Build an Accurate Transistor Tester

FEBRUARY 1959

Radio-Electronics

HUGO GERNSBACK, Editor

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All-Transistor 10-Meter Receiver

Standing Waves Kill Color

All About Reflex Enclosures

The Parametric Amplifier

(See Page 4)

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- 20,000 ohms per volt DC; 5,000 AC.
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- SELF-SHIELDED Bar-Ring Instrument; permits checking in Strong Magnetic Fields.
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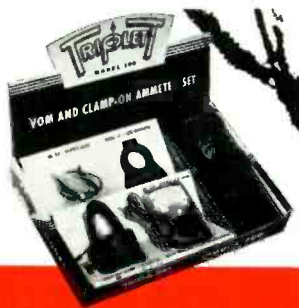

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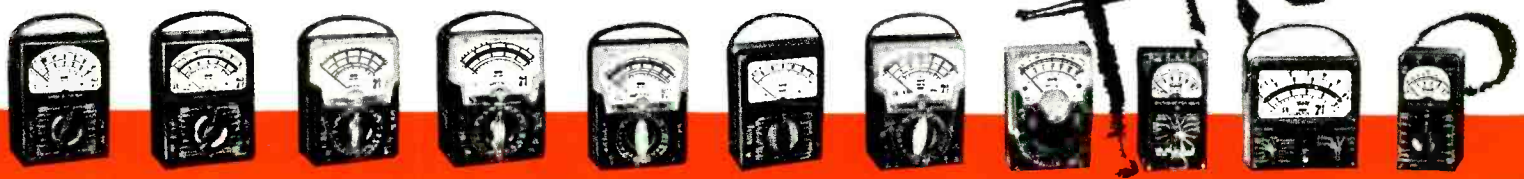

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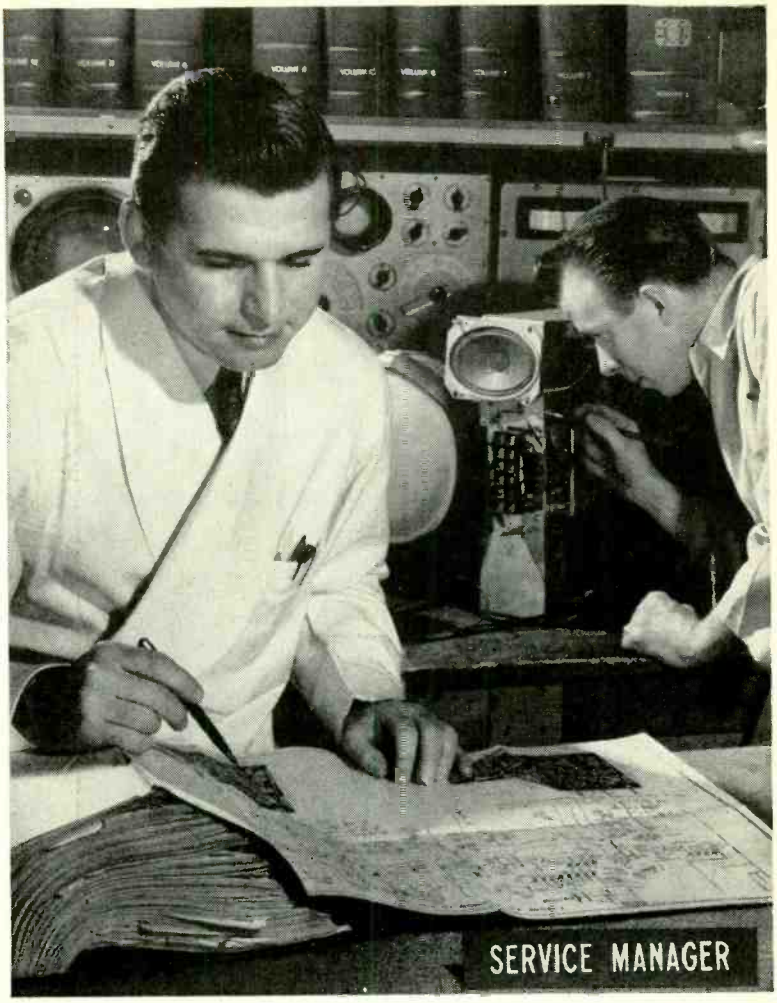

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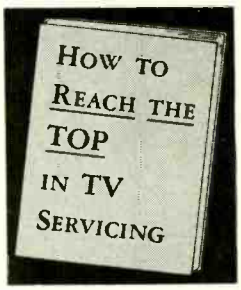

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FEBRUARY, 1959

Radio-Electronics

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ON THE COVER

(Story on page 78)

William Sichak, director of the radio communications laboratory of ITT Labs, is adjusting a variable reactance amplifier designed to operate at about 900 mc. In the insert is the variable-capacitance diode responsible for the amplifier action.

Color original by ITT Labs, research division of International Telephone & Telegraph Co.

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NEWS BRIEFS

WORLD'S FASTEST switching diode operates at a speed of about 50-trillionth of a second (.05 millimicrosecond) and is so tiny it's virtually invisible to the naked eye. Yet it can be mass-produced and already is being turned out in experimental quantities by the Sperry Semiconductor Div. of Sperry Rand Corp., South Norwalk, Conn.

The semiconductor, which measures 12/10,000 inch, is about half the thickness of a fine human hair, and is claimed to be 100 times faster than the most rapid switching diodes previously developed. It's designed to speed up computer operations, and, according to Sperry Semiconductor technical director B. J. Rothlein, may make possible computers which can complete in less than 3 days a problem which requires a full year of continuous operation in present computers.

The elements of the semiconductor are aluminum and silicon. A slight increase in voltage causes current to flow by means of the "avalanche effect," whereby each electron creates a chain reaction which almost instantly carries current across the four-millionths-of-an-inch junction. A slight decrease in the voltage reduces the speed of the electrons and stops the chain reaction.

ERNST WEBER, (left) president of the Polytechnic institute of Brooklyn, (N.Y.) and of the Polytechnic Research and Development Corp., was elected president of the Institute of Radio Engineers for 1959. He succeeds Donald G. Fink, research director of Philco Corp., Philadelphia. The new IRE vice president is Donald B. Sinclair (right), vice president and chief engineer of General Radio Co., West Concord, Mass., succeeding Carl-Eric Granqvist, director of Svenska Aktiebolaget Gasaccumulator, Stockholm-Lidingo, Sweden.

"SUNKEN" RADIOTELESCOPE, described as the world's largest, will be built by the University of Illinois and the Office of Naval Research near Danville, Ill.

The telescope will be built in a huge ravine, the sides and bottom of which will be smoothed and covered with metal, forming a giant reflector to focus radio waves into a line of receiving antennas about 150 feet above the bottom of the trough. These antennas will be supported by tall towers down the center of the reflector.

The radiotelescope which currently is the world's largest, Manchester University's observatory at Jodrell Bank, England (RADIO-ELECTRONICS, February, 1958, page 32) has been forced to turn to the public for funds to keep it in full-time operation. The telescope provided invaluable scientific data in tracking moonrockets and satellites. Because of financial troubles, its operation has been curtailed to 18 hours a day. The university is appealing for contributions from the British public to help make up the deficit.

ELECTRONS WITH "NEGATIVE MASS" are believed to have been discovered in recent solid-state experiments reported to the American Physical Society. The indication that there may be such a thing as "un-mass" is said by physicists to have no counterpart in previous scientific experience. It was said to be analogous to the discovery of materials which respond to gravity by "falling up" or which move the wrong way when pushed.

The discoveries were recorded during "cyclotron resonance" experiments in which a magnetic field was applied to germanium crystals cooled to −452°F. When a few of the electrons whirling around the nuclei of the germanium atoms were lined up by the magnetic field, a rotating field of rf energy was applied.

The presence of the orbiting electrons was measured through their absorption of energy when the applied rf wave had the same frequency as the rotating electrons. This is a relatively common cyclotron resonance experiment. The recent experiments, however, showed dips rather than peaks in the absorption pattern, indicating that electrons were rotating in the direction opposite from the rotation of the rf wave field. Physicists said this indicated that there may be electrons which behave as though they have negative mass, at least in some solids.

The experiments were conducted by Dr. George C. Dousmanis, Dr. Roscoe C. Williams, R. C. Duncan Jr. and J. J. Thomas of RCA Laboratories, Princeton, N. J., and a preliminary report was published in the American Physical Society's *Physical Review Letters.*

If the preliminary conclusions are verified, the discovery could lead to entirely new types of amplifiers and other electronic applications and perhaps to even more significant and basic applications of "un-mass" in other physical fields.

AM STEREO BROADCASTING has been proposed to the FCC by Philco Corp., Philadelphia, which has asked for permission to conduct extensive field tests of its compatible stereophonic system on the AM broadcast band.

Philco proposes a combination of amplitude and phase modulation and claims that receivers and converters can be produced economically, that stereo broadcasts can be received monophonically without distortion on present AM receivers and that its own test results have indicated excellent stereo and mono reception.

Here's a basic description of the Philco system:

For stereo broadcasting, the sum of left and right audio tracks would be transmitted by the conventional amplitude modulation method. A signal containing the stereophonic differences between the two audio tracks would be transmitted on the same carrier frequency, but using phase modulation. However, audio frequencies below 300 cycles would be identical on both tracks, because, Philco says, "we do not observe stereophonic effects to any marked extent at low audio frequencies."

Stereo-equipped receivers would contain a matrixing circuit which would separate the audio tracks and feed

(*Continued on page* 10)

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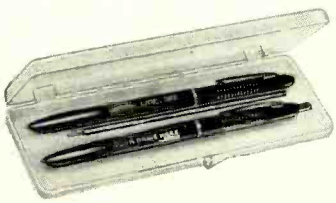
TRUCK DECAL (SP-Q-7587)
A heavy duty, outdoor type decal ideal for trucks, doors or panels.



BALL POINT PEN AND PENCIL SET (SP-Q-7634)
A slim-line-styled pen with new push-top retractable action and a matching mechanical pencil.

TV SCREEN POLISHING CLOTH (SP-Q-7617)
Chemically treated to clean dust and dirt with a quick swipe over face of TV screen.

them to the proper amplifier–speaker combinations. Conventional mono receivers would simply detect the amplitude-modulated "sum" signal, reproducing both stereo tracks monophonically. When a broadcast station wishes to switch from stereo to mono programming, it would discontinue transmission of the phase-modulated (stereo-difference) channel.

The system differs markedly from the AM stereo method proposed by RCA, which would impose one complete stereo track on each sideband of the broadcast carrier (RADIO-ELECTRONICS, January, 1959, page 6).

Calendar of Events

Indianapolis Hi-Fi Music Show, Jan. 30-Feb. 1, Hotel Antlers.
San Francisco High Fidelity Show, Feb. 7-10, Cow Palace.
Western Audio Engineering Convention Feb. 17-20, Biltmore Hotel, Los Angeles, Calif.
Los Angeles High Fidelity Show, Feb. 18-22, Biltmore Hotel, RADIO-ELECTRONICS and the Gernsback Library will exhibit.
Solid State Circuits Conference, Feb. 12-13, University of Pennsylvania, Philadelphia, Pa.
Western Joint Computer Conference, March 3-5, Fairmont Hotel, San Francisco, Calif.
Denver Hi-Fi Music Show, March 6-8, Hotel Cosmopolitan.
British Electrical Engineers' Exhibition, March 17-21, London.
Baltimore Hi-Fi Music Show, March 20-22, Lord Baltimore Hotel.
IRE National Convention and Radio Engineering Show, March 23-26, Waldorf-Astoria Hotel (convention) and New York Coliseum (show).
Symposium on Millimeter Waves, March 31-April 2, Engineering Societies Building, New York, N.Y.

DIRECT COMPARISON of the advertised characteristics of hi-fi components made by competing companies may soon be more meaningful, thanks to the industry standards now being formulated by the Institute of High Fidelity Manufacturers.

The difficulty in comparing current advertised characteristics is that the measurements are made by many different methods and sets of standards.

IHFM's first set of standards—for measurement of tuners—is a 24-page document listing testing and measurement procedures agreed upon by manufacturer members of the institute. The standards aren't binding on any manufacturers, but the institute hopes they will meet industry-wide acceptance.

Substantial agreement has been reached on measurement standards for stereo and monophonic amplifiers and preamps, and a final document is due soon. Next on the schedule will be turntables and record changers, to be followed by loudspeakers standards and eventually by phono cartridges.

10 NEW TV STATIONS have started with the new year:

WUFT, Gainsville, Fla..... 5
KCIX, Nampa, Idaho..... 6
KGLD, Garden City, Kans.....11
WWOR-TV, Worcester, Mass.....14

(Continued on page 16)

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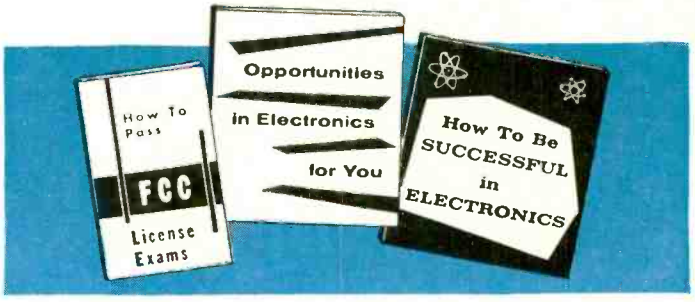

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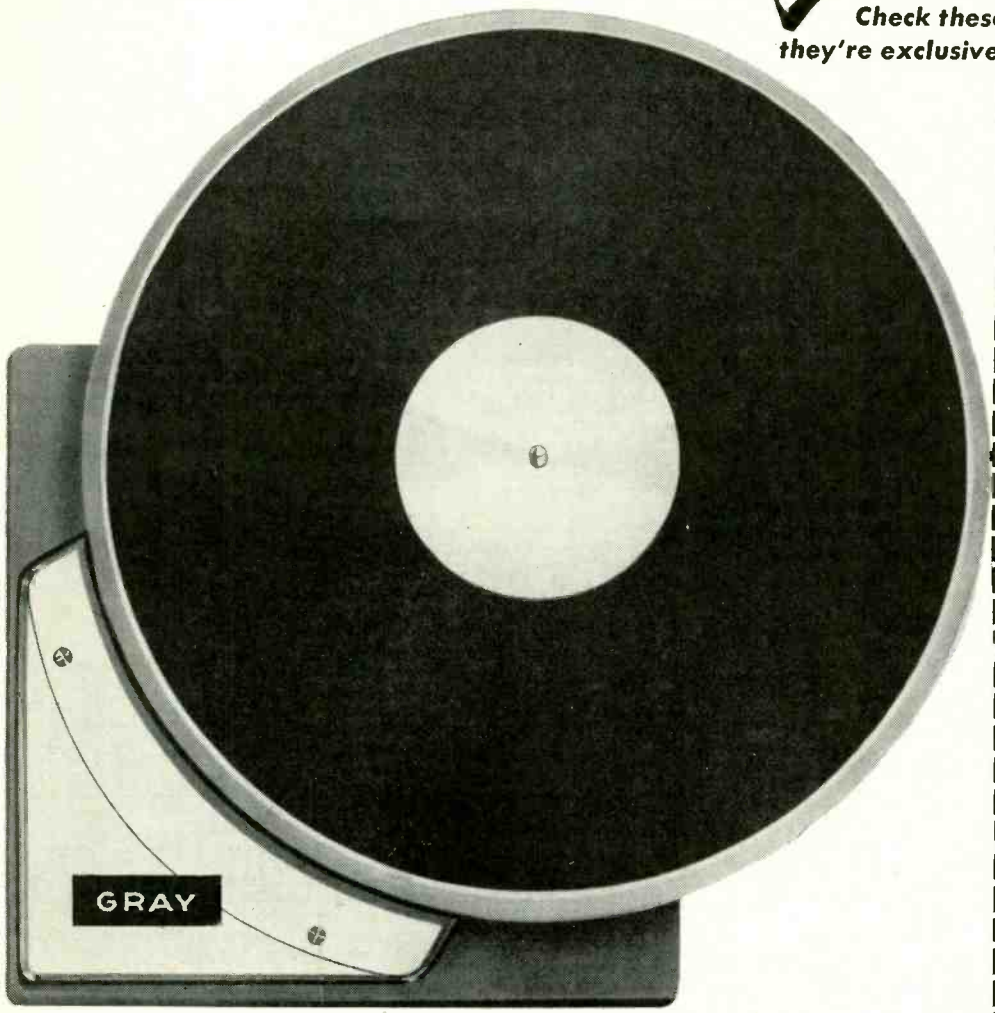

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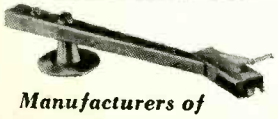

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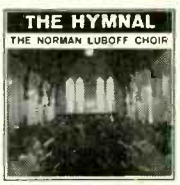

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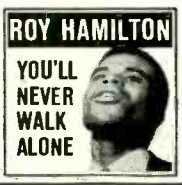

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7. **Frankie Laine** *Jezebel, High Noon, Jealousy*, 9 more
10. **Schweitzer—Bach** Includes 3 major Bach organ compositions
11. **Johnny Mathis' Greatest Hits** *No Love, Chances Are, Twelfth of Never, I Look at You*, 8 more
12. **Grofe: Grand Canyon** This vivid musical painting has become an American classic
13. **Doris Day's Greatest Hits** Doris sings 12 hits — *Love Me or Leave Me, It's Magic, Que Sera*
14. **South Pacific** Mary Martin and Ezio Pinza star in this original Broadway Cast recording
15. **Sing Along With Mitch Miller** *You Are My Sunshine, Sweet Violets, Don't Fence Me In* — 16 favorites in all
16. **Schubert: Unfinished Symphony; Mendelssohn: A Midsummer Night's Dream** Philadelphia Orchestra, Ormandy, cond.
17. **Desert Song** Romberg's operetta is still a joy to hear
18. **Beethoven: Emperor Concerto** Casadesus, piano; New York Philharmonic, Mitropoulos, cond.
19. **Eddy Duchin Story** Duchin plays *The Man I Love, April Showers, Am I Blue?*, 12 more
20. **Dvorak: New World Symphony** Philadelphia Orchestra, Ormandy, cond.
21. **$64,000 Jazz** 13 Jazz Greats performing *Honeysuckle Rose, Perdido*, etc.
22. **Mozart: Requiem** New York Philharmonic, Walter, cond.
26. **Tchaikovsky: Nutcracker Suite; Ravel: Bolero**, etc. Philadelphia Orchestra, Ormandy, cond.
27. **Benny Goodman** *Let's Dance, Sing Sing Sing, Avalon, Moonglow* — 11 swing classics
28. **Romantic Music of Rachmaninoff** Andre Kostelanetz and his Orchestra play this haunting music
29. **Roy Hamilton** The "Big Voice" sings *Unchained Melody, Ebb Tide, I Believe*, 9 more
30. **Tchaikovsky: Swan Lake Ballet Suite** Philadelphia Orchestra, Ormandy, cond.
34. **Ellington at Newport** *Newport Jazz Festival Suite, Jeep's Blues*, etc.
38. **The Hymnal** Norman Luboff Choir sings 12 beloved hymns — *Let Him In, Sweet Hour of Prayer*, etc.
39. **Firebird Suite; Romeo and Juliet** Two colorful scores — performed by Bernstein and N.Y. Philharmonic
44. **Pop Hit Party** A dozen hit tunes performed by 12 pop artists — Day, Mathis, Laine, Bennett, etc.
46. **Erroll Garner—Paris Impressions** *Moulin Rouge, I Love Paris, Left Bank Swing* —8 numbers in all
48. **My Fair Lady** Original cast recording with Rex Harrison and Julie Andrews
49. **Waltzes of Strauss and Tchaikovsky** Philadelphia Orchestra, Ormandy, cond.
51. **Front Row Center** *September Song, House of Flowers, Bewitched, April in Paris*, 9 more
60. **Music of Victor Herbert — Faith** *Dream Girl, A Kiss in the Dark, Gypsy Love Song*, 9 more
61. **Rossini: William Tell Overture, etc.** Six stirring overtures and marches
62. **Frank Sinatra** A dozen songs — *Blue Skies. The Nearness of You, Mean to Me*, etc.

K-41

BIG REWARDS

for the most-wanted men in Radio-TV-Electronics

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"I had been in the radio-repair business for 30 years, when I enrolled in the I.C.S. Television Servicing Course.

"Now I am able to approach a television job in a systematic manner, while others are still operating on the hit-or-miss level." *Kelsey G. Cobb*

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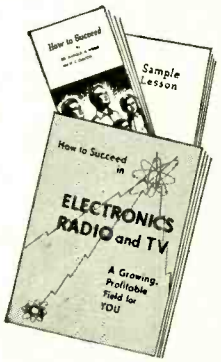

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NEWS BRIEFS *(Continued from p. 10)*

KNOP, North Platte, Neb..... 2
WKBW-TV, Buffalo, N. Y..... 7
WTOL-TV, Toledo, Ohio.....11
KXAB-TV, Aberdeen, S. D..... 9
KVKM-TV, Monahans, Tex..... 9
KLOR-TV, Provo, Utah.....11

Two stations, however, have closed down:

WHCT, Hartford,.....18
KTRX, Kennewick-Pasco, Wash.....31

Consequently, our total of operating stations for the US is now 546, which figure includes 461 vhf and 85 uhf. The noncommercial is up to 35 (7 uhf).

WTAS, Albany - Schenectady - Troy, channel 35, has changed its call letters. It was formerly WTRI.

Our Hawaii listing in the January "Television Station List" should have read channel 7 for KALA in Wailuku. The channel 15 listing for Lebanon, Pa., should have been WLYH-TV.

ELECTRONICS PRODUCTION and sales in 1958 set a record, despite a slump in such consumer items as radios, TV sets and phonographs. David R. Hull, president of the Electronic Industries Association, estimated 1958 sales of all electronic products totaled about $7.7 billion (factory prices), or $100,000,000 more than the 1957 figure.

Military electronics accounted for $4.1 billion, with 70% of this amount representing missile and aircraft electronics, compared with 1957's military electronics figure of $3.9 billion, 55% missile and aircraft. Industrial electronic equipment was a $1.4 billion market in 1958, up from $1.3 billion in '57. Consumer equipment was the only category to show a decrease last year.

For 1959, he predicted about $8.3 billion in electronic sales, with military orders totaling $4.4 billion, industrial $1.5 billion, consumer products $1.4 billion and replacement parts $1 billion.

He foresaw no mass sales of color TV in 1959 and little possibility of a technological breakthrough which would result in substantial reductions in the prices of color sets.

RUSSIA now has more than 60 TV stations and over 3,000,000 television sets in use, Soviet Ambassador Mikhail Menshikov told a New York audience recently. He said more than 100 new stations will go on to the air in the next few years. He conceded that most Russian television sets have been small-screen models, but asserted that 17- and 21-inch sets are "now coming in."

