preliminary servicing, color sync servicing, servicing chroma demodulators, matrix testing, signal tracing and test equipment.—*LS*

ACOUSTICAL ENGINEERING, by Harry F. Olson. D. Van Nostrand Co., Inc., 257 Fourth Ave., New York 10, N. Y. 6 x 9 inches, 718 pages. $13.50.

Modern acoustics has become a science of gigantic proportions. It is an essential part of radio, TV, recording, sound movies, ultrasonics and underwater detection and communications. This revised and enlarged edition

BOOKS *(Continued)*

brings the whole subject up-to-the-minute for technicians and engineers. The author explains his subject by frequent comparisons with electronics and mechanics. Analogies between the systems appear often.

The book covers basic principles of sound waves, radiators and vibrators. Detailed data and charts are provided for the various types of speakers, microphones and specialized transducers.

Calibration of microphones, testing of speakers, measurement of wow, absorption and noise are given detailed attention. Of course, there is an entire chapter on the nature of hearing. After all, it is the ear mechanism that decides what hi fi is and distinguishes between sounds.—*IQ*

TRANSISTOR CIRCUITS AND APPLICATIONS, edited by John M. Carroll. McGraw-Hill Book Co., 327 W. 41 St., New York 36, N. Y. 8½ x 11 inches, 283 pages, $7.50.

More than 100 articles are reprinted in their entirety, from past issues of *Electronics* magazine. Theoretical and practical subjects are included. Transistor ratings and tables also appear.

Articles are grouped into sections: circuit design, amplifiers, oscillators, broadcast applications, communications computers, etc. Among the devices are a video amplifier, binary counter, pocket-size FM transmitter, hearing aids and hi-fi equipment. Besides germanium triodes, there are articles on tetrodes, silicon transistors and special high-frequency units. This is a convenient and comprehensive source of transistor information.

MOST-OFTEN-NEEDED 1957 RADIO DIAGRAMS AND SERVICING INFORMATION, compiled by M. N. Beitman. Supreme Publications, 1760 Balsam Rd., Highland Park, Ill. 8½ x 10¾ inches, 192 pages. $2.50.

A compilation of original manufacturers' schematic diagrams and servicing data on the most popular late 1956 and early 1957 home and auto radios, phonographs and tube and transistor portables. Sets covered include several hundred models and chassis made by 33 manufacturers. END

"Well, he shouldn't give us too much competition."

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

SCHOOL DIRECTORY PAGE 163

BRANCH ADVERTISING OFFICES: Chicago: 1413 Howard St. Tel. ROgers Park 4-800. Los Angeles: Ralph W. Harker and Associates, 600 South New Hampshire. Tel. DUnkirk 7-2328. San Francisco: Ralph W. Harker and Associates, 444 Market St., Tel., GArfield 1-2481.

FOREIGN AGENTS: Great Britain: Atlas Publishing and Distributing Co., Ltd., 18 Bride Lane, London E.C. 4. Australia: McGill's Agency, Melbourne. France: Brentano's, Paris 2e. Belgium: Agence et Messageries de la Presse, Brussels. Holland: Trilectron, Heemstede. Greece: International Book & News Agency, Athens. So. Africa: Central News Agency, Ltd., Johannesburg, Capetown, Durban, Natal; Universal Book Agency, Johannesburg. India: Broadway News Centre, Dadar, Bombay #14. Pakistan: Paradise Book Stall, Karachi 3.

FREE! LAFAYETTE CATALOG

JUST OFF THE PRESS!