The Soviet newspaper *Trud* announced that a giant television tower—the world's tallest—would be built this year in Moscow. It would rise, 1,667 feet, topping the present tallest man-made structure—the 1,610-foot KSWS-TV tower in Roswell, N. M.—by 57 feet.

The US Information Agency now estimates there are 639 TV stations and 21,585,000 sets in use outside of the US and Canada. The US has about 50,000,000 sets and 550 stations, Canada more than 3,000,000 sets and 55 stations. END

What Does F.C.C. Mean To You?

What is the F. C. C.?

F. C. C. stands for Federal Communications Commission. This is an agency of the Federal Government, created by Congress in 1934 to regulate all radio communication and radio and television broadcasting in the United States.

What is an F. C. C. Operator License?

The F. C. C. requires that only qualified persons be allowed to install, maintain, and operate electronic communications equipment, including radio and television broadcast transmitters. To determine who is qualified to take on such responsibility, the F. C. C. gives technical examinations. Operator licenses are awarded to those who pass these examinations. There are different types and classes of operator licenses, based on the type and difficulty of the examination passed.

What are the Different Types of Operator Licenses?

The F. C. C. grants three different types (or groups) of operator licenses – commercial radiotelePHONE, commercial radioteleGRAPH, and amateur.

COMMERCIAL RADIOTELE*PHONE* operator licenses are those required of technicians and engineers responsible for the proper operation of electronic equipment involved in the transmission of voice, music, or pictures. For example, a person who installs or maintains two-way mobile radio systems or radio and television broadcast equipment must hold a radiotelePHONE license. (A knowledge of Morse code is NOT required to obtain such a license.)

COMMERCIAL RADIOTELE*GRAPH* operator licenses are those required of the operators and maintenance men working with communications equipment which involves the use of Morse code. For example, a radio operator on board a merchant ship must hold a radioteleGRAPH license. (The ability to send and receive Morse is required to obtain such a license.)

AMATEUR operator licenses are those required of radio "hams"—people who are radio hobbyists and experimenters. (A knowledge of Morse code is necessary to be a "ham".)

What are the Different Classes of RadiotelePHONE licenses?

Each type (or group) of license is divided into different *classes*. There are *three* classes of radiotelephone licenses, as follows:

(1) Third Class Radiotelephone License. No previous license or on-the-job experience is required to qualify for the examination for this license. The examination consists of F.C.C. Elements I and II covering radio laws, F.C.C. regulations, and basic operating practices.

(2) Second Class Radiotelephone License. No on-the-job experience is required for this examination. However, the applicant must have already passed examination Elements I and II. The *second class* radiotelephone examination consists of F. C. C. Element III. It is mostly technical and covers basic radiotelephone theory (including electrical calculations), vacuum tubes, transistors, amplifiers, oscillators, power supplies, amplitude modulation, frequency modulation, measuring instruments, transmitters, receivers, antennas and transmission lines, etc.

(3) First Class Radiotelephone License. No on-the-job experience is required to qualify for this examination. However, the applicant must have already passed examination Elements I, II, and III. (If the applicant wishes, he may take all four elements at the same sitting, but this is not the general practice.) The *first class* radiotelephone examination consists of F. C. C. Element IV. It is mostly technical covering advanced radiotelephone theory and basic television theory. This examination covers generally the same subject matter as the second class examination, but the questions are more difficult and involve more mathematics.

Which License Qualifies for Which Jobs?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain, and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain, and operate every type of radiotelephone equipment (except amateur, of course) including all radio and television stations in the United States, and in its Territories and Possessions. This is the highest class of radiotelephone license available.

How Long Does it Take to Prepare for F. C. C. Exams?

The time required to prepare for FCC examinations naturally varies with the individual, depending on his background and aptitude. Grantham training prepares the student to pass FCC exams in a minimum of time.

In the *Grantham Correspondence Course*, the average beginner with NO previous experience or training in radioelectronics should obtain his *second class* radiotelephone license after from 200 to 300 hours of study. This same student should then prepare for his *first class* FCC license in approximately 100 additional hours of study.

In the *Grantham Resident Course*, the time required to complete the course and get your license (under normal circumstances) is as follows:

In the DAY course (5 days a week) you should get your *second class* license at the end of the first 9 weeks of classes, and your *first class* license at the end of 3 additional weeks of classes. This makes a total of 12 weeks (just a little less than 3 months) required to cover the whole course, from "scratch" through *first class*.

In the EVENING course (2 nights a week) you should get your *second class* license at the end of the 22nd week of classes and your *first class* license at the end of 8 additional weeks of classes. This makes a total of approximately 7 months required to cover the whole course, from "scratch" through *first class*, in the evening course.

The Grantham course is designed specifically to prepare you to pass FCC examinations. All the instruction is presented with the FCC examinations in mind. In every lesson test and pre-examination you are given constant practice in answering FCC-type questions, presented in the same manner as the questions you will have to answer on your FCC examinations.

Why Choose Grantham Training?

The Grantham Communications Electronics Course is planned primarily to lead to an F.C.C. license, but it does this by TEACHING electronics. This course can prepare you *quickly* to pass F. C. C. examinations because it presents the necessary principles of electronics in a simple "easy to grasp" manner. Each new idea is tied in with familiar ideas. Each new principle is presented first in simple, everyday language. Then after you understand the "what and why" of a certain principle, you are taught the technical language associated with that principle. You learn more electronics in less time, because we make the subject easy and interesting.

Is the Grantham Course a "Memory Course"?

No doubt you've heard rumors about "memory courses" or "cram courses" offering "all the exact FCC questions". Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this "meaningless" material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand – choose Grantham School of Electronics.

Is the Grantham Course Merely a "Coaching Service"?

Some schools and individuals offer a "coaching service" in FCC license preparation. The weakness of the "coaching service" method is that it presumes the student already has a knowledge of technical radio and approaches the subject on a "question and answer" basis. On the other hand, the Grantham course "begins at the beginning" and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC-type test so you can discover daily just which points you do not understand and clear them up as you go along.

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.
Robert H. Moore, 807 Grace St., Baldwin, L.I., N.Y.	1st	12
Otis A. Towns, 3638 Bates St., St. Louis, Mo.	1st	12
Robert A. Herrman, 608 Walker Ave., Baltimore, Md.	1st	14
Walter Mengel, Jr., 423 James St., Crystal Lake, Ill.	1st	8
Serge G. Miller, 1315 W. 15th St., San Pedro, Calif.	1st	12
John A. Hayes, 1519 Madison Ave., Memphis, Tenn.	1st	14
Franklin A. VanLeuven, 6061 Woodlawn Ave., Maywood, Calif.	1st	12
Robert A. Morgan, 25 Barrow St., New York, N.Y.	1st	9

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Correspondence

ELECTROSTATIC SPEAKERS

Dear Editor:

George Augspurger's article on the Ring Radiator in your December issue (page 43) prompts us to write in rebuttal on certain of his statements pertaining to the electrostatic high-frequency speaker.

First, Mr. Augspurger states that the electrostatic approaches the problem (of sound generating) by the use of a very large diaphragm. This is manifestly not so in the case of the JansZen, which uses the equivalent of many small diaphragms, achieving the end of keeping the acoustic load high on the vibrating surfaces, but at the same time avoiding the problem of poor control of those surfaces. Distortion is thus reduced to less than 0.5% (harmonic).

Second, the author refers to the electrostatic as expensive. Although this statement is somewhat justified, since proper electrostatic manufacture requires adherence to close tolerances and great attention to detail, it is not justified when comparing it to the Lansing 075 Ring Radiator which Mr. Augspurger is reviewing. That model sells for about $60 (above $100.00 with cabinet), compared to the JansZen Model 65 (with cabinet) at about $90. In cabinet, this makes a price advantage in favor of the electrostatic, and the balance is further tipped when it is considered that the electrostatic is not just a tweeter, but a tweeter–mid-range designed for use with several woofers without the need or expense of a mid-range speaker.

Third, Mr. Augspurger writes of the "relative inefficiency" of the electrostatic, inferring that this is an inherent characteristic. Such is not the case. Efficiency limitations are imposed on the electrostatic only because its lower limits are extended flat to 900 cycles. The ring tweeter goes only to 2,500 cycles. Within those less stringent limits, the electrostatic can be made very efficient.

Further—and this is important—high efficiency was never a consideration (at least in Arthur Janszen's designs) in constructing an electrostatic; rather he was concerned with matching his unit with a woofer whose response was uniformly efficient throughout its entire range down to below 40 cycles. The only woofer meeting those requirements at that time was the Bozak, subsequently followed by the AR, KLH, Tannoy, and his own JansZen Dynamic. These speakers are by popular definition "inefficient," but are in fact very efficient if one considers the total energy distribution over the entire frequency range.

Fourth, we must take exception to the author's comments concerning certain reported unpleasant "crackling" sounds heard on the electrostatic in connection with some percussive sounds. We are pleased that he mitigates his emphasis by stating that the problem frequently may be caused by faulty associated components, but we can state categorically, with a very careful followup on our serialized units out in the field for over 4 years, that we have never found a properly installed JansZen that couldn't handle any percussive sounds perfectly, even using over 100 watts of amplification (except in the rare instance of component failure in the power supply).

Lastly, we feel that it is a bit unfair to speak generally of electrostatics as though they were all alike. Their designs vary widely and are as different as horn-loaded, cone and ring tweeters.

Speaking for the multiple-diaphragmed, sheathed-electrode JansZen design with which we have been working and have been producing for the past 4 years, we do not believe that any of the criticisms raised by Mr. Augspurger are valid today.

FRANCIS D. WETHERILL
President, Neshaminy Electronic Corp.
Neshaminy, Pa.

USE A MICROSCOPE

Dear Editor:

I have just finished reading the article titled "Sapphire Vs Diamond" (October, 1958, page 47).

It seems that the stylus experts are setting up a ridiculous standard for estimating the useful life of a stylus by basing this on the number of hours of playing. One gets the impression that it is merely necessary to count the hours—20, 100 or 1,000, if the stylus is of metal, sapphire or diamond, respectively, with the hope that it was of proper form originally, and that at some time during the time of use it did not get chipped. Some valuable records could be ruined in the interim. Also, how do the experts suggest that a record of the hours be kept?

Why not discard this ridiculous rule and recommend that styli be periodically inspected under one of the several microscopes now offered for $3 to $4? It may come as a surprise to many that they should have replaced the stylus long before the theoretical time to change came around. Ruined records can testify to the truth of this.

I am sure that the experts will agree that stylus wear is influenced to a great extent by stylus pressure, dust in the grooves, rough treatment and other factors.

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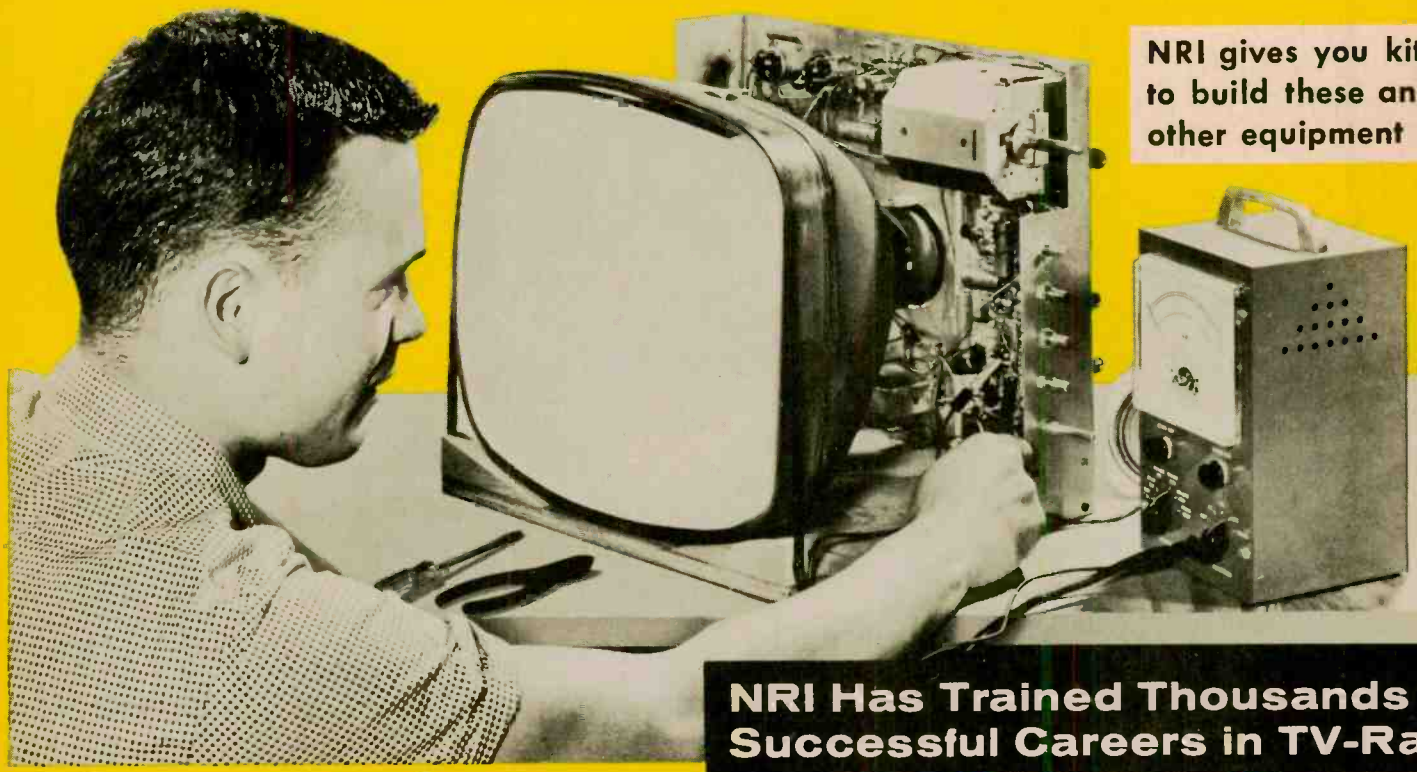
by Practicing at Home in Spare Time



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YOU BUILD Vacuum Tube Voltmeter

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J. E. Smith, Founder

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SEE OTHER SIDE

The only use that I can see for the rule based upon the number of hours of playing to be expected from a stylus is to give the buyer a guide by which he can know the approximate life of the stylus for the sole purpose of helping him to decide which stylus is the best buy in view of economy.

AXEL H. JOHNSON

Racine, Wis.

MARINE SHORE STATIONS

Dear Editor:

A reader has called my attention to an additional fact which should have been included in my series on "Radio for Weekend Sailors" (RADIO-ELECTRONICS, November and December, 1958).

While nongovernment shore stations operated in the 2–3-mc marine band are licensed almost exclusively to telephone companies and similar common carriers, shore-station licenses may be granted to others under some circumstances. These "limited" shore stations are sometimes permitted in areas not now covered by shore facilities. Some independent shore stations at inland lakes have been licensed as limited common carriers. Such stations are open to public correspondence, charging for services rendered, but on a limited basis.

LEO G. SANDS

Ridgewood, N. J.

MINIATURE POWER PLANT

Dear Editor:

Several radical improvements could be made in the electronic anemometer described on page 82 of your September issue by the substitution of one major component—the motor.

Almost every hobby shop sells tiny dc motors for use in model equipment. One is the *Mighty Midget*, an English-made unit which has been imported in large numbers. It is very small and weighs an ounce or less. I recently purchased one of these motors for a little less than $3 to supply power to some experimental radio-controlled equipment. Knowing that almost any motor can also function as a generator, I decided to make a few rough tests and was pleasantly surprised. Depending upon the speed of rotation, the output voltage will vary from 0 – 3 volts with 1½ – 2 volts being a common voltage at a speed such as would be encountered if driven anemometer-style by a moderately stiff wind. Current output is over 150 ma at a high speed of rotation with a commonly generated current output of 30 – 90 ma.

Perhaps the above figures have already given you some idea of the possibilities of this little motor. It is obvious that an anemometer could be constructed which would indicate wind speed merely by hooking a common inexpensive 100-ma meter across the terminals, thus eliminating the cost of a transistor amplifier, battery and sensi-

(*Continued on page* 24)

THANK THE KEEN-EYED SNOOPER

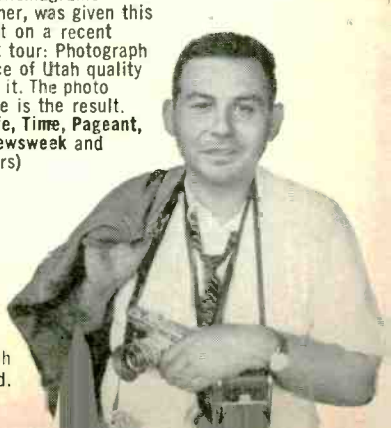
As little as .0035 of an inch off in the dimensions of this Utah speaker basket—and a reject hits the bin! At Utah the quality of final performance in the speaker you buy is a jealously guarded value. If you could visit our Huntington plant you'd probably agree with Ace Photographer Lieberman that Utah speakers prove rejection is the foundation of perfection.

Pre-assembly, plating, coil winding, wiring . . . at every step down the production line stand the "keen-eyed snoopers." They search ruthlessly for the tiniest defect that could mar, even minutely, the response performance of a Utah.

Make certain your next speaker is a Utah. Know that your sound will be as perfectly reproduced as human skills, controlled by rigid inspection, can produce.

See the Utah Custom Line: a quality speaker for every system need.

*** ARCHIE LIEBERMAN,** famous newsmagazine* photographer, was given this assignment on a recent Utah plant tour: Photograph the essence of Utah quality as you see it. The photo shown here is the result. (*Look, Life, Time, Pageant, Parade, Newsweek and many others)



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—Arch B. Caraway
Blountstown, Fla.

"PHOTOFACT is indispensable . . . a terrific aid in cutting down service time . . . One of your biggest helps is your listing of parts other than manufacturers' originals . . ."

—Victor V. Jasper
Ross Radio & TV, Washington, Mo.

HERE'S MORE PROOF...FROM COAST-TO-COAST

CALIFORNIA

"We use PHOTOFACT daily. I can't believe we could conduct a first-class service shop without them. They are a time saver. With them, you can get to the base of your troubles in a hurry."

—P. W. Earls, *Fallbrook, Calif.*

IOWA

"I would find it impossible to give consistently reliable service without a complete PHOTOFACT file of service information."

—Ralph L. Reints, *Ottumwa, Iowa*

CONNECTICUT

"PHOTOFACT provides accurate information—convenient handling. Of necessity, repair with such information as a guide must be better repair."

—Lewis J. Smith, *Norwich, Conn.*

OHIO

"With PHOTOFACT, I always have complete service data for any set that comes into my shop, at my fingertips."

—Earl J. Price, *Sciotoville, Ohio*

PENNSYLVANIA

"I just can't seem to get a long without PHOTOFACT."

—Joseph F. Blahovic,
Barnesboro Pa.

NEW YORK

"They have saved time. This is the biggest factor. Also, they have built good will for me. I can find what tubes are needed for customers that come in to buy tubes ...or even on telephone calls..."

—Fred C. Booth,
Poughkeepsie, N. Y.

WASHINGTON

"PHOTOFACTS save hours of probing in the dark."

—L. H. Bradbury, *Edmonds, Wash.*

NEW YORK

"Gives quick, accurate, up-to-date facts on replacement parts. And, when a set needs to be taken out of a customer's home, you can more easily convince him if you have the PF Folder and explain you need special equipment to check out the circuits..."

—William Birdsell, *Fulton, N. Y.*

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tive meter. Refinements such as a capacitor in parallel with the meter and a fixed or adjustable series resistance on the motor side of the capacitor could be employed to smooth the meter action. The diode is eliminated because the output is dc. You can't get things much simpler.

With a diode to prevent a back flow of current and one of the new rechargable cells used in portable transistor radios, one would have a fine power supply for almost any kind of transistor equipment, as indicated by the liberal amounts of current and voltage which may be generated.

It would be suited especially to equipment which is run constantly, perhaps isolated from human attention for long periods, such as remote recording instruments of various types. There would be no worries about power-line failures or battery replacement. It could be used to power equipment for explorers and scientists working in uncivilized parts of the world far from power lines and a source of batteries. There is always some wind on even a "still" day, and the particular motor I mentioned has a 6-to-1 gear assembly which will cause it to turn very fast when the larger gear is turned at a moderate speed. This gives a built-in amplification of any motion imparted to the gear.

If there should not be sufficient wind to drive the unit, which isn't too likely, even turning it by hand for a while would be sufficient to charge small storage cells. If one were near a small stream, various arrangements of paddle wheels or propellers could be rigged up to provide a miniature hydroelectric power plant.

DORANCE RIGNEY

Greenacres, Wash.

CLEANING PLASTIC

Dear Editor:

In the October RADIO-ELECTRONICS, page 142, the item by E. Mayover on "Cleaning Plastic Safety Glass" requires some qualification—it won't always work!

It may be entirely possible that a penetrating oil will minimize the fog on the surface of some types of plastic safety windows; however, it most definitely should not be used on polystyrene lenses.

Oil, wax or grease of any kind will reduce the critical stress in polystyrene windows and ultimately result in worsening the fog or haze as well as causing the windows to check or craze. Try watching a set through such for a while. The writer would recommend using a plastic cleaner and polish preparation called "Polishine." This is produced by the Paint Products Laboratory in Chicago and does a good job.

J. C. CHOPSKIE

Cabinet Specialist
Television Receiver Dept.
General Electric Co.
Syracuse, N. Y.

END

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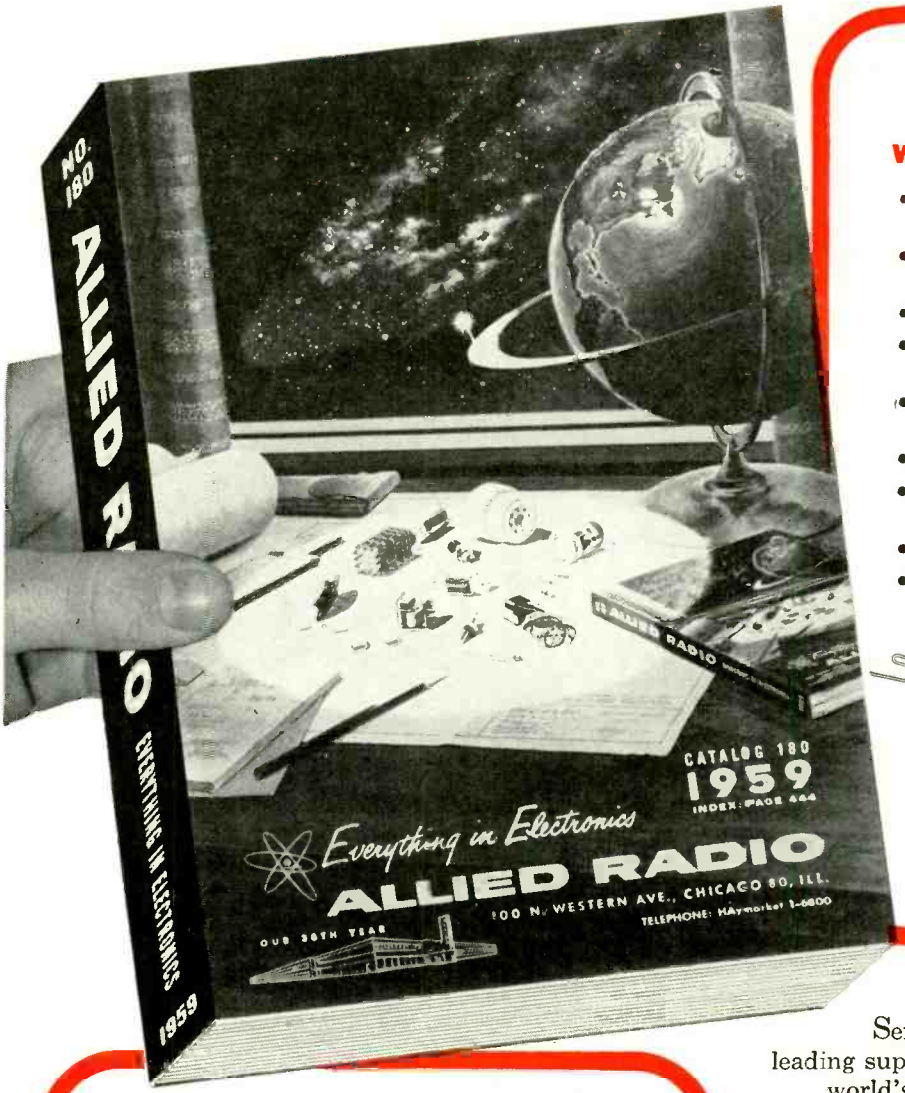

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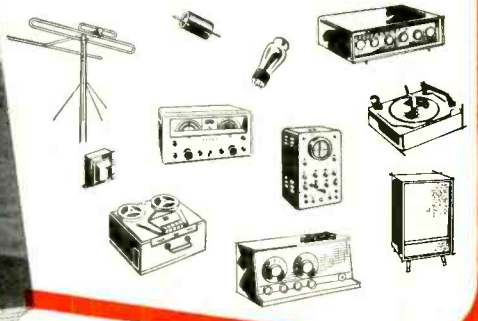

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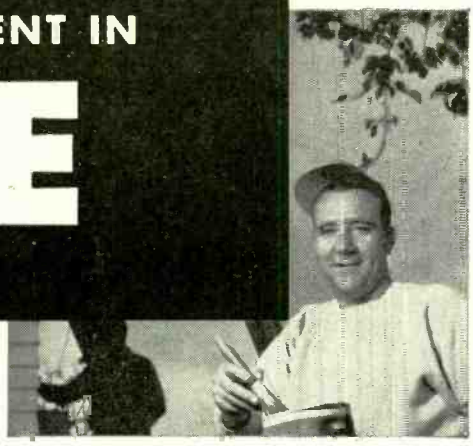
25,000,000 PEOPLE SAW THIS RECENT ADVERTISEMENT IN

LIFE

COACHES MIDGET-LEAGUE TEAM. For the past two years, Theodore W. Fickert, TV technician of Hatfield, Pa., has shown his 25-boy club how to play baseball. Active in community causes, he helped organize the Hatfield Junior Chamber of Commerce, and served as its secretary and state director; participates in the Heart Fund and other worthy drives; and is on the planning committee of St. Peter's Lutheran Evangelical Church.



A BRIGHTER, CLEANER CITY owes much to Bryce McNeely's work in connection with the Kelso, Wash., program for civic beautification. Bryce is on the mayor's committee for school and city improvement, is state JC vice president, and promotes young men's leadership training.

MAKES OTHERS' TROUBLES HIS OWN. One of the few TV technicians in an 85-mile area, T. E. "Buck" Adams of Channing, Tex., often aids in roadside emergencies, helps pen run-away cows, and has worked to improve local Baptist Church, parsonage.

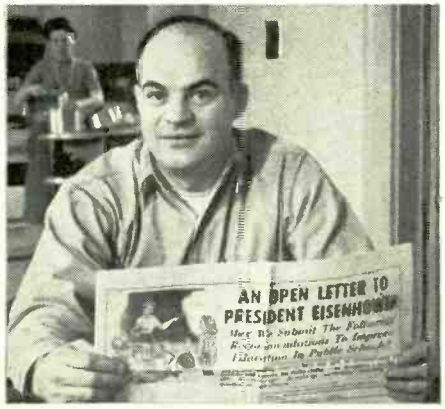
CRIPPLED CHILDREN LEARN TO WALK through fund-raising efforts of Vernon E. Brooks, Norristown, Pa., who helped obtain $100,000 to build a school for spastic paralytics. Mr. Brooks (center) is a director of the Chamber of Commerce, and a prime mover in Red Cross, Community Chest, United Fund, and Salvation Army work. As national president of the American Business Club, he helped obtain more than 100 scholarships for the training of physical and speech therapists. He is chairman of the Muscular Dystrophy unit for the Tall Cedars of Lebanon.

All-American TV Technicians

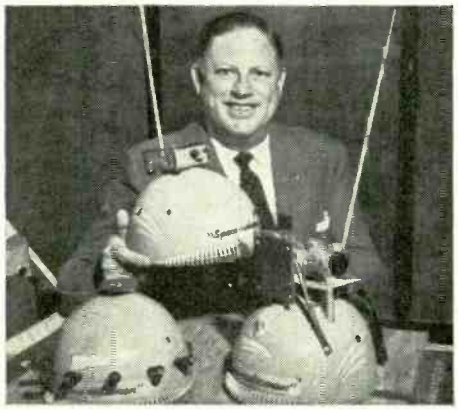
HELPED TORNADO VICTIMS. When disaster struck the area around Menomonie, Wis., on June 4, Vernon Townsend quickly organized emergency radio facilities to speed relief to the sufferers. A leading member of the Radio Amateur Civil Emergency service, he is active in Dunn County civil defense work, and also maintains a radio entertainment service for the local city-county hospital.

TEACHES SCOUTS RADIO. Boys in Brockton, Mass., learn Morse Code and the elements of electronics at an early age, from instruction by TV technician Albert P. Kazukonis. Much of the equipment he supplies without charge. A devoted youth and community worker, Mr. Kazukonis is treasurer and a past president of the Electronic Technicians Guild of Massachusetts, Brockton Chapter.

DONATED LOUDSPEAKER SYSTEM. The 1958 Centennial parade and pageant at Bloomington, Minn., owed much of its success to the fine amplifier system installed without charge by Edwin B. Haines. Ed is widely known for the time, effort, and equipment he has supplied for the 2,000 boys in Bloomington's sports program. He is a leader and counselor in Boy Scout work, and gives assistance to the Lions and the Bloomington Civic League.



SPENDS TO PROMOTE EDUCATION. Out of his own pocket, A. George Catavolo, TV technician of Somerville, Mass., financed two full-page newspaper ads which presented to the President recommendations on public school education. Last year George contributed over 30 radios, plus his time, to teach boys electronics.



WORLD OF TOMORROW! This novel space radio-man hat, invented by Stanley Everett of Alhambra, Cal., helped publicize many worthy drives. Stanley is president of the Los Angeles Electric League; a director of the Alhambra Chamber of Commerce; past president of Kiwanis and district chairman of the United Fund drive.

COMMUNITY SERVICE is a watchword with Wayne E. Lemons of Buffalo, Mo. An active Rotarian, he works with Boy Scouts, promotes Little League baseball, and has instructed TV technicians in surrounding cities. He is West Central vice-president of the National Alliance of Television Electronic Service Associations.

Win General Electric Awards

PEOPLE the nation over nominated candidates for the 1958 All-American Awards, honoring TV service technicians. This broad response showed how important a place the television technician holds in our community life, and how widely esteemed are his efforts in aid of others.

The Award winners, shown here, were chosen by a panel of judges including John Sparkman, U. S. Senator and Chairman, Select Committee on Small Business; Bennett Cerf, television panelist and head of Random House publishing firm; and Charles Shearer, 1957-58 president of the National Junior Chamber of Commerce.

With these Awards, General Electric pays tribute to the part played by the independent television technician in making this a better country for all. *General Electric Company, Receiving Tube Department, Owensboro, Kentucky.*

Winners received this trophy, $500 for community benefit, and a trip to Wash., D.C., for luncheon with Senator John Sparkman.

Progress Is Our Most Important Product

GENERAL ELECTRIC

2-111-231

Sylvania received Altoona's official welcome through front-page headlines and a special feature section filled with congratulations.

Why the whole town made such a fuss over

Sylvania's new tube plant

For one thing—Altoona folks know that progress by an important resident company means the whole town progresses. Sylvania's President, Don Mitchell, at the multi-million-dollar plant's formal opening called it "the largest in the receiving tube industry—containing many innovations."

This is where you come in. Because most of these innovations affect your business profit. As the world's most modern tube plant, Altoona will be producing the world's most reliable tubes in both commercial and military types. Two of the industry's biggest bugaboos, intermittent shorts resulting from dust and lint and unstable emission caused by contamination and humidity variations during tube manufacture, promise to be vastly improved. You'll be hearing more about these developments in the future.

The Altoona plant is as much a dedication to the independent serviceman as it is to the entire tube industry. It's a modern example of why profit-minded dealers are relying on Sylvania tubes.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N.Y.
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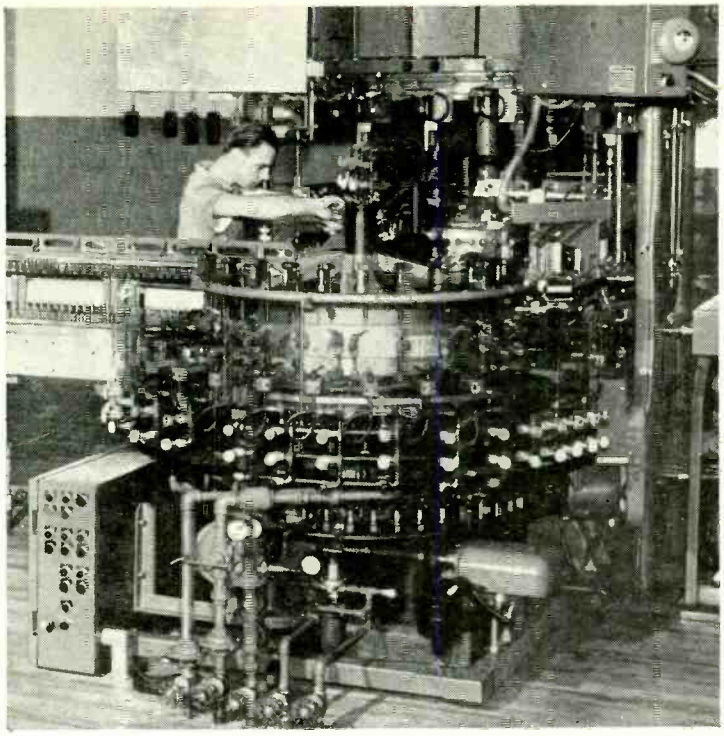
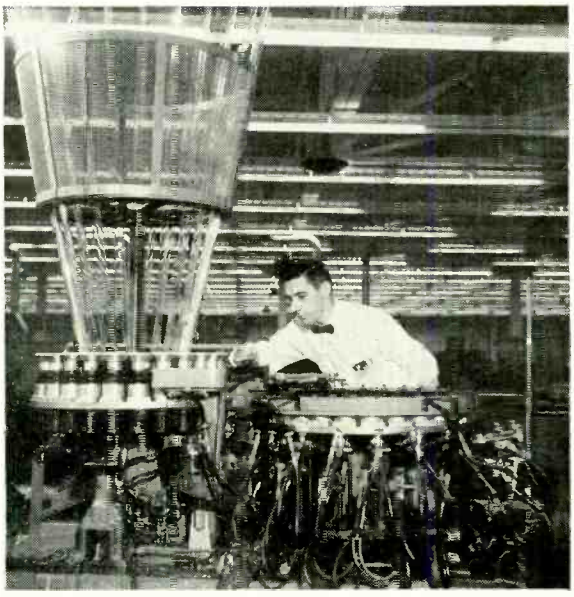


New concepts in tubemaking, which have been in development for the past decade, are put into high-speed production facilities at Altoona. The new concept bulb, in the making here, adds new tube reliability.

in Altoona



The new double-turret sealex is an important new development. Oil-diffusion pumps work in series with mechanical pumps to produce the most nearly perfect vacuum possible.

New Transistor Servicing Course

Now you can get a thorough grounding in servicing transistorized equipment with Sylvania's new 12-lesson transistor Servicing Course. Specially prepared by Sylvania engineers and the Radio-Television Training Association, it will help you cash in on the fastest growing segment of the electronics industry.

Now is the time to prepare for your share of this fast-growing business. See your authorized Sylvania Distributor or mail the coupon below for complete information on the Sylvania—RTTA Transistor Servicing Course.

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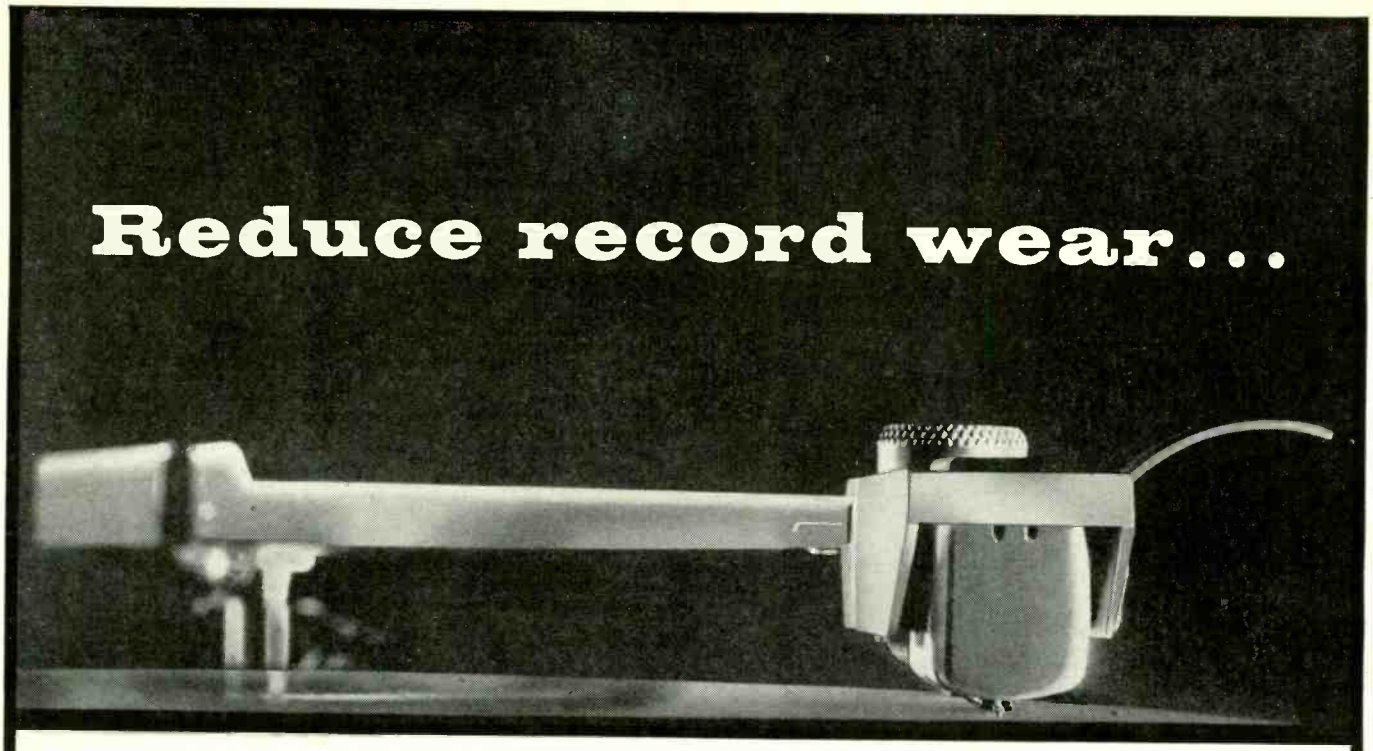
Reduce record wear...

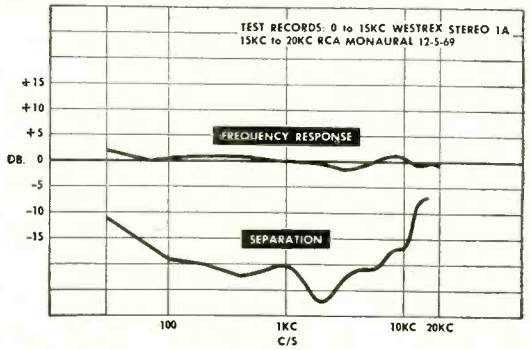


Less mass, higher compliance with G.E.'s "Golden Classic" stereo-magnetic cartridge

The more moving parts, the more resistance to groove motion. General Electric's "Golden Classic" has only one moving part—the stylus—which "floats" freely in special-formula damping cushions. This means freer motion in the record groove. You get less wear on records and stylus, and superior sound at all frequencies. Hear the "Golden Classic" GC-5 or GC-7 soon. You'll agree they are a fitting climax to the famous General Electric cartridge tradition.

• Plays both stereo and monaural records • Frequency response, 20 through 20,000 cycles • Output 8 mv • Effective mass of stylus about 2 milligrams • Lateral compliance 4 x 10^{-6} cm/dyne; vertical compliance 2.5 x 10^{-6} cm/dyne • Recommended tracking force with professional-type tone arm 2 to 4 grams. (Specifications for Madel GC-5.)

Model GC-5 (shawn) with .5 mil diamond stylus, **$26.95.** Model GC-7 with .7 mil diamond stylus, **$23.95.** Model CL-7 with .7 mil synthetic sapphire stylus **$16.95** (Manufacturer's suggested resale prices).



Smooth response on both stereo and monaural records. Consistently high channel separation, because the stylus is *magnetically* linked to the coils.

TM-2G "Stereo Classic" tone arm

A professional-type tone arm designed for use with G-E stereo cartridges as an integrated pickup system. Unusual two-step adjustment permits precise setting of tracking force from 0 to 6 grams. Lightweight, brushed aluminum construction minimizes inertia. Statically balanced for minimum friction, reduced stylus and record wear **$29.95** (Manufacturer's suggested resale price).

GENERAL ELECTRIC

See and hear the G-E "Stereo Classic" cartridges and tone arm at your Hi-Fi dealer's now. For more information and the name of your nearest dealer, write General Electric Company, Specialty Electronic Components Dept., 4412 W. Genesee St., Auburn, New York.

NEW REVISED EXPANDED transistor course

Still Only $25.00 net

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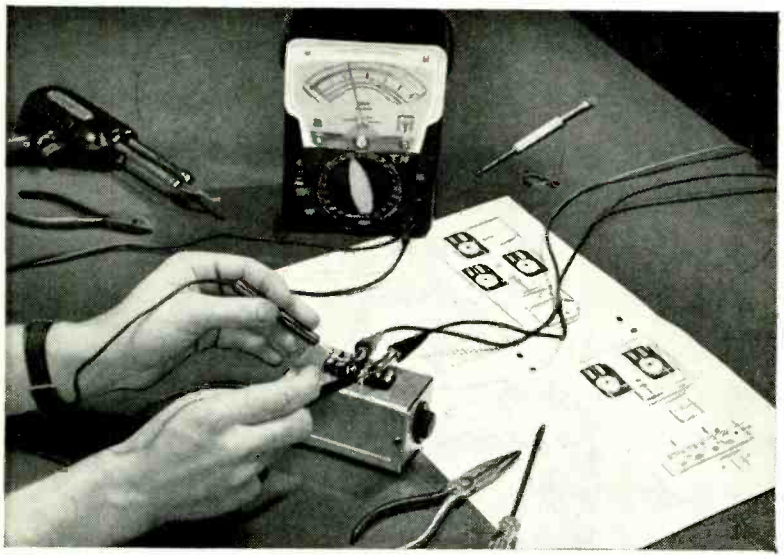

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- Ten intensive lessons (with 3-ring binder) . . . up-to-date, complete
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Call your CBS-Hytron distributor. He'll tell you how to get the CBS-Hytron Home-Study Transistor Course, PA-275. See him or write us . . . today!

Learn about transistors by using them

Advancement opportunities await service-dealers, engineers and technicians who know about basic transistor fundamentals. The newly revised and expanded edition of this popular and economical Transistor Course can help you too. A CBS-Hytron first, it was especially written and illustrated by A. C. W. Saunders, well-known educator and author, to make it easy for you to learn about transistors by *using* them. What you learn you can be sure you will remember . . . by making for yourself the practical transistor devices described. Check the expanded features. Read how easy it is to start your fast, fascinating Transistor Course.

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STEREO
STEREO AND MONAURAL

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Stereo Preamplifier HF85

FM Tuner HFT90

Stereo Amplifier-Preamp HF81

Bookshelf Speaker System HFS1

Monaural Integrated Amplifiers: 50, 30, 20, and 12-Watt (use 2 for Stereo)

Speaker System HFS2 36" H x 15¼" W x 11½" D

Monaural Power Amplifiers: 60, 50, 35, 30, 22 and 14-Watt (use 2 for Stereo)

Monaural Preamplifiers: HF65, HF61 (stack 2 for Stereo)

Over 1 MILLION EICO instruments in use throughout the world.

NEW STEREOPHONIC EQUIPMENT

HF85: Stereo Dual Preamplifer is a complete stereo control system in "low silhouette" design adaptable to any type of installation. Selects, preamplifies, controls any stereo source—tape, discs, broadcasts. Superb variable crossover, feedback tone controls driven by feedback amplifier pairs in each channel. Distortion borders on unmeasurable even at high output levels. Separate lo-level input in each channel for mag. phono, tape head, mike. Separate hi-level inputs for AM & FM tuners & FM Multiplex. One each auxiliary A & B input in each channel. Independent level, bass & treble controls in each channel may be operated together with built-in clutch. Switched-in loudness compensator. Function Selector permits hearing each stereo channel individually, and reversing them; also use of unit for stereo or monophonic play. Full-wave rectifier tube power supply. 5-12AX7/ECC83, 1-6X4. Works with any 2 high-quality power amplifiers such as EICO, HF14, HF22, HF30, HF35, HF50, HF60. Kit **$39.95.** Wired **$64.95.** Includes cover.