NEW 180 PAGE ELECTRONIC CATALOG FEATURING THE BEST BUYS IN THE BUSINESS

The newest and largest assortment of Electronic, Radio and TV parts, Hi-Fi and Public Address Components and systems, Test Equipment, tubes, Transistor Kits and miniaturized components for transistor circuitry, Ham Equipment, Builders Kits, Tools, Books, Microscopes, Binoculars, Telescopes, Cameras, and Drafting Equipment.—**ALL AT LOWEST PRICES**—Catering to the economy minded dealer, serviceman, engineer, technician, experimenter and hobbyist. **CRAMMED FULL OF MONEY SAVING BUYS. SEND FOR YOUR FREE COPY TODAY.**

Lafayette Introduces Hi-Fi Gems

... at prices everyone can afford

KT-300 IN KIT FORM 39.50

LAFAYETTE MASTER AUDIO CONTROL CENTER with BINAURAL CHANNEL AND DUAL VOLUME CONTROL.

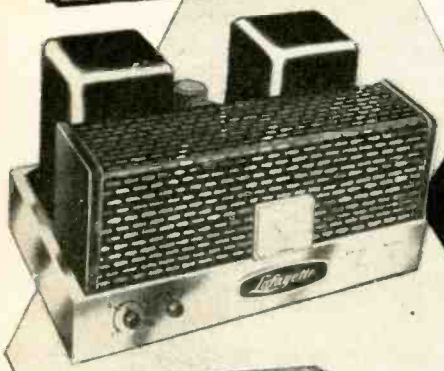
Years Ahead of Every Other Control Unit ... Ahead In Sound ... Ahead In Styling

***Ahead In Design ... Ahead In Features ...* Available In Kit and Wired Form**

This is not only the finest hi-fi preamp characterized by unmatched features, but it has been functionally designed to keep pace with the conversion of your present hi-fi system to binaural (Stereophonic) sound. Incorporates an extra channel and dual volume control for binaural reproduction. Features include DC on all tube filaments, negative feedback in every stage, dual cathode follower output stages and latest printed circuit construction. Less than 0.09% IM distortion and less than 0.07 harmonic distortion at 1V. Hum and noise level better than 80 db below 3V. Uniformly flat frequency response over entire audible spectrum. 7 inputs for every type of phono, tuner or tape. Tasteful styling, brilliantly executed. Size 12¾ x 9⅛ x 3¾". Shpg. wt., 10½ lbs.

KT-300—Lafayette Master Audio Control Kit Complete with cage and detailed assembly instructions. ..... Net **39.50**

LT-30—Same as above completely wired and tested with cage and instruction manual. Net **59.50**



KT-400 IN KIT FORM 69.50

DELUXE 70 WATT BASIC AMPLIFIER

- **Conservatively Rated At 70 Watts**
- **Ultra-Stable**
- **Variable Damping**
- **Metered Balance And Bias Adjust Controls**
- **Available In Kit And Wired Form**

Here's ultra-stability in a 70 watt basic power amplifier employing highest quality components conservatively rated to insure performance and long life. Features matched pair KT 88's and wide range linear output transformer, variable damping control, meter for bias and balance and chrome plated chassis. Frequency response 10-100,000 cps ± 1db. Hum and noise 90db below full output. IM distortion less than 1½% at 70 watts, less than 0.3% below 30 watts. Harmonic distortion less than 2% at 70 watts from 20 to 20,000 cps ± 1db. Output impedance 4,8 and 16 ohms. Handsome decorative cage perforated for proper ventilation. Size 14½ x 10 x 7⅜" including cage and knobs. Shpg. wt., 40 lbs.

KT-400—Lafayette 70 watt Deluxe Basic Amplifier Kit complete with cage and detailed assembly instructions. ..... Net **69.50**

LA-70—Same as above completely wired and tested with cage and instruction manual. Net **94.50**

KT-100 LESS CAGE 34.95

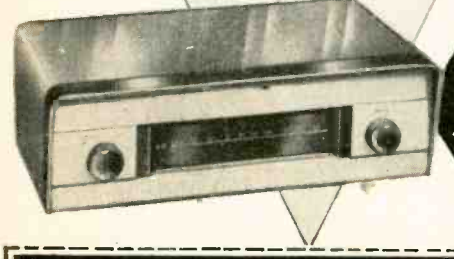
LAFAYETTE'S EXCLUSIVE FM-AM TUNER KIT

FM-AM Tuner with outstanding Specifications and astonishing Performance — All at a Budget Price — In easily assembled kit form.