HF81: Stereo Dual Amplifier-Preamplifier selects, amplifies & controls any stereo source—tape, discs, broadcasts—& feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Monophonically: 28 watts for your speakers; complete stereo preamp. Ganged level controls, separate focus (balance) control, independent full-range bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers, excellent output transformers. "Service Selector" switch permits one preamp-control section to drive the internal power amplifiers while other preamp-control section is left free to drive your existing external amplifier. **"Its performance is excellent, and the operation is uncomplicated."**—HI-FI MUSIC AT HOME. **"Excellent"**—SATURDAY REVIEW. Kit **$69.95.** Wired **$109.95.** Incl. cover.

MONAURAL PREAMPLIFIERS (stack 2 for Stereo)

NEW HF65: superb new design, Inputs for tape head, microphone, mag-phono cartridge & hi-level sources. IM distortion 0.04% @ 2V out. Attractive "low silhouette" design. **HF65A** Kit **$29.95,** Wired **$44.95. HF65** (with power supply) Kit **$33.95.** Wired **$49.95.**

HF61: "Rivals the most expensive preamps" — Marshall, AUDIOCRAFT. **HF61A** Kit **$24.95,** Wired **$37.95, HF61** (with power supply) Kit **$29.95.** Wired **$44.95.**

MONAURAL POWER AMPLIFIERS (use 2 for STEREO)

HF60: 60-Watt Ultra Linear Power Amplifier with Acro TO-330 Output Xfmr.; **"One of the best-performing amplifiers extant; an excellent buy."** AUDIOCRAFT Kit Report. Kit **$72.95.** Wired **$99.95.** Cover E-2 $4.50.

HF50: 50-Watt Ultra Linear Power Amplifier with extremely high quality Chicago Standard Output Transformer. Identical in every other respect to HF60, same specs at 50W. Kit **$57.95.** Wired **$87.95.** Cover E-2 $4.50.

NEW HF35: 35-Watt Ultra-Linear Power Amplifier. Kit **$47.95.** Wired **$72.95.** Cover E-2 $4.50.

HF30: 30-Watt Power Amplifier. Kit **$39.95.** Wired **$62.95.** Cover E-3 $3.95.

NEW HF22: 22-Watt Power Amplifier. Kit **$38.95.** Wired **$61.95.** Cover E-2 $4.50.

NEW HF14: 14-Watt Power Amplifier. Kit **$23.50,** Wired **$41.50.** Cover E-6 $4.50.

MONAURAL INTEGRATED AMPLIFIERS (use 2 for STEREO)

HF52: 50-Watt Integrated Amplifier with complete "front end" facilities & Chicago Standard Output Transformer. **"Excellent value"**—Hirsch-Houck Labs. Kit **$69.95.** Wired **$109.95.** Cover E-1 $4.50.

HF32: 30-Watt Integrated Amplifier. Kit **$57.95.** Wired **$89.95.** Both include cover.

HF20: 20-Watt Integrated Amplifier. "Well-engineered" — Stocklin, RADIO TV NEWS. Kit **$49.95.** Wired **$79.95.** Cover E-1 $4.50.

HF12: 12-Watt Integrated Amplifier. "Packs a wallop"—POP. ELECTRONICS. Kit **$34.95.** Wired **$57.95.**

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*LESS COVER, F. E. T. INCL.

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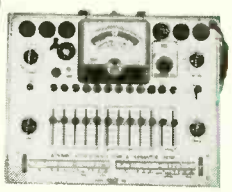
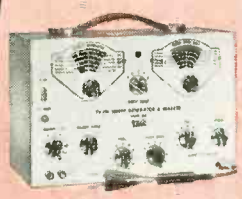


NEW! DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666

KIT $69.95 WIRED $109.95

COMPLETE with steel cover and handle.

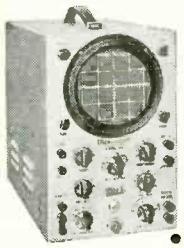
SPEED, ease, unexcelled accuracy & thoroughness. Tests all receiving tubes (and picture tubes with adapter). Composite indication of Gm, Gp & peak emission. Simultaneous sel of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate 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



NEW! TV-FM SWEEP GENERATOR & MARKER #368

KIT $69.95 WIRED $119.95

Entirely electronic sweep circuit (no mechanical devices) with accurately-biased incereductor for excellent linearity. Extremely flat RF output; new AGC circuit automatically adjusts osc. for max. output on each band with min. ampl. variations. Exceptional tuning accuracy: edge-lit hairlines eliminate parallax. Swept Osc. Range 3-216 mc in 5 fund. bands. Variable Marker Range 2-75 mc in 3 fund. bands; 60-225 mc on harmonic band. 4.5 mc Xtal Marker Osc., xtal supplied. Ext. Marker provision. Sweep Width 0-3 mc lowest max. deviation to 0-30 mc highest max. dev. 2-way blanking. Narrow range phasing. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Cables: output, 'scope horiz., 'scope vertical. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.



COLOR and Monochrome DC to 5 MC LAB & TV 5" OSCILLOSCOPE #460

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• Features DC Amplifiers!

Flat from DC-4.5 mc, usable to 10 mc. VERT. AMPL.: sens. 25 rms mv/in; input Z 3 megs; direct-coupled & push-pull thruout; K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. SWEEP: perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); preset TV V & H positions; auto. sync. ampl. & lim. PLUS: direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen; dimmer; filter; bezel fits std photo equipt. High intensity trace CRT. 0.06 usec rise time. Push-pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.

5" PUSH-PULL Oscilloscope #425: Kit $44.95, Wired $79.95.
7" PUSH-PULL Oscilloscope #470: Kit $79.95, Wired $129.50.

NEW! RF SIGNAL GENERATOR #324

KIT $26.95 WIRED $39.95

150 kc to 435 mc with ONE generator! Better value than generators selling at 2 or 3 times its cost! Ideal for IF-RF alignment, signal tracing & trouble-shooting of TV, FM, AM sets; marker gen.; 400 cps audio testing; lab. work. 6 fund. ranges: 150-400 kc, 400-1200 kc, 1.2-3.5 mc, 3.5-11 mc, 11-37 mc, 37-145 mc; 1 harmonic band 111-435 mc. Freq. accurate to ±1.5%; 6:1 vernier tuning & excellent spread at most important alignment freqs. Etched tuning dial, plexiglass windows, edge-lit hairlines. Colpitts RF osc. directly plate-modulated by K-follower for improved mod. Variable depth of int. mod. 0-50% by 400 cps Colpitts osc. Variable gain ext. amplifier: only 3.0 v needed for 30% mod. Turret-mounted coils slug-tuned for max. accuracy. Fine & Coarse (3-step) RF attenuators. RF output 100,000 uv; AF sine wave output to 10 v. 50-ohm output Z. 5-way jack-top binding posts for AF in/out; coaxial connector & shielded cable for RF out. 12AU7, 12AV7, selenium rectifier; xmfr-operated. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

NEW! PEAK-to-PEAK VTVM #232 & UNI-PROBE (pat. pend.)

KIT $29.95 WIRED $49.95

Half-turn of probe tip selects DC or AC-Ohms.

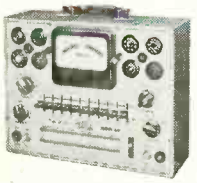
Uni-Probe — exclusive with EICO — only 1 probe performs all functions!

Latest circuitry, high sensitivity & precision, wide ranges & versatility. Calibration without removing from cabinet. New balanced bridge circuit. High Z input for negligible loading. 4½" meter, can't burn-out circuit. 7 non-skip ranges on every function. 4 functions: +DC Volts, −DC Volts, AC Volts, Ohms. Uniform 3 to 1 scale ratio for extreme wide-range accuracy. Zero center. One zero-adj. for all functions & ranges. 1% precision ceramic multiplier resistors. Measure directly peak-to-peak voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200. DC/RMS sine volts: 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 v. with HVP probe & 250 mc with PRF probe). Ohms: 0.2 ohms to 1000 megs. 12AU7, 6AL5, selenium rectifier; xfmr-operated. Deep-etched satin aluminum panel, rugged grey wrinkle steel cabinet.

New!

Series/Parallel R-C COMBINATION BOX #1140

KIT $13.95 WIRED $19.95



TUBE TESTER #625

KIT $34.95 Wired $49.95

• tests 600 mil series string type tubes
• illuminated roll-chart

Pix Tube Test Adapter $4.50

6V & 12V BATTERY ELIMINATOR & CHARGER #1050

KIT $29.95 WIRED $38.95

Extra-filtered for transistor equipt. #1060 KIT $38.95 WIRED $47.95

New!

Miniaturized MULTI-SIGNAL TRACER #145A

KIT $19.95 WIRED $28.95

20,000 Ohms/Volt V-O-M #666

KIT 24.95 Wired $29.95

1000 Ohms/Volt V-O-M #536

KIT $12.90 Wired $14.90

Reads 0.5 ohms —500 megs, 10 mmfd—5000 mfd, power factor.

KIT $19.95 Wired $29.95

R-C BRIDGE & R-C-L COMPARATOR #950B

VTVM PROBES	KIT	Wired
Peak-to-Peak	$4.95	$6.95
RF	$3.75	$4.95
High Voltage Probe-1		$6.95
High Voltage Probe-2		$4.95
SCOPE PROBES		
Demodulator	$3.75	$5.75
Direct	$2.75	$3.95
Low Capacity	$3.75	$5.75

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Radio-Electronics
Hugo Gernsback, Editor

US WANTS ELECTRONIC INVENTIONS

. . . *Our Armed Forces Call for New Developments* . . .

IT IS a mistaken notion that our armed forces are responsible for *all* our military inventions. While many outstanding developments are made by Government personnel, many more are invented by civilians. Every once in a while, the Government, through the National Inventors Council, issues a call to inventors and technicians for basic inventions needed for the national defense program. In our May, 1957, issue, we published such a list of inventions; a new one, just issued, is partially reprinted here. We list only 26 electronic ones.

Anyone may submit proposals to the council. Each should be submitted separately, typewritten, if possible. Descriptions should be complete and include reference to the basic principles underlying the invention and a discussion of any experimental work or tests that have been conducted as well as the advantages of the invention as compared to existing devices or techniques. Sketches or drawings need not be professional.

Keep copies of all items presented and retain a copy which has been notarized with the exact date so you will always have proof of conception for patentability. Your original copy will not be returned.

In the list given below, due to the length of the description of certain items, the word *condensed* appears at the end. It is therefore suggested that you write for the booklet *Inventions Wanted by the Armed Forces, Supplement, November 1958* from the National Inventors Council, US Department of Commerce, Washington 25, D. C.

* * *

395. (Revised) ARTILLERY ORIENTATION SYSTEM. A system of orientation of artillery to a reference independent of line of sight, the earth's magnetic field or rotation with azimuth accuracy of ¼ mil. Present artillery fire control systems rely on an earth-reference device to aim the weapon. (Condensed)

541. (Revised) MICROWAVE DIRECT STORAGE OR MEMORY CIRCUIT. The need exists for a direct-viewing storage tube capable of handling demodulated pulse type signals encountered in field operations. Such a tube can provide an important assist in visual analysis of signal information, and also facilitate photographic recording of short-duration signal transmissions. (Condensed)

648. (Revised) INFRA-RED TRANSMITTING MATERIALS. Development of infra-red transmitting materials having the following properties: (1) 75% transmission from 0.8- to 8-micron wavelength in 1-cm thickness. (2) Melting or softening point above 500°C. (3) Capable of standing thermal shock of 100°C per second. (4) Be resistant to abrasion and solution by atmospheric fluids.

733. (Revised) ACOUSTIC TRANSDUCER. A sharply unidirectional device of small size compared to wavelength for sound detection on signals as low as 5 cycles per second.

742. (Revised) POWER RECTIFIERS. Power rectifiers to work in an ambient temperature of −20° to +500°C.

744. (Revised) ELECTROMAGNETIC RADIATION RECEIVER. A device for receiving electromagnetic radiation in the 9–14-micron region, which will have a response time of microseconds and will operate at normal temperatures.

822. (Revised) TRANSISTORS. Transistors capable of operating efficiently (greater than 50%) as oscillators and amplifiers at uhf.

829. (Revised) RESISTORS. Resistors in the 1–100-megohm range with positive temperature coefficients, preferably as high as 1000 parts per million per °C are needed for temperature compensation of circuits. It is desirable that they have a power rating of at least ¼ watt and be no larger than ½-watt commercial composition resistors.

858. (Revised) TRANSISTORS. Transistors which will operate satisfactorily in the hf, vhf and uhf ranges at temperatures well in excess of 150°C. There is also need for transistors which will function at the various microwave frequencies.

862. (Revised) TELEVISION SYSTEM. TV systems of improved resolution which will permit optical tracking of guided missiles. Quality of the images should approach that of a photograph. Present guided-missile tracking instrumentation, as related to this problem, is of both optical–photographic and electronic types. No successful application of television systems has yet been made in regular missile-range operations. (Condensed)

895. COMMUNICATING OVER A BROKEN WIRE LINE There is a need for means of communicating over a wire line, even though the line be physically broken.

899. HIGH-ANGLE DIRECTION-FINDING TECHNIQUES. A method is required to permit accurate direction finding (in azimuth) on steeply downcoming sky-wave signals in the frequency range 1–12 mc. Instrumental bearing accuracy required is of the order of 2° standard deviation on signals with a minimum field strength of 20 microvolts per meter. (Condensed)

902. PHOTOMAGNETIC PROCESS. A new method for converting light energy into magnetic energy without the intermediate step of electrical energy. Such a method would simplify the equipment for recording images on magnetic tape.

903. NONREFLECTING OR ABSORBING SURFACES TO ELECTROMAGNETIC (INCLUDING RADAR) ENERGY. Aircraft, missiles, artillery shells, military vehicles, etc. are normally metallic and good reflectors or targets to incident electromagnetic energy. Much effort is being expended to develop means of making the surfaces of these items nonreflecting or absorbing to such energy. It is important to solve this problem by means which will not adversely affect normal functioning.*

904. MICROWAVE SUPERGAIN ANTENNA. The range of a radar set or communication equipment can be increased by having a highly directive antenna, especially in the microwave-frequency bands between 1,000 and 30,000 mc. Many techniques are being investigated to achieve supergain by using large numbers of current elements in a relatively small volume array rather than using a large unwieldy aperature, but to date the effort has been mostly theoretical rather than practical.

907. VIDEO COMPRESSION. Development of a method of bandwidth compression of 3.5-mc video signals, down to the order of 1 mc for transmission, and to re-create the original bandwidth signals after transmission.

908. SECURE CABLE. The universal integrated communications system (UNICOM) will provide secure cables between automatic switching centers and subscribers. The problem is to develop a cable which carries groups of four wires and which is secure against interception by the enemy. This requires invention of a warning alarm, to be activated—whenever the cable is disturbed in any fashion—to improperly read the messages passing through the cable.

909. TIME SYNCHRONIZER. A technique for synchronizing absolute time over distances of from 100 to 1,000 miles, to accuracies in the order of 1/10 microsecond or less. Present techniques require approximately 10 mc of bandwidth and many microwave relay stations, or very powerful low-frequency transmitters with complex associated equipment, both methods being undesirable.

911. DATA TRANSMISSIONS. A means for transmitting, at the instant of sensing, aerial photographic-mapping sensory presentations and allied data from an airborne vehicle to a ground station without loss of resolution or geometric fidelity. The system should be non-jammable and not limited to line-of-sight range.

914. ELECTRONIC DISTANCE-MEASURING SYSTEM. An accurate method of measuring geodetic distances up to 1,500

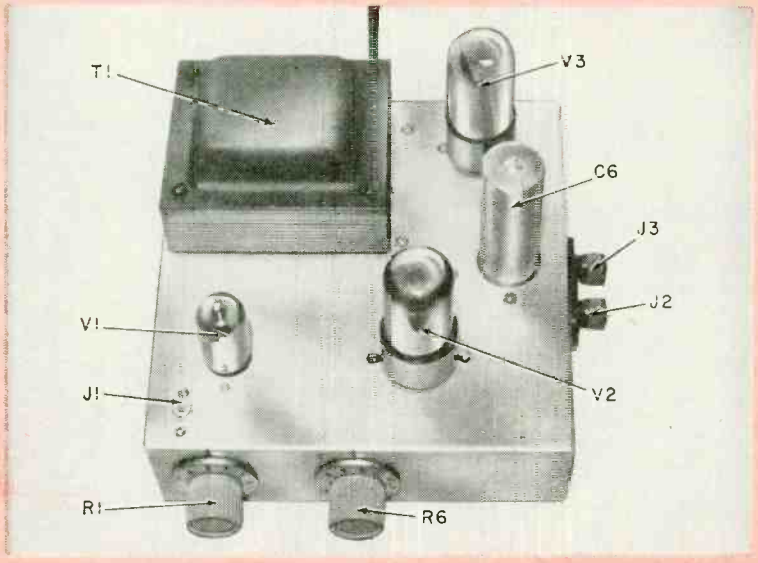
(*Continued on page* 133)

* See also September, 1958, RADIO ELECTRONICS on same subject.

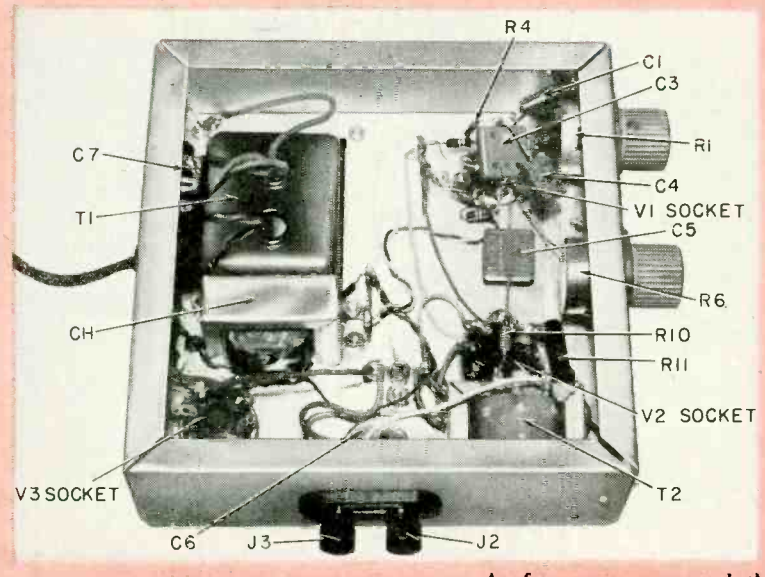
For frequencies above 2,000 cycles only, this 3-tube audio amplifier puts you on the road toward a quality dual-channel hi-fi system

AMPLIFIER for your TWEETER

By ROBERT G. VAUGHN



From the top the amplifier presents a very ordinary appearance.



As few parts are used there is no crowding under the chassis.

THIS amplifier is used to drive a high-frequency speaker. It is the product of 2 years of practical testing, in practical systems.

Nonessentials have been discarded, and the result is a unit that is simple, inexpensive, easy to construct, and does the specialized job required of it.

Despite its low cost, it will perform as part of a high-quality system of any power up to at least 25 watts. The crossover, at 2,000 cycles, is part of the amplifier's response characteristic.

Because of the amplifier's strictly high-frequency character, some problems found in low-frequency amplifiers are avoided. For example, with an output transformer costing about $3, 20 db of feedback is used with complete stability under any signal or load condition.

Mainly, the unit's low cost is possible because little power is needed in its range. But there are other reasons not directly related to power. The advantages of push-pull operation are less apparent at the frequencies involved. A single output tube, especially with feedback, is not the disadvantage it is at very low frequencies. And, of course, the huge primary inductance of a low-frequency output transformer is unnecessary.

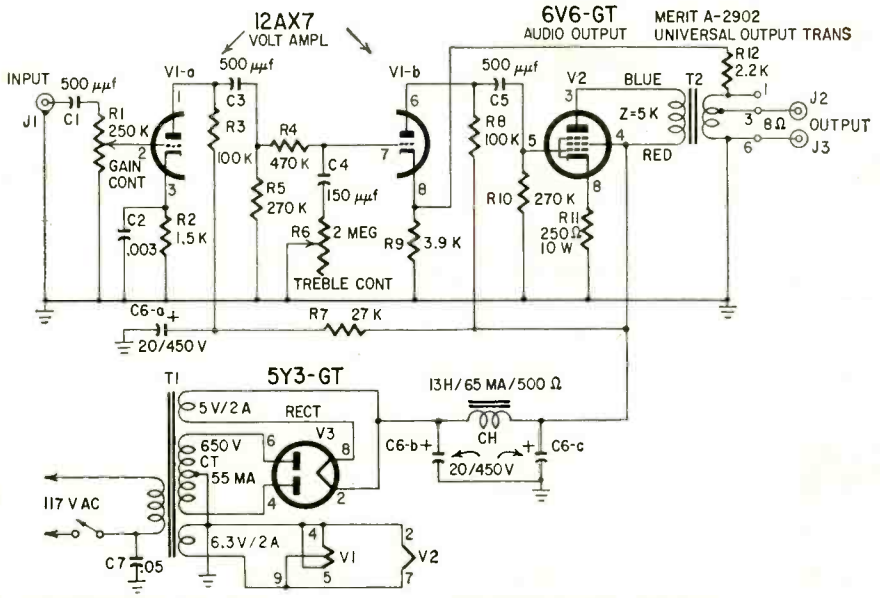
These things combine to make a unit (see Fig. 1) that works well in a quality system having a main or low-frequency amplifier, with many times the power output of the high-frequency one. Self-powered, it is only 7 inches square. Its three tubes are a 6V6-GT audio output, a 12AX7 two-stage voltage amplifier and a 5Y3-GT rectifier.

Circuit features

The key to the circuit's design lies in using coupling values barely sufficient to maintain a flat response down to the crossover frequency, and no more. This provides a sharp drop below 2,000 cycles, even with feedback, which tends to flatten out the curve and avoids the need for special filters or networks in the high-frequency channel. Frequency response is shown by Fig. 2, plotted with 2,000 cycles as the reference frequency.

Since the amplifier is normally connected to the output of a preamp, or to an equalized source such as a tuner, large low-frequency voltages at its input have to be guarded against. Otherwise, a serious overload might result. The input capacitor, with a reactance of more than 3 megohms at 100 cycles, and the GAIN CONTROL effectively prevent this.

While further economy might seem possible in power supply filtering, it cannot be neglected simply because hum, which is inaudible in the output, may modulate the delicate high-frequency tones, destroying their brilliance and clarity.



R1—pot, 250,000 ohms, audio taper
R2—1,500 ohms
R3, 8—100,000 ohms
R4—470,000 ohms
R5, 10—270,000 ohms
R6—pot, 2 megohms, audio taper
R7—27,000 ohms
R9—3,900 ohms
R11—250 ohms, 10 watts
R12—2,200 ohms
All resistors ½-watt 10% unless noted
C1, 3, 5—500 μμf, mica
C2—.003 μf, mica
C4—150 μμf, mica
C6—20-20-20 μf, 450 volts, electrolytic
C7—.05 μf, 400 volts, paper
CH—13 henrys, 65 ma, 500 ohms (Stancor C-1708 or equivalent)
J1—phono jack
J2, 3—binding posts
T1—power transformer: primary, 117 volts; secondary, 650 volts ct, 55 ma; 5 volts, 2 amps; 6.3 volts, 2 amps (Stancor PM- or PC-8407 or equivalent)
T2—universal output transformer, 10 watts (Merit A-2902 or equivalent)
V1—12AX7
V2—6V6-GT
V3—5Y3-GT
Switch, spst, optional
Chassis, 7 x 7 x 2 inches
Miscellaneous hardware

Fig. 1—Circuit of the compact high-frequency amplifier.

It may seem that the 470,000-ohm resistor (R4) in series with V2's grid, would normally degrade high-frequency response. The curve (Fig. 2) shows that this does not happen. There are two reasons why this is so.

First is the greatly reduced input capacitance of V2 because of feedback. The other is that the loss that does occur is compensated for by the effect of C2, the small cathode bypass capacitor in the first stage. Their effects are exactly opposite and tend to cancel each other.

Resistor R4 is needed for satisfactory operation of the high-frequency attenuator circuit which includes R6 and C4. Without R4, C4 would have to be so large to be effective that it would load V1's plate circuit and create serious distortion.

Hooking into the system

There are several ways of hooking it into your present system, depending on the system itself and your desires. The ideal is a setup with separate main amplifier and preamplifier, already using two speakers and a crossover network. Two approaches are possible. The perfect one would be to insert an electronic crossover after the preamp, then attach the tweeter to the high-frequency amplifier and the woofer to the main amplifier.

A solution almost as satisfactory is to connect the high-frequency and main amplifiers in parallel at the output of the preamp, connect the tweeter to the high-frequency amplifier and connect a resistor of the same ohmage and approximate wattage across the tweeter terminals of the crossover network.

If you are using an amplifier with the preamp built in and only one speaker, the problem is not so simple. You may not be sure just where the main amplifier begins. The best way to find out is possibly to trace the main feedback loop from the output, which nowadays in most cases runs back to the cathode of the first tube of the main amplifier. By connecting to the grid of that tube, you also avoid the danger of getting your input circuit inside the feedback loop, which was certainly not designed for its inclusion.

In a number of amplifiers it may be advisable to connect the high-frequency amplifier one stage still further toward the input. Many amplifiers have a frequency control in that stage. By connecting the high-frequency amplifier across or ahead of it, you can use it to keep higher notes out of the woofer and to control response in the upper part of the woofer's range to some degree. When set for maximum treble attenuation, it will act much like a low-frequency divider.

However, if the treble control is ahead of the high-frequency amplifier input, you may prefer to use it and leave off R6 and C4. It is best to leave R4, because it has a stabilizing influence.

The volume control of the main amplifier will in practically all cases be ahead of the high-frequency volume control, and may be used to control volume of the whole system, maintaining balance with the high-frequency amplifier control. If, however, you want completely independent controls, the place to connect the amplifier is across the volume control of the main amplifier. Then balance is adjusted with both controls, but it will also be necessary to juggle both controls to raise or lower the overall level.

If you are among those who prefer the effect of wide separation between high- and low-frequency speakers, this unit fits in. The separate control of gain through each channel heightens the realistic effect. With this kind of system, using the main amplifier's treble control as suggested earlier has a more noticeable effect than when the speakers are close together.

The value of feedback resistor R12 is based on use of the Merit A-2902 transformer and may differ widely with any other for the same amount of feedback. Also, any substantial change in R12 calls for a change in R9, if V2 is to have the correct bias. The two in parallel should total about 1,500 ohms, but the ratio determines the amount of feedback. Keep this in mind when considering substitution.

The numbers 1 and 6 at the secondary terminals in the diagram refer to those on this transformer. These are the outside terminals, the whole winding being used for feedback. Consult the sheet that comes with the transformer for the nearest match to your speaker, this being a universal type unit. Most likely the 8- or 12-ohm terminals will prove best. This is convenient because these are terminals 3 and 6, and 2 and 6, respectively. Terminal 6 is grounded for feedback purposes.

If you are one of those who share the increasing interest in dual-channel systems, this unit has much to recommend it. If you stick to the values specified and to good construction practices, you can hardly have serious trouble. The circuit itself is little different from any other audio circuit. The coupling capacitor values will seem strange and perhaps wholly inadequate to anyone accustomed to low-frequency circuits. But as you have seen, they have a very definite purpose.

A ½ volt rms at 2,000 cycles drives the unit to full output—just over 4 watts at the clipping point. But don't let this fool you. At frequencies in this range, 4 watts, even into an inefficient speaker, is more than most people can stand indoors. END

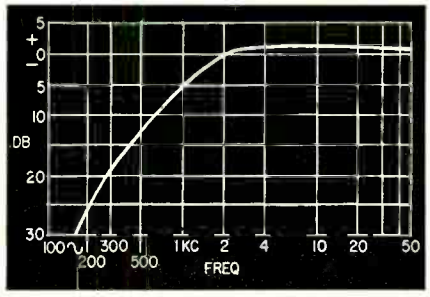


Fig. 2—Amplifier's response is almost flat from 2,000–20,000 cycles. Note sharp rolloff below 2,000 cycles.

ALL ABOUT THE REFLEX ENCLOSURE

Part I—Development, resonance, air motion in the enclosure

By P. G. A. H. VOIGT

THE so-called reflex cabinet is, in effect, a box baffle with an extra feature. Therefore, practically everything which we discussed earlier applies and we will not waste time repeating what has already been said. (See "A Box for Your Speaker," RADIO-ELECTRONICS, January, 1959, page 48.)

The extra feature of the reflex cabinet is its port or vent. In its simplest form this is a rectangular or circular hole. Sometimes it consists of a number of small holes. The expression distributed port is then used to describe it. Sometimes a short pipe or "duct" is fitted internally at the opening.

When discussing the box baffle, we were concerned with preventing air flow from the back of the cone to the front. So making one or more holes in the enclosure seems a crazy thing to do, for surely it will permit some flow and diminish the baffle's effect? If everything is taken into consideration, the idea is not quite as absurd as it seems. Making the opening does introduce disadvantages, certainly, but there are also advantages, and to understand how these come about, we must go into fundamentals a bit more. We shall then discover something quite unexpected which is not obvious at first glance. So let us go back to the beginning.

History behind the reflex

There are many famous names in the world of radio—Marconi, Fleming, Lee de Forest, Armstrong and many others. In each case the person concerned was responsible for one or more important developments, and if that person's name is mentioned his work immediately comes to mind. The reflex cabinet is an exception. No one person's name comes to mind when it is mentioned.

In 1933–34, I was very much concerned with trying to increase the amount of bass you can get from a speaker with a fairly small cone. That cone was already driving a short horn but the system was inefficient below the horn cutoff. Several cubic feet of space were available in the cabinet below the horn, and the problem was to find a way to augment the lowest frequencies within the available volume. The method finally adopted used a tapered, folded pipe (rather like the neck of a horn) which exhausted near the floor. I named the bass department of the system a bass chamber and would certainly *not* have done so had I been aware of the impending introduction of what is now called the reflex cabinet. For that has a much better right to be called a chamber than my more complex tapered folded pipe system. In Britain, reflex cabinets were in circulation before the war (September, 1939). This places the arrival of reflex enclosures somewhere between 1934 and 1939.

Recently, I have been able to trace the arrival details properly, thanks to the cooperation of the library of the University, the Reference Library, Ontario Hydro and the Ryerson Institute of Technology, all in Toronto and the library of Queen's University, Kingston, Ontario.

Langford Smith's *Radiotron Designers Handbook*, Fourth Edition (1952), in a prolific source of references. Reflex cabinets are discussed there and indexed under "Baffles, Loudspeaker, Vented." Most references to reflex cabinets given in the text date after the outbreak of the war.

The two earliest refer to an article in *Radio Engineering* for October, 1936, and to "New Features in Broadcast Receiver Design" in the *RCA Review* for July, 1937. That review also refers to the October, 1936, article in *Radio Engineering*, as does Olsen's book[1]. There was, however, a hint of things to come in a still earlier article on "Improving the L.F. Response" in *Radio Engineering* for June, 1936. This referred to the "recently announced" RCA receiver and gave a brief description of the system. So, with a first hint in June and the full story in October, the reflex cabinet became known to the technical public in 1936.

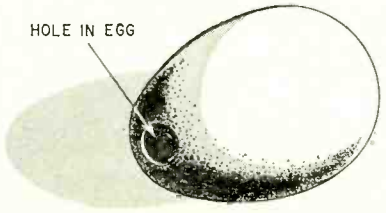


Fig. 1–1—The basic Helmholtz resonator consists of a hollow body with an aperture.

In connection with the October, 1936, article, three authors' names are given (all of RCA). They acknowledged the assistance of still more people. Evidently it was an RCA team effort with RCA signing the checks.

The article in the July, 1937, *RCA Review* discusses the next year's models and, in connection with the acoustical end, mentions work on the application of acoustic filter theory to single or multiple "tone chambers." It describes an enclosure with a curved enclosing panel and rows of holes near the bottom and elsewhere, "the holes being proportioned to produce the best acoustic effect, the combined inertia of the air resonating with the enclosed cavity."

So it seems that RCA deserves the credit. However, I have recently come across another reference: US Pat. No. 1,869,178 assigned to Bell Labs. The inventor, A. L. Thuras, bears an honored name among the early workers in electro-acoustics. He describes a system in which the cabinet has openings with short pipes internally. The date of filing Thuras' patent was Aug. 15, 1930! So, it seems that Thuras "fathered" the idea and RCA as "midwife," about 6 years later, helped to bring it before the public.

Jensen Manufacturing was also at work in 1936, though it seems that they did not publish anything that was made available to the enthusiast that year. However, the name Bass Reflex, which they gave to their infant has stuck ever

[1]Harry F. Olson, *Elements of Acoustical Engineering*, 2nd Edition, 1947. D. Van Nostrand Co., Inc.

since and has been adopted on a worldwide basis.[2]

Resonances produced in an enclosed cavity with one or more openings have been known for a very long time. Back in the 19th century an Austrian physicist named Helmholtz made a study of this type of resonator. Whether he did his work because of possible applications to musical instruments or just out of scientific curiosity is irrelevant. What matters is that he studied the subject in detail and worked out the mathematical equations for a resonator in which the moving part is air moving in and out of an opening and the elasticity is provided by the compressibility of the air in the cavity.

A simple form of Helmholtz resonator (see Fig. I–1) is an eggshell with a single hole in it (through which the contents have been drained). This leaves a hollow body having an aperture. By blowing across the hole in certain ways, it is possible to produce a musical tone. Another type of Helmholtz resonator is a bulbous flower vase in which the customary neck opening forms the aperture. Any container enclosing a body of air and having one or more openings can act as a Helmholtz resonator.

An eggshell and a flower vase are usually round, but the shape of the internal volume does not affect the resonance, so long as certain requirements are met. A rectangular volume resonates just as well. Therefore, if an opening (a port or vent) is made in one side of a box baffle such as we discussed before, the enclosure becomes a Helmholtz resonator capable of being excited at its resonant note.

The resonant frequency is determined by the inertia of the moving air in the aperture(s) and thereabouts, acting in combination with the compressibility of the air cushion inside the cavity. The natural resonant frequency can be adjusted by altering the volume of the air cushion. Doing something which affects the inertia of the air at the opening is another way of changing the frequency. Changing the area of the aperture does just this, and once the box has been built is a much easier way of varying the resonant frequency than by changing the volume.

In the 1920's, resonance was regarded as the "root of all evil" as far as speaker design was concerned and designers did what they could to get away from inherent resonances. From a theoretical point of view that is still correct. But in practice, if theoretical perfection is not attainable within a certain space or price range, it is good engineering to examine the various "not quite so perfect" possibilities and to select one of the next best. The reflex cabinet, especially when designed or adjusted to suit the speaker with which it is to be used, is perhaps the simplest of these "next bests" and has become very popular.

It is this matter of matching the reflex cabinet to the speaker that makes the main difference between the best in reflex systems and the ordinary ones. However, before we can discuss adjusting reflex cabinets intelligently, a few comments on speakers have to be made.

A moving-coil speaker has a voice coil driving a cone. These moving parts have to be kept in their proper place with respect to the magnet. Axial motion, within certain limits, is necessary to produce the sound, but lateral motion should be negligible. In any normal system, the supports for the moving parts have some elasticity, which returns the coil and cone to a central point when no other forces are acting against it.

The coil and cone with their accessories all have mass. So there is combined mass under elastic control. When mass is under elastic control, there is a frequency at which resonance can occur. The extent to which this resonance builds up with a given stimulus at the resonant frequency depends on the losses.

Of the losses, the useful loss is the work done by the front face of the cone in creating the wanted sound output. There is also a loss because of the work done by the rear face of the cone. This may or may not be useful. Normally, there are various inherent molecular and air frictions and there is also the electromagnetic control of the voice coil. Properly speaking, this is not a loss but it is involved in the problem of the amplitude of motion produced.

If the coil is immersed in an intense magnetic field and is driven from a low-impedance source (such as a power triode), the electromagnetic control is fairly rigid and no great buildup occurs at the resonant frequency, for the back emf generated by motion opposes the applied voltage. However, if the magnetic field is weak, or the driving circuit has high impedance—as when a pentode is used without feedback—the control is slight and a relatively large amplitude may build up at the speaker's lower resonant frequency. At lower frequencies the mechanical forces tend to control and limit the cone's motion.

For a given sound output at the lower frequencies, the amplitude has to increase greatly as the frequency is reduced if the speaker is working in a baffle. The mechanical control below resonance prevents the required increase in amplitude and limits the speaker's low-frequency output. In general, therefore, a speaker cuts off rapidly below its own lower mechanical resonant frequency.

I mentioned earlier that, when we come to examine the way in which a reflex cabinet works, we would find something rather surprising. This interesting effect comes next.

Let us consider the sequence of events in reverse and begin by thinking of air rushing in and out at the port. That air will have some inertia; consequently, before it can attain any velocity it must be accelerated. When the air has experienced all its acceleration in one direction, it has acquired its maximum velocity in that direction. From that moment on deceleration (reverse acceleration) takes place, which, after stopping the air motion, reverses the direction of motion and in time produces the moment of maximum reverse velocity. By then the reverse acceleration has become zero and is replaced by acceleration in the initial direction. This continues cycle after cycle.

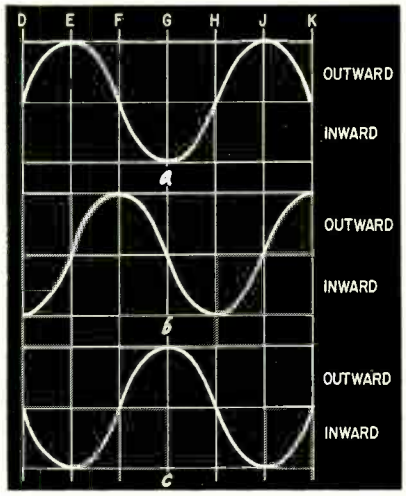


Fig. I–2—Why air displacement ends up out of phase with the speaker movement: a—accelerating force; b—port air velocity; c—air displacement.

If, on the curve in Fig. I–2-a, we have outward acceleration between D and F, then from F to H the acceleration is reversed and from H to K it is outward again. Now how is this acceleration applied?

If we assume that the air outside the cabinet is still and at normal barometric pressure, acceleration can occur only if there is a higher or a lower pressure inside the cabinet. So long as the pressure in the cabinet is above that of the air outside, the acceleration is outward, but when the pressure in the cabinet is below that of the outside air, the acceleration is reversed and is now inward.

In our baffle box we knew that when the speaker was in operation, pressures and rarefactions were set up in the air cushion in the cabinet. It is the difference between this air-cushion pressure or rarefaction at any moment and the outside pressure which provides the accelerating force that sets up the oscillatory motion at the enclosure's port or vent.

With a sine wave of compression and rarefaction, the acceleration varies sinusoidally. The outward acceleration, starting at D (Fig. I–2-a) and stopping at F, reaches its maximum at E. The reverse acceleration starts at F and goes on to H. It reaches its maximum

[2]D. J. Plach and P. B. Williams, "Loudspeaker Enclosures," *Audio Engineering*, July, 1951.
P. B. Williams and J. F. Novak, "Improvement in 'Air Suspension' Speaker Enclosures With Tube Venting," *Audio*, November, 1958.

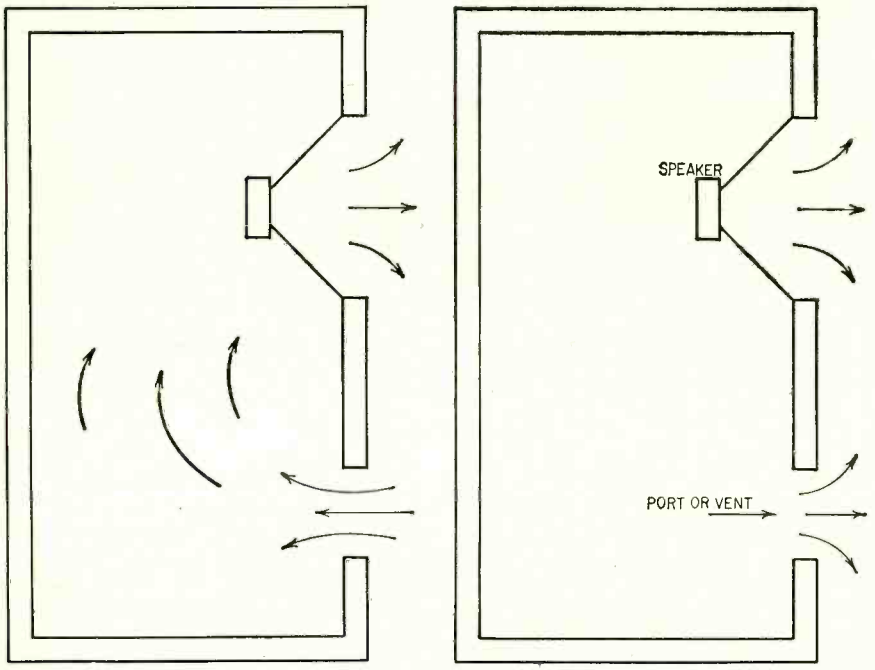


Fig. I–3—Because of the phase reversal, under certain conditions the air is rushing in and out of the port in sync with the speaker's cone motion.

at G. Therefore, the air-cushion pressure is greatest at E and lowest (maximum rarefaction) at G.

To simplify things, assume for a moment that the pressures and rarefactions of the air cushion are produced solely by the motion of the speaker cone and that we are dealing with such low frequencies that the transit time of the sound within the cabinet can be neglected. Now, the pressure inside the cabinet is greatest when the cone has moved inward to the peak of its excursion. This corresponds to the moment of maximum acceleration force. That is at E in Fig. I–2-a. Half a cycle later, the air in the cabinet is at its peak of rarefaction, and the cone is at the outward peak of its excursion. This occurs at G. Between E and G the cone has moved from its rearmost point to its foremost point. Obviously, its velocity was forward. Now look at the diagram of Fig. I–2-b and see what the air velocity is doing. It also increases between E and G. The air moving through the port (Fig. I–2-c) also moves forward between E and G, but is reversed in phase. The reversal is caused by the delay between the application of the accelerating force and the time this force starts air moving and the time the air does move. So instead of flowing out when the cone goes in, as one might expect, it is doing exactly the opposite.

Since air moves out of the port when the cone is moving forward, air cannot flow through the port from the front of the cone to the back. And the port, instead of being a disadvantage, actually helps under these conditions because of the phase reversal.

It so happens that the force which makes the air in the port move forward was initiated when the cone moved backward half a cycle earlier. This half-cycle delay has no effect on a sustained note such as an organ pedal note, but it might cause an imperfection in the "attack" of a drum note. The important thing, however, is that this reinforces the cone's action in a certain low-frequency range. At higher frequencies at which standing waves might be set up inside the cabinet or where the transit time of the air wave between the cone and the port affects the phase, all kinds of peculiar things might happen. But, as a rule, they are only minor and so of little consequence compared with the low-frequency gain.

The gain is even greater than you would expect because the assumption that the air outside the cabinet is undisturbed is not quite correct.

If the port opening is reasonably near the speaker (in fractions of the wavelength), the port does not exhaust into undisturbed free air, but into air which is disturbed by the speaker. If air in the port is moving outward when the external pressure is up a little because of the positive part of a sound pressure wave from the cone, the air emerging from the port works against an increased load (see Fig. I–3).

The speaker cone is also affected by the action of the nearby port and, if reasonably close together, they load one another so *each* works more efficiently.

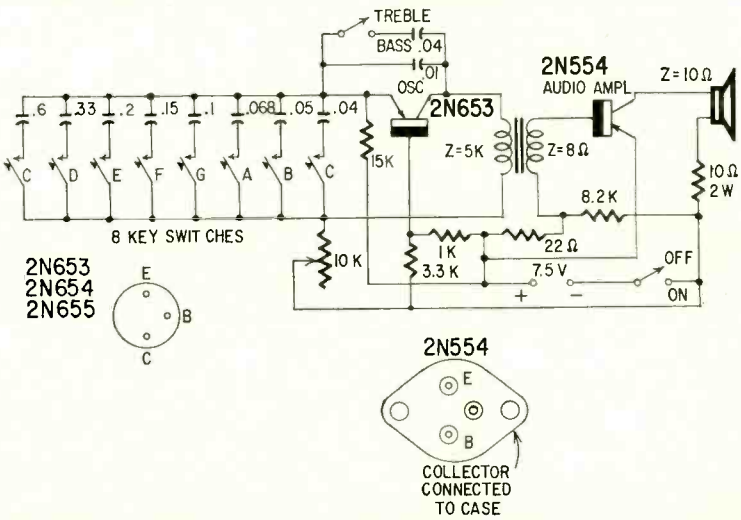
This, however, is only a part of the benefit. So far we have been considering matters in a simplified way. When we take the Helmholtz resonance into account, we find that the motion of the air in the port builds up and helps the cone even more.

So far, we have seen how the reflex enclosure came to be and a little about how it works. Next month we will finish our study of the basic theory behind the reflex and continue with detailed instructions on how to tune the bass reflex, after you have built one, to get the most from it. TO BE CONTINUED

TOY ELECTRIC ORGAN

Here's an easy to build item that will keep the kids (6–60) amused for hours. It's a simple audio oscillator that is tuned so it covers one octave (eight notes) of the musical scale. For practical reasons middle C is the starting point. Standard capacitances inserted by key switches form the variable part of the circuit. Of course, you could wire up the keyboard of a toy piano so the piano keys would activate the oscillator. A BASS switch is included. It lowers the scale by about one octave.