Excellence of design and quality of components provide this compact hi-fi FM-AM tuner with superb characteristics normally found in most expensive tuners. Features Armstrong FM circuit with limiter and Foster — Seeley discriminator, grounded grid triode RF amplifier, AFC defeat circuit combined with front panel tuning control and simplified tuning with slide rule dial and counterweighted mechanism. Excellent sensitivity, selectivity and frequency response. Distortion less than 1% at rated output. Meets FCC requirements for radiation. Attractive etched copper-plated and lacquered finish. Simplified detailed Construction Manual with step-by-step assembly instructions. Size 9⅝" W x 9½" D (excluding knobs) x 5¼" H. Less metal cage. Shpg. wt., 9 lbs.

KT-100—FM-AM Tuner Kit, less Metal Cage ..... Net **34.95**

ML-100—Metal Cage for above. Shpg. wt., 3 lbs. ..... Net **5.00**



LT-60 WIRED FM TUNER 49.95

NEW! Lafayette DELUXE HI-FI FM TUNER COMPLETELY WIRED AND TESTED.

- **Armstrong Circuit with Dual Limiters**
- **9 Tubes Plus Selenium Rectifier**
- **Temperature Compensated and AFC**
- **Custom Styled**

Lafayette engineers bring to the discriminating music lovers who confine their broadcast listening to FM (the true hi-fi spectrum), a tuner giving the utmost possible value in performance and quality. Features Armstrong circuit with Foster-Seeley discriminator, 3-gang condenser with tuned RF stage, 4 IF stages (including dual limiters), AFC and AFC defeat, temperature compensated circuitry, and has 9 tubes plus selenium rectifier. Sensitivity 3.5 μv for 20-30db. Distortion less than 1%. Frequency response 20-20,000 cycles ± 0.5db. Cathode follower and high impedance outputs. Meets FCC requirements for radiation. Low modern lines, attractively finished in brushed gold-brass and maroon, for shelf or table top use. Completely self powered and wired, ready for operation. Size: 14" W x 7" D x 4¼" H. Complete with cover. Shpg. wt., 13 lbs.

LT-60—FM tuner ..... Net **49.95**

Lafayette Radio

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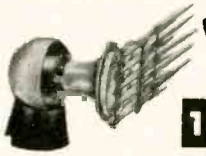
SEND FREE CATALOG 305

CUT OUT AND MAIL TODAY!

HIGH FREQUENCY TWEETER WITH ACOUSTIC LENS



New!

14.95

DIRECT IMPORTATION MAKES THIS PRICE POSSIBLE!

- **FREQUENCY RESPONSE FROM 2000 CPS TO BEYOND AUDIBILITY**
- **LOUVERED ACOUSTIC LENS FOR UNIFORM SOUND DISPERSION**
- **HANDLES 25 WATTS OF POWER**
- **PRICED EXCEPTIONALLY LOW**

New high frequency tweeter featuring a louvered acoustic lens for uniform sound dispersion and capable of handling up to 25 watts of distortion-free power. The directional tendency of high frequency notes is overcome by the natural wide dispersion angle of the short horn and the acoustic lens which disperses and radiates the high notes smoothly throughout the entire listening area. The lens is detachable for panel mounting, with a separate base for the tweeter furnished for external mounting where desired. Aluminum voice coil has 16 ohms impedance. Size: 4¼" long x 3" diameter, lens extends 2½". Requires a crossover network, preferably one with a level control, such as the LN-2. With full instructions. Shpg. wt., 5 lbs.

HW-7 ..... Net **14.95**

LAFAYETTE SENSATIONAL VALUES! IN COMPLETELY WIRED TEST EQUIPMENT at LESS than the PRICE of KITS!

LAFAYETTE SIGNAL GENERATOR

NEVER BEFORE HAS A COMPLETELY WIRED AND TESTED INSTRUMENT OF SUCH ACCURACY AND QUALITY BEEN OFFERED AT SUCH A PRICE!

- FREQUENCY 120 KC TO 260 MC
- 120 KC TO 130 MC ON FUNDAMENTALS
- LABORATORY ACCURACY AND QUALITY

22.50

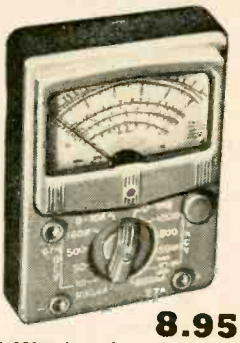
A completely wired and tested instrument not to be confused with units sold in kit form at almost the same price, but with a quality and accuracy of instruments 3 to 4 times its price. Six overlapping ranges generate signals of 120KC — 320KC, 320KC—1000KC, 1MC—3.2MC—11MC, 11MC—38MC and 37MC—130MC all on fundamentals with calibrated harmonics from 120MC to 260MC. Selector switch gives instant choice of ranges. Switch gives choice of internal modulation of 400 CPS or use of any external source at other frequencies. For audio testing the 400 cycle signal can be used separately. Outputs are unmodulated RF, modulated RF and 400 CPS audio. RF output is in excess of 100,000 microvolts and jacks are provided for choice of either high or low RF output. Stability is insured by special circuit design. Has a fine adjustment RF control. AF output is 2-3 volts, AF input is 4 volts across 1 megohm. Large clear 5 inch etched dial plate and pointer are protected by transparent plastic bezel. Common AF terminals for EXT-MOD input and INT-AF for audio tests eliminate need for special AF output connectors. Machine engraved panel lettering. Handsome gray metal case with carrying handle. Measures 6½" x 10" x 4½". Comes complete with pair of leads. AC line cord and plug. Operates on 105-125V 50-60 cycle AC. Shpg. wt., 8 lbs.

LAFAYETTE LSG-10 SIGNAL GENERATOR 22.50

NEW POCKET AC-DC VOM MULTITESTER

2,000 ohm per volt Sensitivity on both DC and AC

160 ua 3" METER
1% PRECISION RESISTORS
SILVER CONTACT SELECTOR SWITCH



FULL SCALE RANGES

DC Volts: 0-10; 0-50; 0-500; 0-1000 Volts — *AC Volts:* 0-10; 0-50; 0-500; 0-1000 Volts—*DC Current:* 500 ua and 500 ma — *Resistance:* 0-10K; 0-1 Meg — *Decibels:* — 20 to +22; +20 to 36 db (0 db — 0.775 V)—*Capacity:* 250 mmfd to .2 mfd—.005 mfd to 1 mfd—*Output Ranges:* 0-10; 0-50; 0-500; 0-1000 volts

8.95

Best Buy in America! A very accurate and sensitive VOM. This Multitester is a complete instrument (not a kit) with high quality and sensitive 160 microamp meter; 2000 ohm per volt on both AC and DC. Single selector switch, 1% precision resistors, 3" meter. Features extreme versatility, accuracy and ruggedness. In attractive plastic front panel, with metal bottom for ruggedness and shielding. First capacity range requires 50 volt AC source. Second capacity range requires 10 volt AC source. Size 4¼"x3½"x1⅝". Complete with test leads and batteries. Shipping weight 4 lbs.