An all-transistor circuit means the unit is safe for children. The 7.5-volt battery is, of course, absolutely safe. It is made up of five series-connected flashlight batteries. The oscillator transistor may be a 2N653, 2N654, 2N655 or some other general-purpose audio unit. In the output stage a 2N544 is used. It produces about ¼ watt of audio, ample speaker volume for a toy instrument.—*Motorola Semiconductors*



STABILIZING FEEDBACK AMPLIFIERS

Part II—How to use voltage feedback without destroying stability

By HERBERT I. KEROES*

INVARIABLY, voltage feedback is applied to high-fidelity amplifiers. This makes the relatively low output impedances which provide best speaker performance possible. The requirements of variable damping for optimizing output impedance make it desirable to include some kind of adjustable current feedback as well. However, with a variable damping control, the major share of feedback is still voltage feedback, and the stability of an amplifier may be analyzed on this premise.

Simplified schematics of four types of feedback amplifiers are shown in Fig. 2. In Fig. 2-a, feedback is taken from the output transformer's primary. Since the output stage is push-pull, the feedback must be of the balanced type, each side being exactly 180° out of phase with the other at all frequencies. This is a very difficult requirement to meet. Moreover, this type of feedback does not correct for any possible distortion caused by nonlinearity of the output transformer core. The scheme does eliminate voltage phase shifts between the output transformer windings.

* Arco Products Co., Philadelphia, Pa.

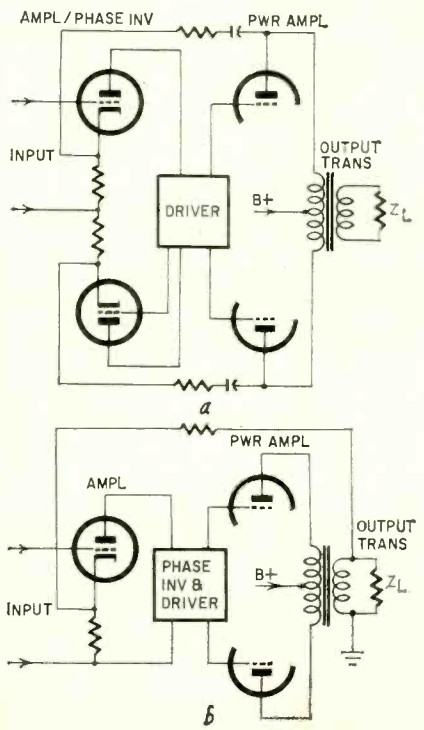


Fig. 2-b shows the conventional method of deriving feedback voltage used in most of today's high-fidelity amplifiers. Feedback voltage is taken across all or part of the output winding of the output transformer. An accurate sample of the output voltage, complete with total distortion content, is fed back to the input stage, where correction is made. However, the phase shift caused by the output transformer must be considered.

Fig. 3-a is the equivalent circuit of an output transformer. To simplify the circuit, all constants are referred to the secondary. L_{ep} is the primary leakage reactance, C_p the distributed capacitance across the primary and L_{es} the secondary leakage reactance. These parasitic elements form a single T-section low-pass filter in which the high-frequency response outside the useful band falls at the rate of 12 db per octave, with an ultimate phase shift of 180°. It is interesting to note that the Nyquist diagram for the output transformer alone will appear similar to Fig. 1-c, so the complete amplifier must finally be designed

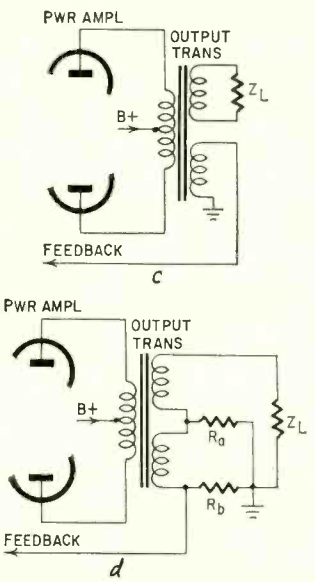


Fig. 2—Types of feedback arrangements: a—balanced feedback from output-tube plates; b—unbalanced feedback from output-transformer secondary; c—tertiary feedback; d—hybrid feedback.

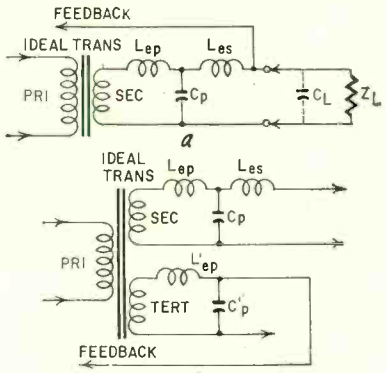


Fig. 3—Equivalent circuits of output transformers in feedback circuits; a—conventional feedback; b—tertiary feedback.

to produce a diagram similar to Fig. 1-d. (The Nyquist diagrams appeared last month in the first part of this article.) There is one further point of interest. If a capacitive load is connected to the terminals of the output transformer (dashed lines in Fig. 3-a), an additional half-section of filter is added, producing an additional 180° of phase shift. This has the effect of rotating the Nyquist plot into the position shown in Fig. 1-e. The point located at −1 is now enclosed, and the circuit oscillates. So, while Fig. 1-d predicts a rather wide stability margin on a resistive load, this condition is completely destroyed by introducing a capacitive load. Stability margin given in terms of db alone and taken for a resistive load is, therefore, an incomplete way to determine stability, and the phase angle between vector OB on the diagram and the negative real axis must also be considered. This is the angle α shown in Fig. 1-d.

Tertiary feedback

Other feedback arrangements are used to alleviate this situation. Fig. 2-c shows feedback taken from a special winding on the output transformer. This is commonly called a tertiary winding, and the arrangement is called tertiary feedback. The tertiary winding is tightly coupled to the output transformer's primary and the equivalent high-frequency circuit is shown in Fig. 3-b. At high frequencies the secondary

circuit decouples out, including the load, so performance is relatively independent of load. The tertiary is lightly loaded by the feedback resistor and its leakage reactance produces only a very small phase shift. The equivalent circuit is, therefore, a simple half-section low-pass filter with a maximum phase shift of 180°.

Adding a load to the output winding has little effect on the tertiary voltage. Therefore, the Nyquist diagram of Fig. 1-d can be achieved and maintained more easily, and the amplifier has a higher order of stability. Note that nothing is lost by this device. The sample of voltage taken by the tertiary is still representative of the voltage in the output winding. The tertiary scheme was once used to a greater degree than now. However, its advantages were not fully appreciated, and it was discarded.

As the tertiary delivers no power to speak of, the winding may be quite small, with the design advantage of tighter coupling with the primary.

The conditions given for tertiary feedback, as outlined above, have been idealized. In practice, the tertiary must couple to some degree with the secondary, so some of the load variation in the secondary is reflected into the tertiary. Somewhat more than the 180° of maximum phase shift is induced into the tertiary winding, and feedback is not totally unaffected by the load.

Hybrid feedback

A modified version of tertiary feedback gives practically complete independence of load variation. It is shown in Fig. 2-d and is called hybrid feedback. As in the tertiary arrangement, a separate winding on the output transformer is used. However, this winding is tightly coupled to *both primary and secondary* and is connected to the secondary series-aiding. Resistor R_a is located at the junction of the two windings and connected to ground. The load Z_L (voice coil) is connected between the top end of the secondary and ground. Another resistor, R_b, is connected between the open end of the hybrid winding and ground.

The arrangement forms, in effect, a balanced bridge with many interesting properties. If the primary of the transformer is matched to the impedance of the output tubes and a voltage is introduced in series with the load, the emf thus set up in the load section of the secondary, plus emf reflected from the primary, will prevent a voltage from appearing across R_b. This holds, of course, only for fairly critical settings of R_a. Since a variation in output impedance can be considered a generator which sets up a back emf, the back emf caused by the impedance variation is not reflected across R_b.

Another factor of lesser importance is that R_a can be adjusted to a value where the voltage across it is zero. Then all the load current flows through R_b and a certain amount of current feedback is obtained. By making R_a variable various degrees of current feedback can be provided and used to control damping factor. If R_a is zero, the system reduces to tertiary feedback with a load on the tertiary winding, and the feedback is 100% voltage.

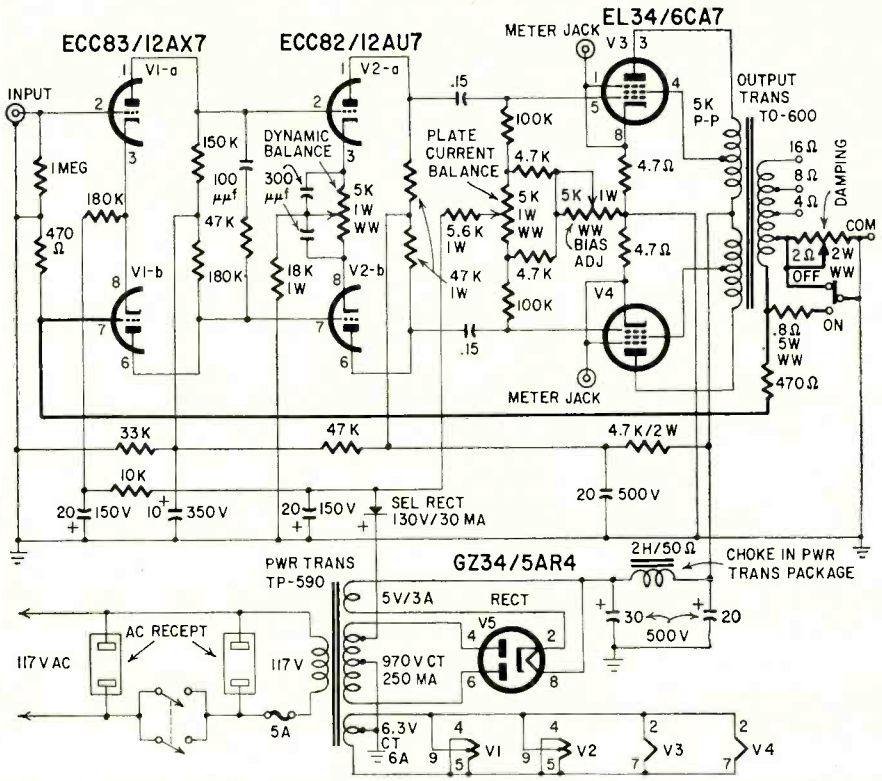


Fig. 4—Circuit of the Ultra-Linear II, a 3-stage 60-watt amplifier using hybrid feedback.

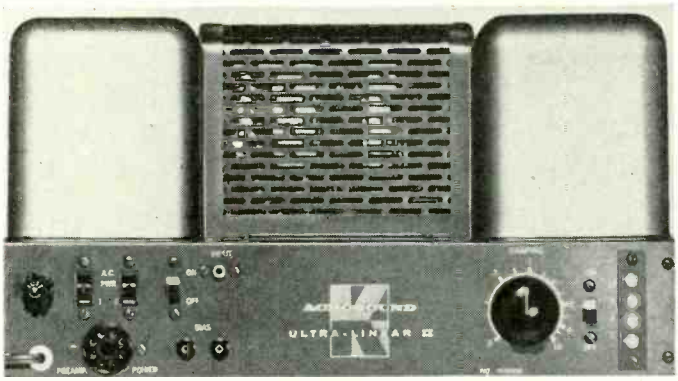
A simple example will show the high degree of stability of the system with large variations of output load. In the conventional system, with feedback voltage obtained across the output winding, a capacitive load will short the output winding at very high frequencies. At infinite frequency this reduces the voltage across the winding to zero. However, the phase shift will approach 180° long before the voltage reaches zero. In the hybrid system, a capacitor will short the load, placing all of the induced secondary voltage in series with the hybrid voltage, and the value of the feedback voltage will be constant. If this voltage is constant, there is no phase shift, because there must be attenuation to have phase shift. In this way complete isolation between feedback voltage and load in both magnitude and phase is obtained.

Practical design applications

Hybrid feedback has been successfully applied to the circuit of the Ultra-Linear II, a 3-stage 60-watt amplifier. Its schematic is shown in Fig. 4. The first stage is a cathode-coupled phase inverter and amplifier which is direct-coupled to the driver stage. The driver is R-C-coupled to the output stage, which uses Ultra-Linear-connected EL34's. Fixed bias is used. At low frequencies there are two attenuating networks, the shunt inductance of the output transformer and the R-C network between driver and output stage. The Nyquist diagram is of the form of Fig. 1-c. Therefore, the low-frequency stability is very high. A shunt R-C network is used in the plate circuit of the first stage to modify response, and this, combined with the cathode degenerated driver stage, which is partially bypassed, gives a high-frequency plateau starting at about 140 kc to effect a phase reversal. The Nyquist diagram with damping control "off" is of the form of Fig. 1-d. Stability is such that a capacitive load has little effect on 15-kc square-wave response. With hybrid feedback "on," stability is even higher.

The output transformer, the Acrosound TO-600, contains the hybrid winding and has been specially designed to complement the circuit. The leakage reactance between primary and secondary is very low, in the order of 3.5 mh referred to the primary side. This provides extremely wide bandwidth and low phase shift. The secondary's hybrid section is wound of copper tape to obtain tight coupling with the load section.

It is interesting to examine what happens to a square wave under various conditions of loading. This is illustrated by the series of oscillograms in Fig. 5. Since the amplifier's low-frequency stability is practically perfect, the results are confined to a discussion of the high-frequency stability as illustrated by the response of the circuit to a 15-kc square wave. A qualitative conclusion regarding the stability can be made by comparing circuit response to the equivalent response given by a passive network composed of lumped



The Acrosound Ultra-Linear II amplifier.

circuit elements. Any deviation from this would then be an imperfection introduced by feedback in the amplifier.

Fig. 5-a represents the normal amplifier response on a resistive load. There is little deviation from the ideal waveshape. With the damping reduced, the wave shows a small amount of overshoot followed by a slight oscillatory wiggle, as in Figs. 5-b and -c. This is caused by the residual inductance in the load impedance and is typical of a load with a small inductive component.

Figs. 5-d, -e and -f show the response to a load of greater inductance. Note that the exponential length of the decay of the wave is lengthened with the increase in inductance. The overshoot of the wave with reduced damping factor is caused by the effective increase in generator impedance. At the beginning of the wave, the inductance of the load sets up a high back emf, and little current flows. All the generator emf is then applied across the load. As time increases, current starts to flow and there is an exponential drop in voltage across the load. This happens just as theory predicts.

Figs. 5-g, -h and -i are taken for a capacitive load. Of these, Fig. 5-g is a slight departure from what one would expect, since there is a small rise in voltage on the leading edge. The top of the wave is smooth and completely free of the ringing usually associated with a capacitive load. The rise time is decreased exactly in accordance with circuit theory, as the generator impedance is increased in Figs. 5-h and -i. In fact, Fig. 5-i is a perfect illustration of what happens when a square wave is fed to a capacitive load by a generator of relatively high internal impedance. In this instance, the effect is just the opposite of that of an inductive load—the back emf across the capacitor is initially zero, and high current flows. The voltage slowly builds up and the charging current is correspondingly reduced until the peak value of the voltage is reached.

In Figs. 5-j, -k and -l the load is comprised of L, R, and C. Here damped oscillation is apparent and expected, since the output circuit contains a resonant frequency. When the generator impedance is low, greater oscillatory current flows, and oscillation is more pronounced. As the generator impedance is increased, the oscillation is damped out more rapidly and agreement with circuit theory is again obtained.

In all the previous cases, the amplifier's response does not differ from what one might expect from a circuit of passive elements, and stability is therefore of a very high order. Perhaps performance can best be summarized by using an apt British description—there is a complete lack of bullying of the listener. You can set the controls for a normal high or low listening level, according to individual preference, and a complete program can be enjoyed without feeling the need to reset controls for emphasis in individual passages.

[The editors built and tested one of these units and agree that it sounds excellent. Frequency response and IM distortion measurements met Acro's specs at all power levels. Particularly noteworthy was the lack of distortion on sine waves down to 20 cycles, and freedom from high-frequency peaking at any frequency up to 200 kc.] END

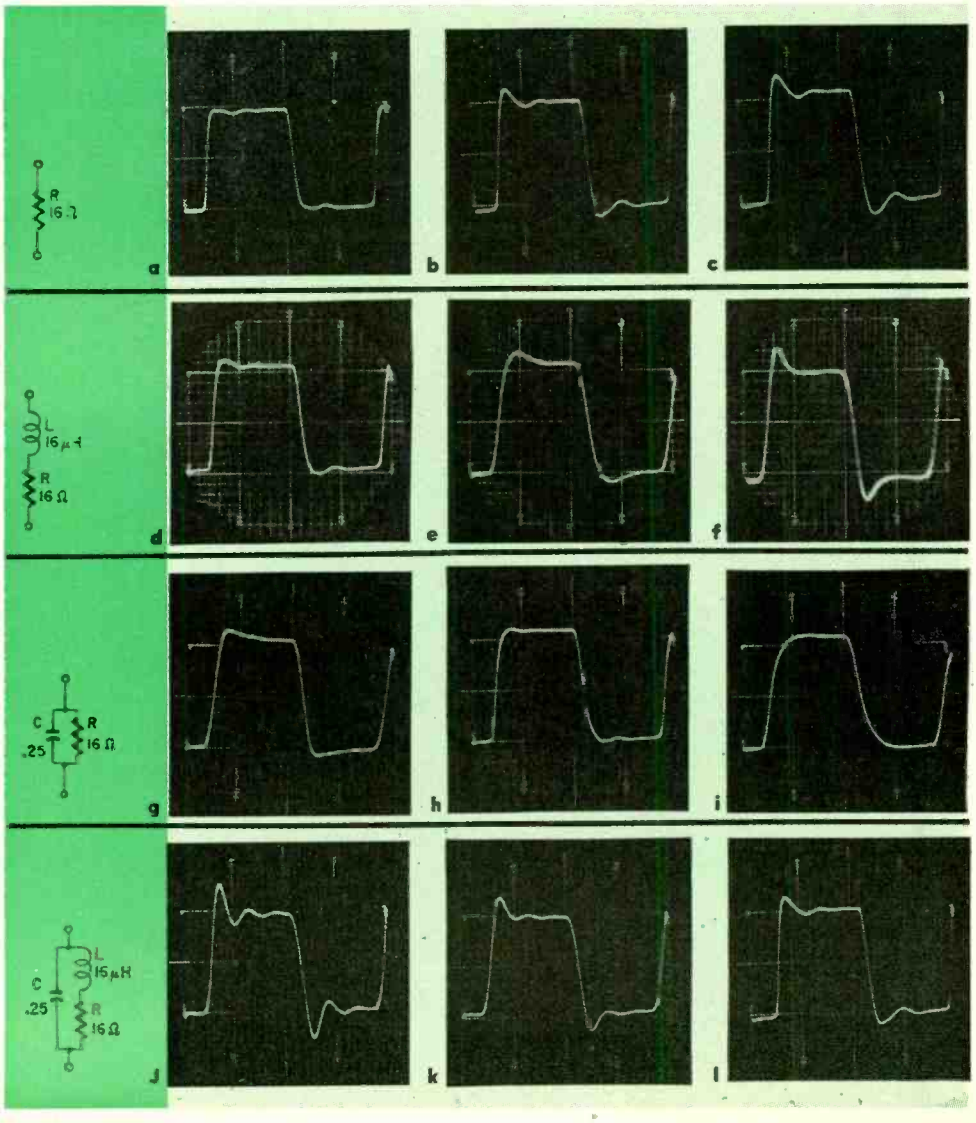


Fig. 5—Waveforms showing amplifier response to 15-kc square waves for various loads and damping.

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new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

TOWARD the end of 1958 the stream of stereo is still full of cross currents. At moment of writing (early in December), observers are pondering the meaning of several new developments. RCA Victor's latest monthly release of classical records is entirely monophonic but other companies continue to offer a very high percentage of their current releases on stereo records. Several firms, notably Capitol and Mercury, are delving back into their outstanding monophonic albums of the last two years and bringing them out in stereo. These will be reviewed as space permits.

Portraits in Sound
Erich Leinsdorf Conducting Concert Arts Symphony Orchestra
Capitol Stereo Tape ZF-96
(7-inch; playing time, 42 min. $14.95)

Those on a diet of thin bass due to listening to stereo discs with a pickup of inferior response will find this tape a revelation. Even hardened tape fans should perk up when Leinsdorf sails into these light concert favorites. España, Russian Easter Overture, Moldau and Sorcerer's Apprentice, with the aid of good stereo, bring out every tonal resource of the orchestra. Put this one on your must-hear list.

STRAVINSKY: *Le Sacre du Printemps*
Leonard Bernstein Conducting New York Philharmonic
Columbia Stereo Tape LMB-24
(7-inch; playing time, 35 min. $12.95)

Columbia, in its latest classical stereo tapes, obviously does not intend to suffer from lack of highs. This tape and some of its immediate companions exhibit a steeply rising treble curve that begins to climb well in advance of the point at which a good tape head usually begins to roll off in response. Once treble has been reduced by those "cursed" with truly wide-range equipment, the sharp edges of Stravinsky's violent score stand out in new perspective. There is greater shock effect in the performance as recorded here than in the reading by Pierre Monteux on the RCA stereo tape.

Concert In Rhythm
Ray Conniff and His Orchestra and Chorus
Columbia Stereo Tape GCB-36
(7-inch; playing time, 17 min. $7.95)

This recent release has much flatter response than does the Stravinsky Columbia tape just mentioned. Overall sound is very clean. This adds greatly to the entertainment riding on this reel. I confess to having been skeptical about the contents of this reel when I read the liner notes before playing it. Popular adaptations of light classics such as these are old hat by now and can be quite dull. However, so fresh and imaginative are most of the ideas given the chorus and orchestra, I think you'll agree that these Conniff arrangements are a triumph of mind over material.

Flamenco Fire
Sabicas and Los Trianeros Flamenco Troupe
DYNA Stereo Tape DY-3004
(7-inch; playing time, 28 min. $11.95)

The great flamenco guitarist Sabicas sparks the excitement found on this wide-range tape. Crisp handling of the sound of castanets and the heel clicks of gypsy dancers adds sharp detail to neatly spaced stereo. A most welcome feature of this new line of Dyna Tapes is a hiss level far below that commonly found on tapes one year ago. This reduction in noise level on the tape stems from a better duplicating process and a quality control more easily maintained by a small firm.

SHOSTAKOVITCH: *Symphony No. 6*
Sir Adrian Boult Conducting London Philharmonic
Everest Stereo Record SDBR-3007

In its first batch of classical releases, Everest is breaking new ground in two directions. From a technical standpoint, their engineers are introducing new standards to the industry. The choice of repertory, moreover, is winning the plaudits of record collectors of every persuasion. Listen carefully to the string sections of the orchestra highlighted in the first movement of this modern, seldom-heard Russian symphony. The significantly lower noise level of the new equipment used is easily noticeable on a playback system of top design. Low-level detail in the string basses, usually masked by noise introduced during transfer from master tape to finished product, establishes this series as a product for the perfectionist. Stereo really has a chance to shine under these conditions.