RW-27A ..... Complete 8.95

NEW! LAFAYETTE CAPACITANCE-RESISTANCE TESTER WITH "IN-SET QUICK CHECK"

COMPLETELY WIRED AND TESTED

- TWO INSTRUMENTS IN ONE
- CHECKS ELECTROLYTIC, PAPER, MICA AND CERAMIC CONDENSERS
- 4 DIRECT READING CAPACITY SCALES FROM .00001 MFD TO 1000 MFD
- CHECK FOR OPEN SHORTS, LEAKAGE AND INTERMITTENTS
- 2 RESISTANCE RANGES FROM 100 TO 5 MEGOHM

34.50

Here is a "must" for servicemen and lab technicians. A completely self-contained AC operated capacitance and resistance bridge, plus a quick check for in the set testing. Large 5 direct reading scale has 4 ranges of .00001-.005 MFD, .001-.5 MFD, .1-50 MFD and 20-1000 MFD. Resistance ranges are 100-50,000 OHMS and 10,000 to 5 megohm. Quick check feature enables you to check capacitors for shorts, open or intermittent while in circuit—no need to remove them from the set till you're sure they need replacement. Leakage test switch gives you choice of 25, 150, 250, 350 or 450 volts for checking leakage under correct potential. Separate power factor control with continuous settings from 0 to 50%. Operation is simple and accurate, using a magic-eye tube as the null detector. Attractively finished steel case with etched panel and rounded corners, measures 14½"L x 8¾"H x 5"D. Shpg wt. 19 lbs.

MODEL LC-4 ..... NET 34.50

HIGH SENSITIVITY 20,000 OHM PER VOLT DC 10,000 OHM PER VOLT AC MULTITESTER

LOOK AT THESE FULL SCALE RANGES!

D.C. Volts: 0-6; 0-30; 0-120; 0-600; 0-1200; 0-6000 Volts — A.C. VOLTS: 0-6; 0-30; 0-120; 0-600; 0-1200 Volts — RESISTANCE: 0-10K; 0-100K; 0-1 Meg; 0-10 Megohms— D.C. CURRENT: 0-60 Microamp; 0-6; 0-60; 0-600 Milliamps — DECIBEL: — 20 to +17 db (0 db—0.774V) — CAPACITY: .0001-.01; .005-.15 mfd — INDUCTANCE: 20-2000 millihenry —OUTPUT RANGES: 0-6; 0-30; 0-120; 0-600; 0-1200 Volts

19.95

The new Lafayette high sensitivity Multitester is a complete instrument (not a kit). In addition to its unusual sensitivity of 20,000 OHMS PER VOLT ON D.C. AND 10,000 OHMS PER VOLT ON A.C., and the extraordinary number and scope of its ranges, it is packed with features that would make it cost at least twice as much if made in this country. Uses 1% precision resistors, silver contacts on selector switch, 35 ua 3" meter. Dependable, rugged and accurate. Even the test leads are heavy duty with high voltage insulation. Voltage source required for low capacity range is 120V A.C., for high range capacity and inductance scale is 6V A.C. Attractive plastic front with metal bottom. Size 6¼"x4¼"x2½". Complete with batteries and leads. Shipping weight 4½ lbs.

RW-30A ..... Singly. Each 19.95
In lots of 3. Each 19.25

NEW! LAFAYETTE CAPACITOR-RESISTANCE TESTER

COMPLETELY WIRED AND TESTED

COMPLETELY WIRED AND TESTED

21.50

- CHECKS ALL TYPES OF CONDENSERS FOR CAPACITY, LEAKAGE, OPEN SHORTS OR INTERMITTENT CONDITION
- DIRECT READING SCALES FROM .00001 TO 1000 MFD AND 100 TO 5 MEGOHMS

A stable and accurate bridge type circuit measures capacitance in 4 ranges of .00001-.005 MFD, .001 to .5 MFD, .1 to 50 MFD and 20 to 1000 MFD. Two resistance ranges of 100-50,000 and 10,000 to 5 megohms. Check leakage under actual load with choice of 25, 150, 250, 350 or 450 volts available by selector switch. Power factor control from 0 to 50%. Checks for leakage, open, short, or intermittent operation. All readings taken directly off scales after setting magic eye to maximum. Completely self-contained power supply. Attractively finished steel case with rounded corners and etched panel. Operates from 110V AC. Size 9⅜"L x 7⅛"H x 5¼"D. Shpg. wt. 10 lbs.

MODEL LC-15 ..... NET 21.50

VISCOUS DAMPED TRANSCRIPTION TONE ARMS

NOW AT THE LOWEST PRICES ANYWHERE

12" VISCOUS DAMPED ARM 11.95

LICENSED UNDER CBS U. S. PATENT NO. 2676806

Here is the finest professional transcription tone arm with its "floating action" at the lowest price ever. Gives dependable stable operation with high compliance and perfect record tracking. Single point jewel bearing support and automatic fluid control. Adapters accommodate all popular cartridges and permit instant plug-in cartridge change. Gray hammertone finish. Shpg. wt., 2½ lbs.

PK-90—12" Transcription Tone Arm ..... Net 11.95

16" VISCOUS DAMPED TRANSCRIPTION TONE ARM

NOW ONLY 17.95

LICENSED UNDER CBS U. S. PATENT 2676806

A 16" viscous damped arm at an unbelievable low price. An exclusive sealed unit eliminates possibility of silicone leakage. Features single point pivot mounting, precision pickup arm adjustment controls, and plug-in adapters for all popular cartridges. Shpg. wt., 3½ lbs. **PK-170**—16" Transcription Tone Arm ..... Net 17.95

TRANSCRIPTION-TYPE MANUAL PLAYER with TONE ARM and TWO PLUG-IN HEADS

PK-160

- MAGNETIC BRAKE FOR FINE ADJUSTMENT OF EACH SPEED
- 4-POLE, HEAVY DUTY TRANSCRIPTION-TYPE MOTOR
- ACCOMMODATES ALL POPULAR CARTRIDGES
- STYLUS WEIGHT ADJUSTMENT SCREW ON TONE ARM

All the important features of professional transcription players have been incorporated in this precision turntable. Extremely smooth and quiet heavy duty 4-pole motor plays 78, 45 and 33⅓ RPM records. Exclusive magnetic brake, controlled by knob on base plate, permits instantaneous fine adjustment of each speed. Stroboscope disc included checks speeds. Speed selector safety switch protects mechanism by making it necessary to pass through OFF position when switching from one speed to another. 10" weighted turntable has rubber traction mat.

Mounting plate has pickup rest and ON-OFF switch. Size 12-15/16" left to right. 10⅞" front to rear. Requires 2¾" clearance below motor board and 3" above. With AC line cord, 2 plug-in heads, output cable, 45 RPM adapter. For 105-120V., 60 cycles AC. Shpg. wt., 12 lbs. *(NOTE: For protection in shipping, tone arm is separate. Just fasten to mounting plate.)*