FALLA: *Nights in the Gardens of Spain*
Gonzalo Soriano, Piano
RODRIGO: *Concerto for Guitar and Orchestra*
Narciso Yepes, Guitar
Ataulfo Argenta Conducting National Symphony Orchestra
London FFSS Stereo Record CS-6046

The long-established reputation of the atmospheric Falla work for piano and orchestra will draw many stereophiles to this record, but I suspect that the remarkable *Guitar Concerto* by Rodrigo will prove to be the most gratifying surprise. Those debating the extent of their investment in good components are advised to try this guitar selection on the best stereo equipment. You'll be tempted to splurge once you hear the transients on this disc—tiny wave fronts that are usually glossed over by inferior pickups, amplifiers and speakers. Delicately balanced, transparent stereo reveals orchestral detail I did not notice in the earlier, monophonic version (London FFRR LL-1738).

DELIBES: *Coppélia*
Ernest Ansermet Conducting L'Orchestre de la Suisse Romande
London FFSS Stereo Record CSA-2201

If your stereo pickup delivers the optimum bass response available today on a first-rate system, you'll be pleased to discover that this stereo album actually calls for a bit of rolloff in the low end. Few of us who heard the first stereo discs and pickups over a year ago suspected that bass response such as this could be attained in so short a time. Ansermet's treatment of Delibes' familiar ballet score had a good reception in the mono version. It is doubly welcome in well-defined stereo.

Paul Barbarin and His New Orleans Jazz
Atlantic Stereo Disc SD-1215

The softer contours of authentic New Orleans jazz provide a new source of material for stereo in this release. The New Orleans drummer Paul Barbarin is a veteran of the King Oliver, Louis Armstrong and Sidney Bechet bands. Most of the tunes are traditional New Orleans spirituals and marches played by musicians who have always specialized in the rhythms and tone colors of the first jazz style.

DEBUSSY: *La Mer*
RAVEL: *Daphnis and Chloe Suite No. 2*
Erich Leinsdorf Conducting Los Angeles Philharmonic
Capitol Stereo Record SP-8395

The occasional faint clicks typical of most microgrooves are the main ingredients identifying this stereo disc when it is A–B'd with the same performance on Capitol stereo tape ZF-25 (reviewed in the August, 1958, issue). The highs on the disc extend beyond those heard on a good home tape machine. The tape has a shade more separation between channels, slightly better signal-to-noise ratio and better weight of bass in the region below 200 cycles. The presence of some highs above 10 kc on the disc lends warmth to the sound of upper strings and woodwind passages in two of the most popular French orchestral works.

Rhapsodies
LISZT: *Hungarian Rhapsodies Nos. 1 and 2*
ENESCO: *Roumanian Rhapsodies Nos. 1 and 2*
Eugene Ormandy Conducting Philadelphia Orchestra
Columbia Stereo Record MS-6018

Invite the Philadelphians into both channels, to discover what can be done with four of the flashier items in the orchestral repertoire. Hungarian-born Eugene Ormandy, heading a truly brilliant orchestra, staked out a claim in this type of music in monophonic days. Now Columbia cashes in with stereo that reveals the full talents of this ensemble. Slightly closer miking is evident in the *Roumanian Rhapsodies*. The sheen of the Philadelphia strings will verify the common sense of assigning your better tweeter to the left channel when forced to use unmatched speakers.

The Play of Daniel
New York Pro Musica
Noah Greenberg, Director
Decca Stereo Record DL-79402

The Middle Ages come alive again in this unique stereo recording. One of the earliest music dramas, the Biblical Play of Daniel dates back to the 12th century. The singers and musicians of the New York Pro Musica revived it in January, 1958, at the Cloisters, the medieval branch of the Metropolitan Museum of Art. Close miking brings out with startling realism the almost forgotten instruments of those days. The tale unfolds to the accompaniment of the straight trumpet, rebec (medieval fiddle), minstrel's harp, portative organ, miniature bagpipes, bells and recorders. Perhaps the most interesting aspect of the entire production is the percussion of Near Eastern origin—finger cymbals, Arabian nakers (tiny kettledrums) and Arabian Jingles.

VICTORIA: *Requiem Mass*
Choir of the Abbey of Mount Angel
Portland Symphonic Choir
RCA Victor Stereo Record LSC-2254

This mass for two choirs is totally dependent on stereo for proper effect under home listening conditions. A choir of monks on the right is heard in its chant proportions. The polyphonic or multi-voiced music is sung in the left channel by the men and women of the Portland Symphonic Choir. Excellent channel separation simulates actual conditions of performance back in the 16th century.

SCHUBERT: *Symphony No. 9 in C Major*
Ataulfo Argenta Conducting Cento Soli Orchestra of Paris
Omega Stereo Disk OSL-12

Heard for the first time in well-distributed stereo, the great Schubert *Ninth* is a rewarding experience. The closer your familiarity with this magnificent work, the more interesting is the interplay among orchestral choirs. Miked in Paris by obviously knowledgable engineers, the tonal mass of the symphony is serenely poised between loudspeakers of similar output.

Chico Hamilton Trio
Freddie Gambrell, Piano
World Pacific Stereo Record 1008

A fine young pianist is introduced on this recording by the already famous Chico Hamilton. As part of the trio, Freddie Gambrell en-

hances the left channel with alert, sensitive piano work in two of his own compositions and favorites such as *Lullaby of the Leaves, These Foolish Things, In the Still of the Night* and *You're the Cream in My Coffee*. Miking favors the drums heard on the right.

GILBERT and SULLIVAN: *The Mikado*
London FFSS Stereo Records (2) OSA-1201
GILBERT and SULLIVAN: *The Pirates of Penzance*
London FFSS Stereo Records (2) OSA-1202

Both of these definitive albums feature the celebrated D'Oyly Carte Opera Co. with the New Symphony Orchestra of London conducted by Isadore Godfrey. The gusto and style of the singers, the saucy melodies of Sir Arthur Sullivan and exemplary wide-range sound provided by the London FFSS process are an unbeatable combination. Stereo's extra dimension makes more intelligible the vital diction of soloists and chorus.

Si Zentner and His Dance Band
Bel Canto Stereo Record SR-1007

Dual channeling adds impact to a big-band sound that might otherwise have been lost among the recent revivals of the band styles of the '30's and '40's. Formerly a lead trombonist with Dorsey, James and Brown, Si Zentner now leads an aggregation that eases Bel Canto's transition to stereo discs. Easy listening.

Songs of Stephen Foster
John Halloran Choir
Concert-Disc (Stereo) CS-30

Drawing upon its experience in the early days of stereo, Concertapes is turning out a fine stereo record. In this release, the rich melodies of Stephen Foster are sung with enthusiasm by the Halloran Choir. The handling of the acoustics is noteworthy. Concert-Disc preserves the bite and presence frequently found in studio miking. To this is added the free flight of sound in a naturally live auditorium. Better-than-average surfaces prove their value in the low-level selections.

OFFENBACH: *The Tales of Hoffmann*
Pierre-Michel Le Conte conducting Chorus and Orchestra of "Concerts de Paris"
Epic Stereo Records (3) BSC-101

Epic's first opera in stereo features tenor Leopold Simoneau and soprano Mattiwilda Dobbs. Miss Dobbs is scheduled to repeat at the Metropolitan Opera one of the roles she performs in this album, that of Olympia the mechanical doll. A greater distance separates the singers than is usually found in stereo operatic recordings. Very smooth sound and quiet surfaces.

The Herd Rides Again . . . In Stereo
Woody Herman Orchestra
Everest Stereo Record SDBR-1003

A sufficient number of original Herdmen is featured in this new stereo release to capture the interest of all Woody Herman fans. Such fans will find it easier to overlook the slight distortion found in the final band on each side of the disc which appears to be cut at slightly higher than usual velocity.

MONOPHONIC RECORDINGS

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

HAYDN: *Salomon Symphonies, Vol. 1*
Sir Thomas Beecham Conducting Royal Philharmonic
Capitol-EMI GCR-7127

The first six of Haydn's "Salomon" symphonies (Nos. 93-104) are now set forth by Beecham in the most elegant combination of style and sound they have enjoyed on records. For maximum results, the listener may find it necessary to experiment with the cross-over control on his preamp. I found that an 800-cycle crossover achieved better balance than did protracted fiddling with the bass and treble settings. Properly equalized, this is one of the most enjoyable albums issued in recent months.

STRAUSS: *Don Quixote*
Eugene Ormandy Conducting Philadelphia Orchestra
Columbia ML-5292

The latest recording of the Richard Strauss narrative for cello, viola and orchestra finds the Philadelphia orchestra in tip-top form. The fantastic adventures of Don Quixote and Sancho Panza are much easier to follow in this framework. Few, if any, stereo discs have the frequency range and freedom from distortion displayed here. The current excitement caused by stereo on discs has not impeded Columbia's progress in the mono medium.

The Composer and his Orchestra
Howard Hanson Conducting Eastman-Rochester Orchestra
Mercury MG-50175

On this record, the noted American composer and conductor, Howard Hanson, introduces the instruments of the orchestra, first individually and then in groups. He explains from the podium how and why he used their tonal and technical characteristics when composing his opera *Merry Mount* some years ago. The musical illustrations were selected from the orchestral suite from this opera. Exceptionally wide dynamic range distinguishes this unusual release.

Buddy Cole Plays Cole Porter
Warner Bros. Records W-1226

Here's a chance to discover the recording techniques of a major film studio. I tried this disc on several systems. On average equipment, this piano and orchestra treatment of Cole Porter tunes had a lot of aural glamour. On other setups, the more accurate and "neutral" the playback system, the more apparent were the various tricks of the sound stage. Buddy Cole does an excellent job with music that never seems to fade.

CHOPIN: *Les Sylphides*
IBERT: *Divertissement*
Roger Desormière Conducting Paris Conservatory Orchestra
Richmond B-19028

Originally available on London FFRR discs (LL-884) the Desormière version of these works was highly regarded by discerning record collectors. Now that London's major efforts are directed toward stereo discs, the earlier releases are an attractive bargain at $1.98 on the Richmond label. Acceptable sound.

Something Else!
Music of Ornette Coleman
Contemporary C-3551

Alto sax player Ornette Coleman leads a group that includes Don Cherry, trumpet; Walter Norris, piano; Don Payne, bass, and Billy Higgins, drums, in the exceptionally free style called for in nine Coleman originals. Intimate yet very clean recording typical of today's finest California products.

Merry Overtures
George Szell Conducting Cleveland Orchestra
Epic LC-3506

The greatest happiness here is reserved for those with top playback equipment. All six familiar overtures are genuine display pieces in Epic's sure-fire sound. Sample the impact of the snare drum at the beginning of Auber's *Overture to Fra Diavolo* and you'll join the other converts to the Cleveland orchestra's present-day music making on records. The *Roman Carnival Overture* of Berlioz and Rossini's *La Gazza Ladra* receive equally exciting treatment.

The Cadet Chapel Organist, West Point
John A. Davis, Jr.
Vox VX-25.800

The West Point Organ is rated the fourth largest in the world. The first Vox recording of this organ 2 years ago picked up considerable background noise created by the instrument's blowers. Subsequent alterations have minimized this problem. Its gigantic resources now mirror the imposing tonal structures found in the Mentielssohn *Organ Sonata Number 3*, the Franck *Pièce Heroïque* and other compositions of the Romantic school.

Famous French Fanfares and Marches
Band of the French Navy
Epic LC-3516

Fanciers of military band music from France will welcome this release of 13 typical marches and parade steps. The price of this disc is a dollar less than those featuring the more famous Band of the Garde Républicaine, yet the sound here is truly outstanding. A very firm foundation of lows balances shimmering highs.

Music of Delius
Sir Thomas Beecham Conducting Royal Philharmonic Orchestra
Capitol-EMI G-7116

In the history of Delius on records, Sir Thomas Beecham has the first and last word. His early 78's first brought the music of Delius to fame. This latest recording sums up in luminous sound the case Beecham has set forth over the years. Many of the most popular Delius works are to be found here.

HOVHANESS: *Concerto No. 1 for Piano and String Orchestra*
Concerto No. 2 for Violin and String Orchestra
Maro Ajemian, Piano; Anahid Ajemian, Violin
Carlos Surinach Conducting M-G-M String Orchestra
M-G-M E-3674

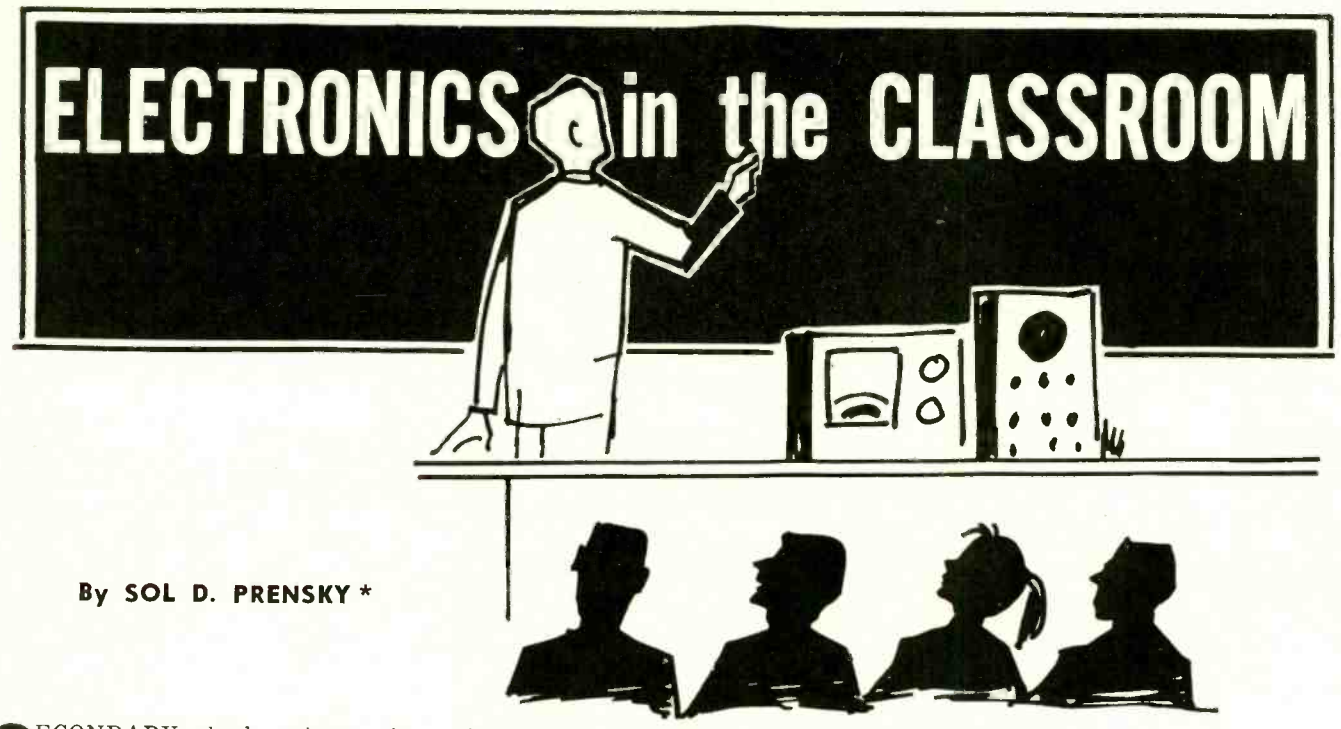
These two concertos by a contemporary American composer immediately intrigue the ear. Born in Somerville, Mass., of Armenian and Scottish parents, Hovhaness has concentrated on unusual sound and rhythm in his music, Oriental, Indian and Armenian influences are to be found throughout his work. In the piano concerto, the solo instrument imitates a number of Armenian instruments: the tar; the kanoon, a zitherlike string instrument; the oud, an Arabic-like lute, and the saz, a simple peasant stringed instrument.

Recommended to the musical tourist who seldom writes home about the sound. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*

Part I—$600,000,000 for science education brings changes in texts and course of study. Part of these funds will be used for quantities of electronic demonstration equipment that will make classroom lectures clear and fascinating.

ELECTRONICS in the CLASSROOM



By SOL D. PRENSKY *

SECONDARY-school science instruction was given a thumping impetus by Congress with the passage of the Science Education Bill. Among other generous financial aids, the bill makes $300,000,000 in Federal funds available to the nation's 27,000 high schools, to match an equal amount from the states, toward the cost of new equipment for revitalizing science study.

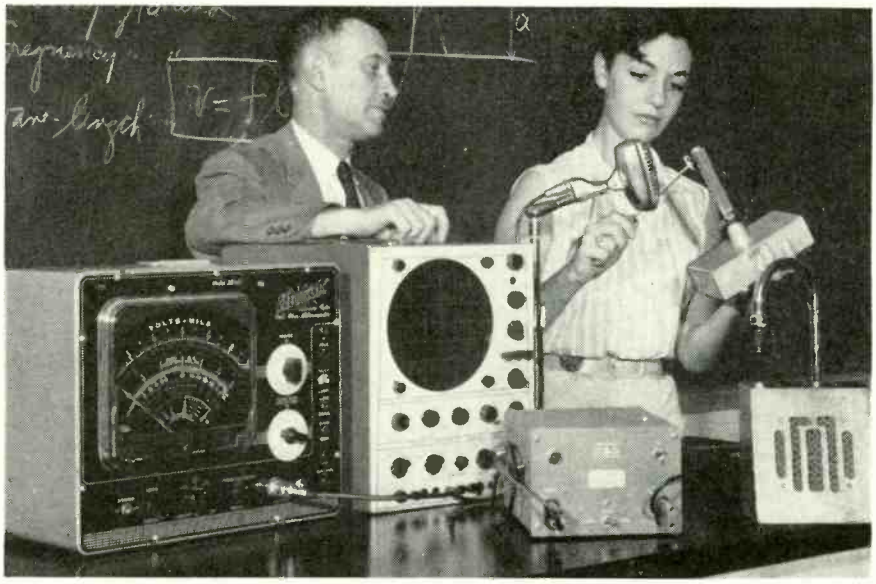
Many excellent ways to improve science classes are being considered. These involve both new courses of study and new texts. In the past, developing new methods for presenting science material has been hampered by the added expense of more effective equipment for demonstrations and laboratory work, or in making more extensive use of films and TV. Now, with funds specifically intended for improving science equipment, it is heartening to think of better ways to get science across and, particularly, to examine some of the many presentations that can be made with the help of the advanced electronic equipment now available.

Two outstanding groups are now working in this field. The Teachers College Curriculum Group at Columbia University has been active in considering new science-course content. At the same time, from the expertly staffed MIT Physical Science Study Committee (headed by Dr. Jerrold R. Zacharias as chairman and with Dr. Elbert P. Little as executive director) have come new texts and new teaching methods including the use of film and TV techniques. For interested persons who wish to follow the activities of these and similar groups and for ambitious students who wish to pursue a given science field in greater detail, a list of references is given at the end of this article.

The articles in this series will present specific demonstrations showing how electronic equipment can be used to present more effectively the principles of a particular science topic. The demonstrations given will not necessarily be connected with any of the references cited. Instead, they will be selected with a view toward representative learning situations.

What can be taught?

Topic selection divides naturally into two directions. In one, we have the teaching of modern subject matter in electricity and electronics, topics that old textbooks cover very inadequately, if at all—new atom concepts, semiconductor and transistor action, analog and digital computer methods in telemetry applications, to mention just a few. In the other direction we have the less obvious but equally important



Vtvm, oscilloscope, amplifier and speaker as they are used to demonstrate the properties of sound.

* Fairleigh Dickinson University, Teaneck, N. J.

help that electronics can give science students in such nonelectrical subjects as physics, biology, chemistry and astronomy. The scheme here is to study some nonelectrical property, using a transducer which lets the instructor present an electrical display of the properties being investigated.

The transducer method immediately brings the study of sound to mind. For example, a microphone can be used to pick up sound from a tuning fork or other sound source and convert it into electrical impulses. Once it is in electrical form, electronic equipment takes over, presenting the information in various forms—simultaneously if desired. Fig. 1 shows a setup that makes sound appear as a visible trace on a 8½-inch scope screen and as a voltage reading on a vtvm that has a 9-inch meter face. At the same time it is heard in amplified form from the loudspeaker.

Before going into the details of particular demonstrations, here are some examples of how other nonelectrical properties could be demonstrated electronically:

- Heat transfer—registered by thermocouple or thermistor action
- Velocity and acceleration—displayed by accelerometer action
- Mechanical vibration—displayed by pressure transducer action
- Light energy—indicated by photoelectric action

These and many other examples readily come to mind. The problem is not so much to find enough ways to use electronic presentation. Rather, it is one of carefully selecting those that are most practical and effective for teaching a desired topic.

Properties of sound

Fig. 1 shows the electronic apparatus used for studying a sound source, a tuning fork in this case. Only general-purpose electronic gear is used—vtvm, oscilloscope, speaker and amplifier. If speaker volume is not needed, the amplifier is unnecessary. However, the amplifier offers some advantages, even if the speaker is not used. It provides an impedance match to the microphone and furnishes a low-impedance output to feed the various indicators, minimizing hum pickup. When using an amplifier, only a moderate amount of gain is needed. If the amplifier is turned up too high, excessive gain appears as a feedback howl in the speaker. (This in itself is a good point to bring out.)

Of course, scopes with smaller

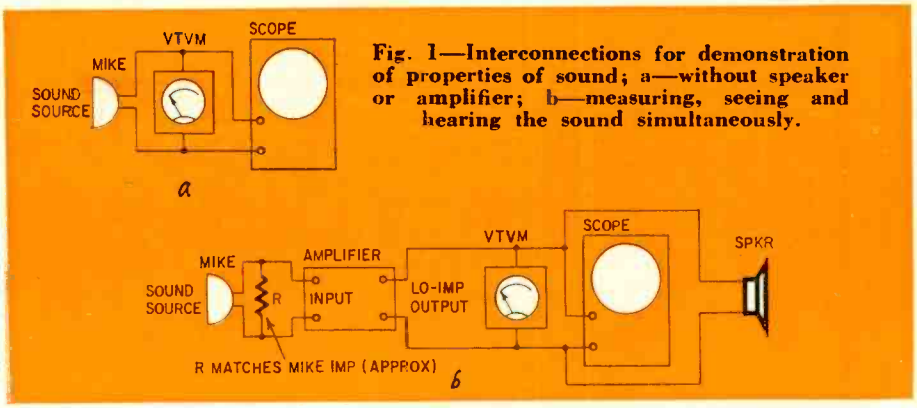


Fig. 1—Interconnections for demonstration of properties of sound; a—without speaker or amplifier; b—measuring, seeing and hearing the sound simultaneously.

Mike: multi-impedance—Shure Dynamic model 51 or equivalent.
Amplifier: 20 and 40 db—Hewlett-Packard decade model 450A or equivalent.
Vtvm: 9-inch Hickok model 209A or equivalent.
Scope: 8½-inch—Precise model 308 or equivalent.
Speaker: between 3 and 45 ohms.