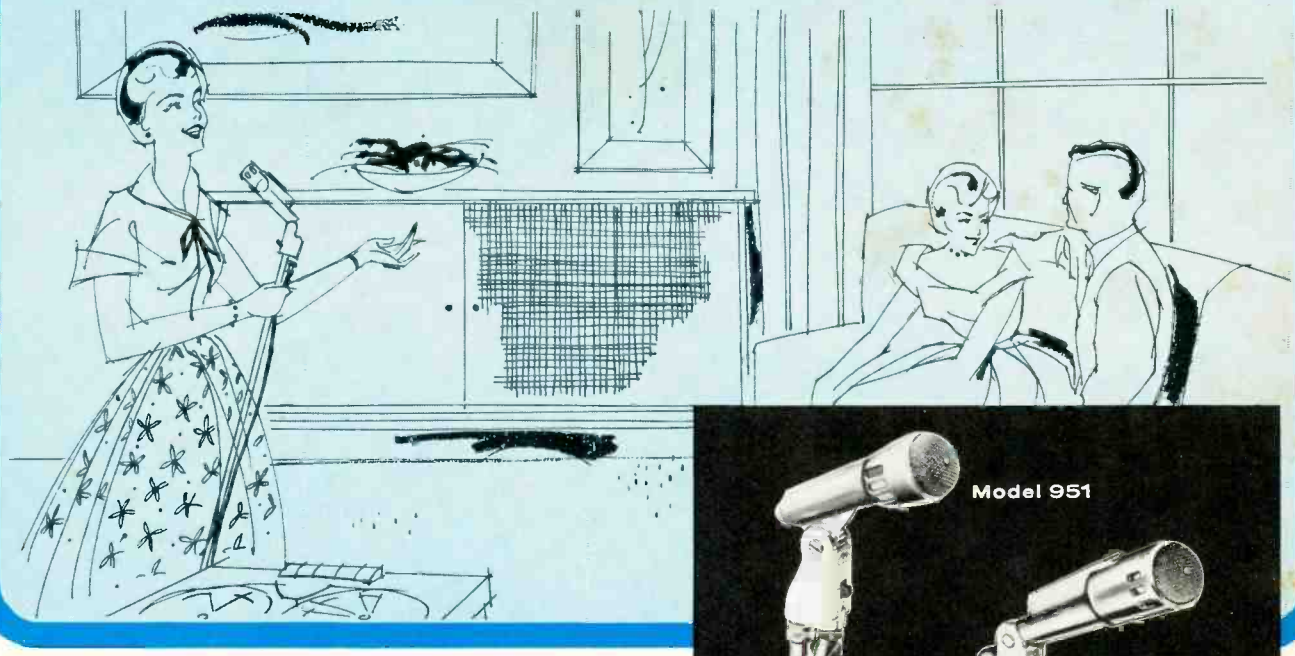
PK-160—Less cartridge and base ..... Net 25.95
PK-162—Wood base for PK-160. Shpg. wt., 5 lbs. ..... Net 3.95
PK-163—Unfinished mounting board only. Shpg. wt., 1 lb. ..... Net .95

LAFAYETTE RADIO 165-08 Liberty Ave. JAMAICA 33; N. Y. DEPT JJ-2

include postage with order.

Electro-Voice® Variable-D Cardioid Microphones

Record the Quality You Want . . . *and that's ALL!*



You'll make professional-quality, high-fidelity tape recordings with an Electro-Voice microphone — the choice of broadcast and TV engineers!

The secret of success is the unique E-V Variable-D, which stops background sound you *don't* want, picks up the sounds you *do* want. Work close — you'll record no "boom." Pick up from a distance — the sound is clean and free from "roominess." The single moving element is E-V's exclusive, virtually indestructible Acoustalloy diaphragm.

NEW Model 951 Crystal Cardioid—Professional quality at a Modest Price

This newest addition to the E-V line uses the same Variable-D principle as E-V's broadcast cardioids to give you uniform directivity of pickup and high discrimination against unwanted sound. Response is 50 to 11,000 cps. Has chrome-finished pressure-cast case, On-Off switch. *Just $49.50, list, less stand.*

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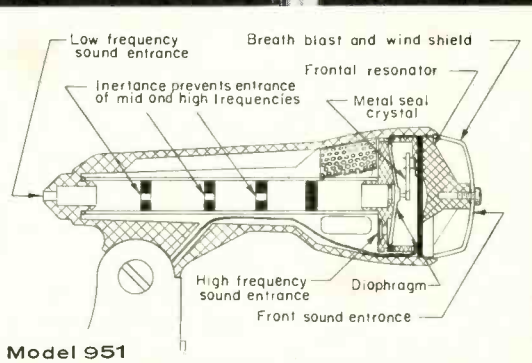

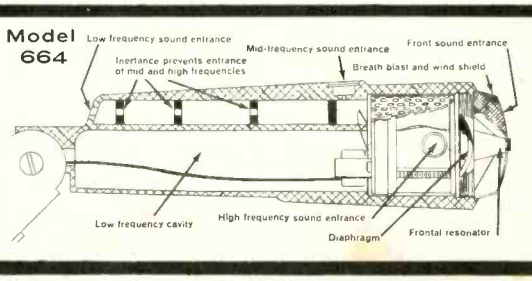

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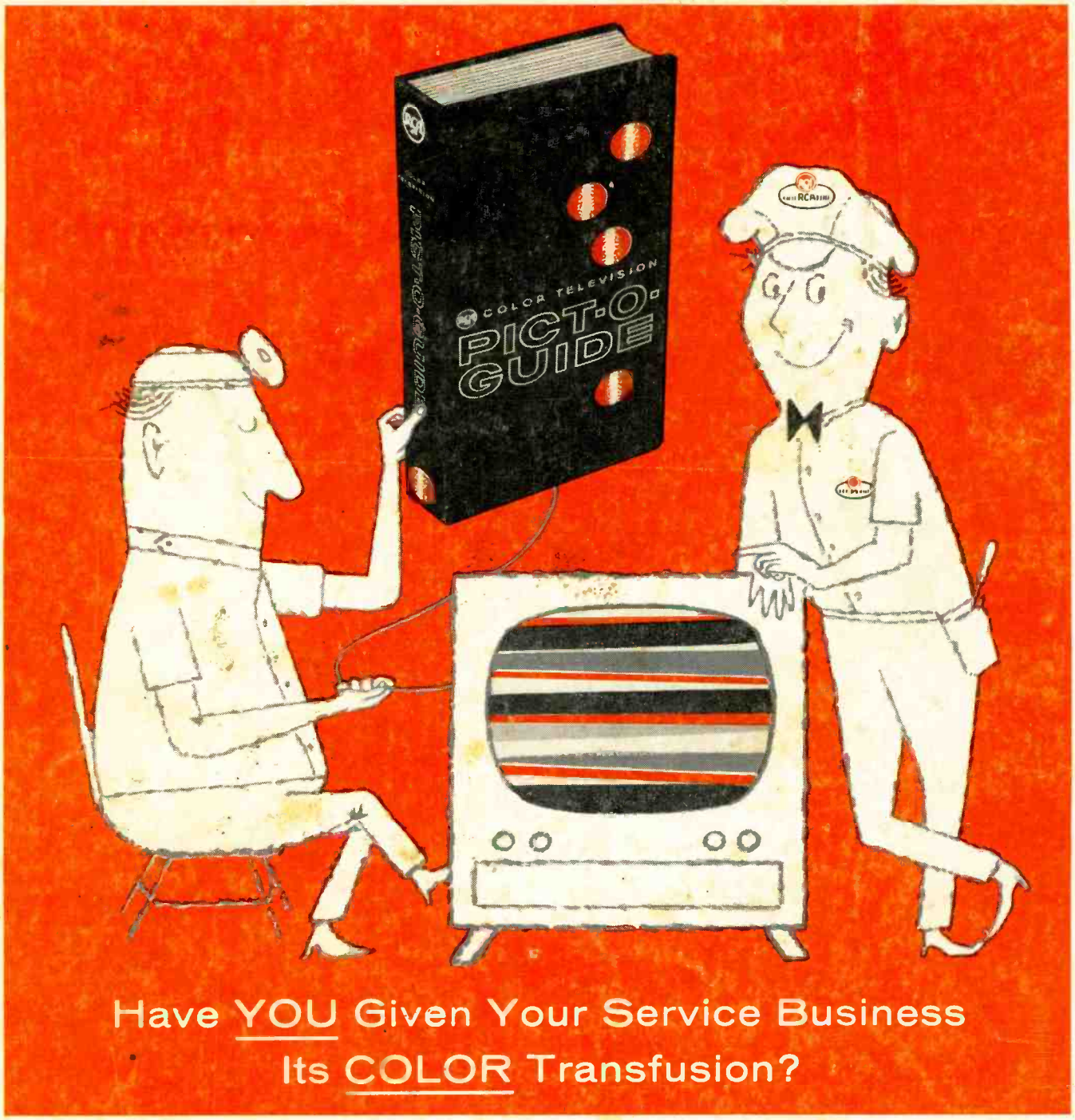

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