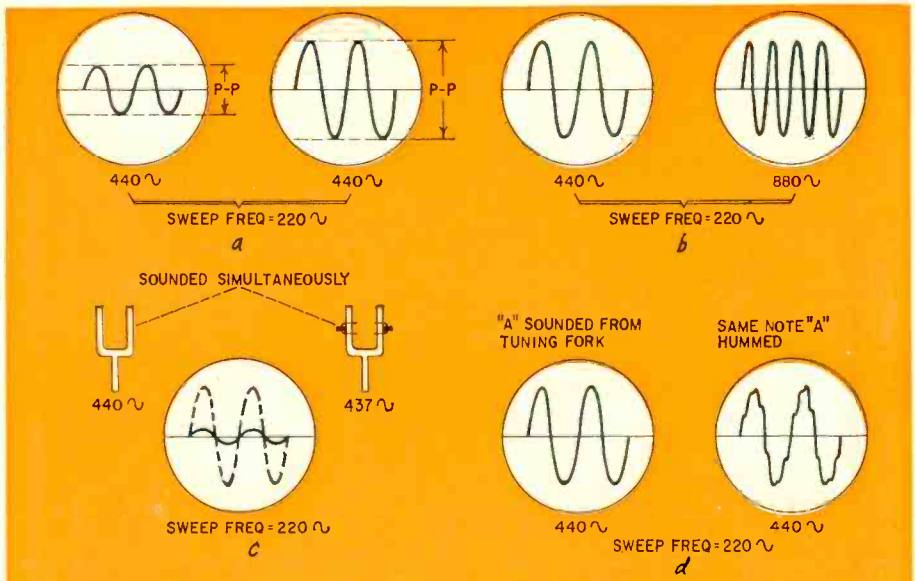
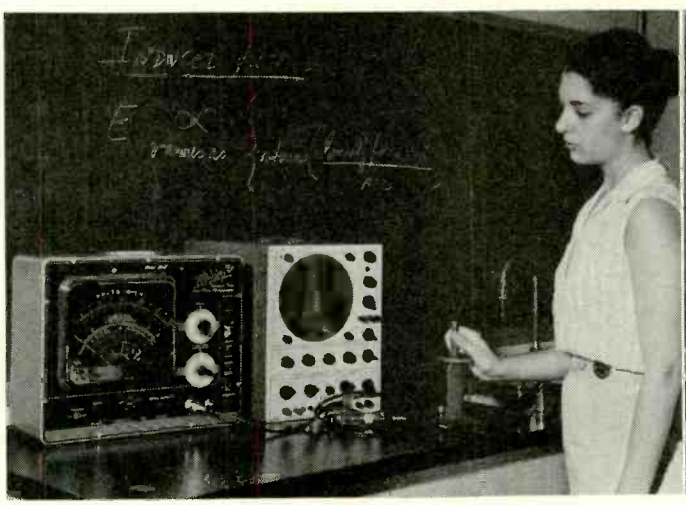
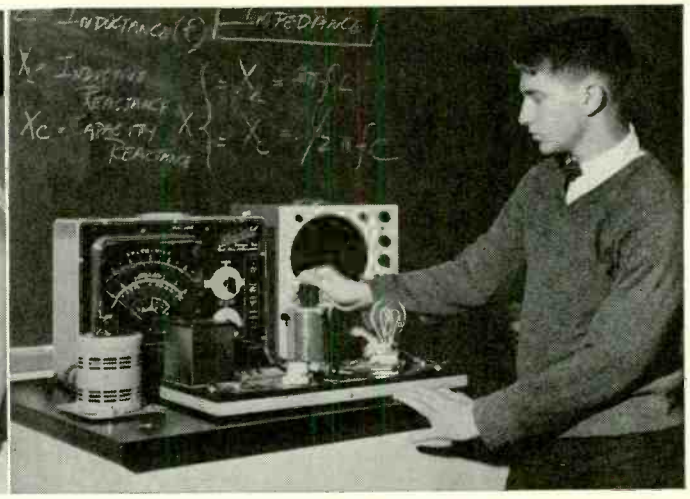


Fig. 2—Waveforms obtained in demonstration on properties of sound: a—varying sound intensity; b—varying sound frequency; c—beat or difference frequency determines the rate at which sound intensity rises and falls; d—quality of sound as determined by harmonics in sound source.



To demonstrate induced voltage only the scope and vtvm are needed.



Here's the setup for showing effects of impedance and inductance.

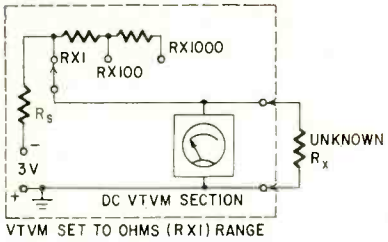


Fig. 3—Simplified circuit showing a vtvm used to read resistance.

screens and meters with smaller faces could be used, but to make the demonstration clear to all members of the class, the larger the displays the better.

Sound intensity may be measured on the vtvm and seen on the scope, using the arrangement in Fig. 2-a. First the tuning fork is given a light blow and the results observed. Then succeedingly harder blows show increased readings.

The effect of different frequencies is shown by using tuning forks of progressively higher frequencies (Fig. 2-b).

Energy required for equal transmission at various frequencies is shown by using different forks, struck with the same intensity and held at a fixed distance from the microphone.

Beats can be produced in the usual way when two forks of slightly different frequencies are sounded together (Fig. 2-c.) When the frequencies are the same, resonance or sympathetic vibration can be shown.

The oscilloscope display will show the presence of complex waxes that include the harmonics which determine the quality of various sounds, even though they have substantially the same intensity and fundamental frequency (Fig. 2-d). For this you can hum or whistle into the mike, use a musical instrument and, for greatest complexity, use a recorded program.

An interesting variation that shows a complex wave is to talk into the microphone through the revolving blades of an electric fan. The periodic breaking up of the sound vibrations in the air by the fan blades can be clearly demonstrated.

Another rich source of harmonics is the howl caused by acoustic feedback. Other possibilities will no doubt occur to the teacher using the microphone, oscilloscope, vtvm, amplifier, speaker demonstration.

Resistance, voltage, current and phase

Fig. 3 is the simplified circuit of a vtvm being used to measure resistance. On a meter with a 9-inch face, readings can be easily seen and resistances compared in clear sight of all members of the class.

When studying voltage and phase relations in ac circuits containing a combination of resistance and reactance, an all-resistive circuit is examined first, with the connections shown in Fig. 4-a.

The alternating current through R_x can be varied in a number of ways. A variable autotransformer connected to a 60-cycle outlet is shown, but the variable current could also be obtained from a voltage-dividing potentiometer connected across the line or from the variable output of an af signal generator.

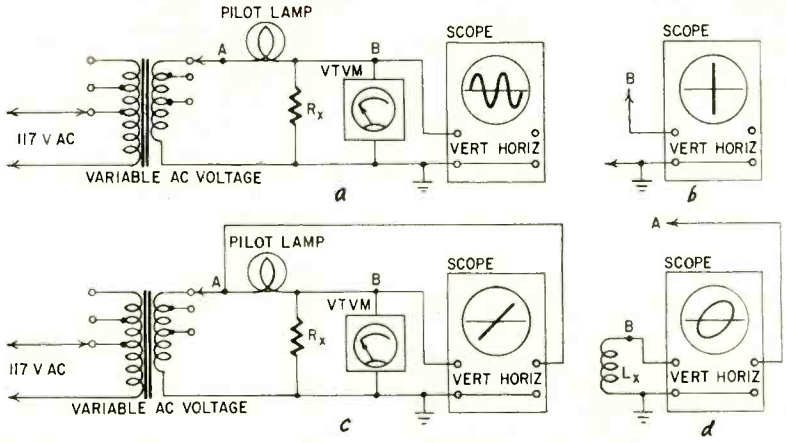


Fig. 4—Display of voltage and phase in resistive and reactive circuits: a—voltage across R_x displayed as a sine wave; b—same as a, but with sweep voltage turned down to zero; c—phase of R_x voltage with reference to input voltage; d—same as c, but R_x replaced by L_x.

No matter which source you use, start with enough current to light the pilot lamp. Then the lamp serves as a rough current indicator and a protective fuse. (A No. 44 lamp needs 250 ma at 6.3 volts. A No. 47 lamp needs 150 ma at 6.3 volts; a No. 49 lamp, 60 ma at 2.0 volts.)

Initially, the scope's sweep and vertical controls are adjusted for a sine-wave display of convenient height, showing two full cycles on the screen (Fig. 4-a). As current through resistor R_x is reduced (and, correspondingly, the voltage drop across it), the decrease in vertical deflection is shown. To make this even clearer, set the scope's horizontal sweep at zero. This gives you a single vertical line as in Fig. 4-b.

The next step is to connect the scope's horizontal input terminals as in Fig. 4-c. Then, by adjusting the vertical and horizontal amplifiers for equal deflection, the 45° straight line for the in-phase resistive condition is shown. The magnitude of the voltage across R_x is monitored with the vtvm.

When a power supply filter choke (L_x) is substituted for R_x (Fig. 4-d), the output voltage is out of phase with the input voltage and shows up as an eliptical trace on the scope screen. This result can then be compared with that obtained by substituting a capacitor for R_x. Further work with reactances is covered in future demonstrations.

Induced voltage

Laws relating to voltages induced by relative motion between magnetic lines of force and a coil can be demonstrated using the vtvm as a zero-center high-impedance dc voltmeter. A scope display is used if meter movement is too sluggish to follow the action of the induced voltages.

Conventional experiments on induced voltages will not be described here. We will merely mention items like changing the number of turns in the coil, strength of the magnet or speed of motion, to show their effect on the induced voltage.

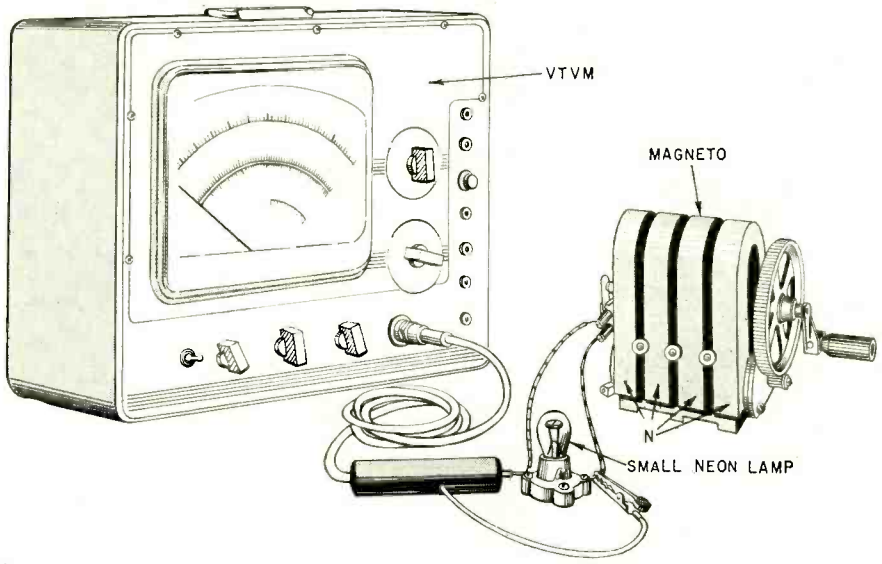


Fig. 5—Measuring induced voltage from a high-impedance source.

Also the effect on the voltage induced in a secondary coil when current in the primary coil is changed. Details on these demonstrations are well covered in many physics texts.

As an interesting variation in standard methods, connect the familiar high-voltage hand-cranked magneto to a vtvm as shown in Fig. 5. In this way you can get an actual voltage reading as well as lighting the neon lamp. A vtvm must be used rather than the usual demonstration-table meter, whose low impedance would drain so much current from the magneto that the lamp might not light.

About the references

The first reference, *Demonstration Experiments in Physics*, is a classic and a gold mine of ideas, containing more than 1,000 demonstrations. Although published in 1938, it lays down a basic philosophy as valid today as when it was written—"Logic and insight transform the commonplace rolling of a ball down an incline into a profound experiment. . . . We turn to demonstration experiments, which by their very number and variety, fill a real need and at the same time, provide one of the most helpful methods of selling physics to students. Above all, the instructor should investigate the possibilities of new commercial products as they appear on the market."

These quotes were never more true than they are today.

Experiment Manual for Electronic Demonstration concentrates on using the most recent electronic equipment for classroom demonstrations of electrical and electronic principles.

The First Annual Report of the Physical Science Study Committee gives an overall picture of the Monograph project of the MIT Physical Science Committee. The group also promises a reference list of many specific science topics for supplementary reading material that "would be usefully broadened to create a shelf of sound, readable science books, capable of doing far more than fill interstice of the (physics) course."

The remaining references are not intended to make up a comprehensive bibliography. However, they do comprise a list that will undoubtedly refresh the reader's mind, whether he or she is a teacher, student or technical worker, as to some familiar stand-by sources and perhaps also introduce him or her to some newer approaches. END

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Duo-Rectifier Power Supply

By NORMAN V. BECKER

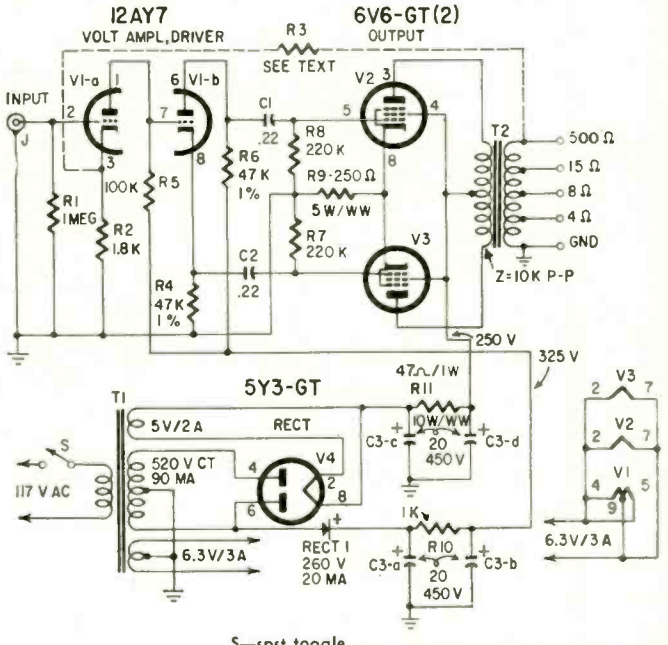
IN the design of certain audio amplifiers, the full output capabilities of the power tubes cannot be realized because the driver stage cannot supply enough voltage to drive them properly. This is probably more true of amplifiers that use such tubes as the 6V6 than of those that have higher-voltage output tubes. The voltage supplied to the plates of the earlier stage (driver or phase inverter) through the plate resistors is just not great enough to permit the required swing without distortion. A simple solution would be to provide a higher voltage source for the voltage amplifiers.

Fig. 1 shows a conventional audio amplifier using push-pull 6V6's in its output stage. They operate with a combined plate and screen supply of 250 volts. Transformer T1 has a high-voltage center-tapped secondary rated at 520 volts at 90 ma. This fulfills power requirements for the output stage, plus the additional current needed for the 12AY7 amplifier–driver. The driver, unfortunately, requires *more* plate voltage to deliver large-amplitude signals with minimum harmonic distortion.

Rather than use a larger power transformer and a conventional voltage-dropping arrangement, I solved this problem by adding RECT1 to the circuit. This selenium unit has a maximum input voltage of 260 rms and maximum current of 20 ma. It operates half-wave fashion from half of T1's high-voltage winding. Plate current drawn by V1 is under 10 ma. Therefore, RECT1 can deliver almost *peak voltage* from its 250-volt rms source by operating far below maximum current ratings.

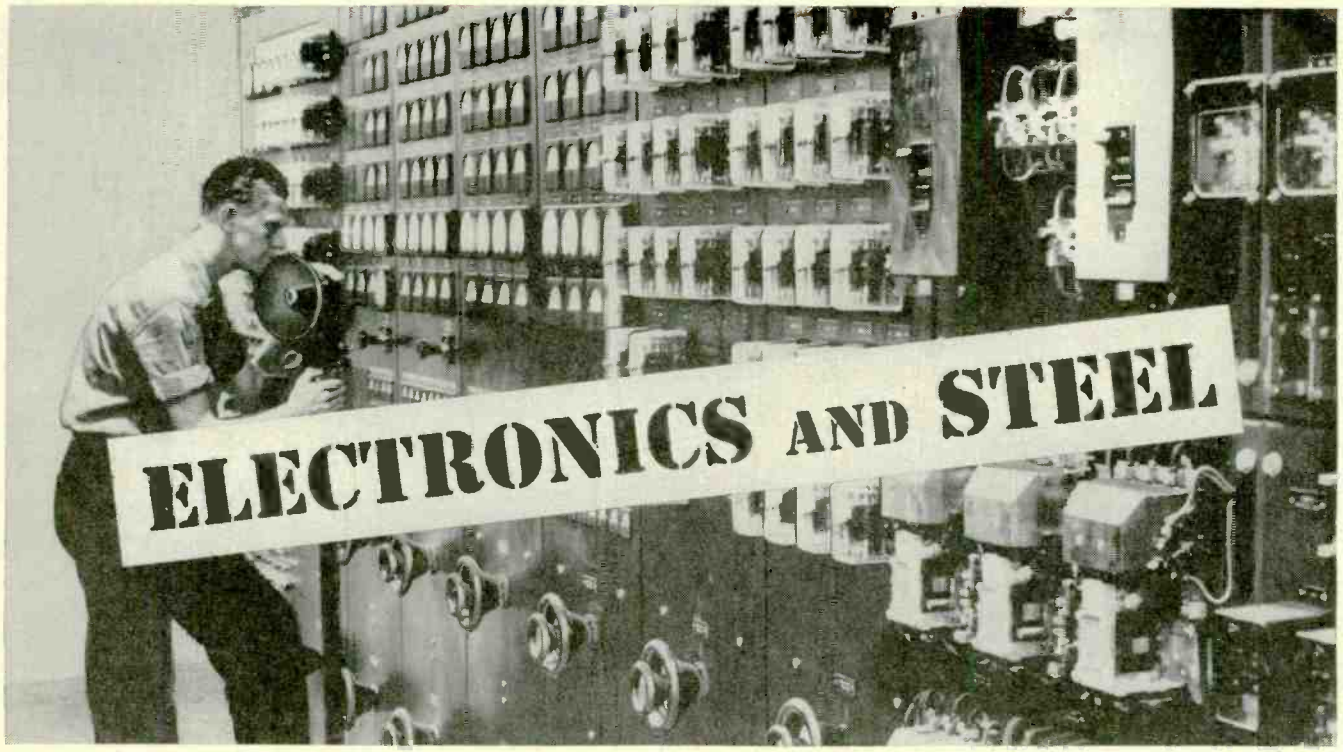
Results of this arrangement netted 325 volts of well filtered dc for the 12AY7. This was sufficient to produce the low-distortion drive signal required. And since RECT1 is *ahead* of V4, voltage drop across the rectifier tube further decouples output from input. In effect, we have two independent B-plus supplies, and low-frequency stability is improved accordingly. Excessively large amounts of negative voltage feedback did not cause motorboating in my amplifier. The only disturbances were high-frequency oscillations caused by electrical asymmetry of the output transformer. Feedback was reduced by adjusting the value of R3 to eliminate this condition.

Notice that the only power resistor is R10, a 47-ohm 1-watt carbon unit. It doesn't even get warm! Filtering is adequate, though, because of the ample capacitance of C3-c and C3-d. Residual hum of the overall amplifier was reduced to insignificance by negative feedback. An ac–dc choke can be used instead of R10 to provide better filtering.



Circuit of a conventional audio amplifier using a duo-rectifier power supply. Dashed lines show the negative feedback loop. R3 may vary widely. In the author's amplifier it was 10,000 ohms, connected to the 15-ohm output transformer tap.

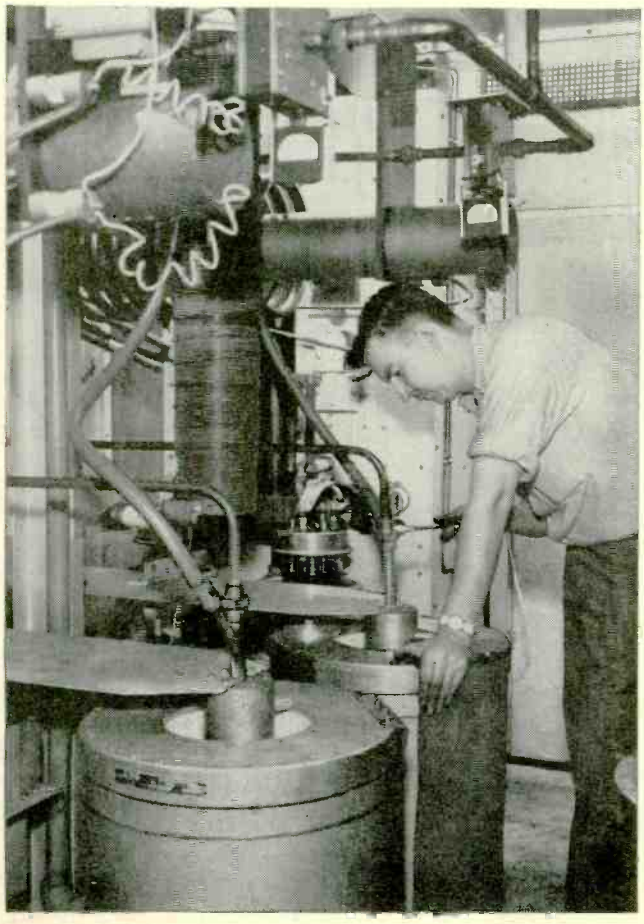
R1—1 megohm
R2—1,800 ohms
R3—see text
R4, 6—47,000 ohms, 1%
R7, 8—220,000 ohms
R9—250 ohms, 5 watts, wirewound
R10—47 ohms, 1 watt
R11—1,000 ohms
All resistors ½-watt 10% unless noted
C1, 2—0.22 μf, 600 volts
C3—20–20–20–20-μf, 450 volts, electrolytic
J—phono plug
RECT1—selenium, 260 volts, 20 ma (Radio Receptor 16Y1 or equivalent)
S—spst toggle
T1—power transformer: primary, 117 volts; secondary, 520 volts ct, 90 ma; 6.3 volts, 3 amps; 5 volts, 2 amps (Stancor PC-8404 or PM-8404 or equivalent)
T2—output transformer: primary 10,000 ohms ct; secondary, 500, 15, 8, 4 ohms; 25 watts (Stancor A-3311 or equivalent)
V1—12AY7
V2, 3—6V6-GT
V4—5Y3-GT
Chassis
Socket, 9-pin miniature, with shield
Socket, octal (3)
Miscellaneous hardware

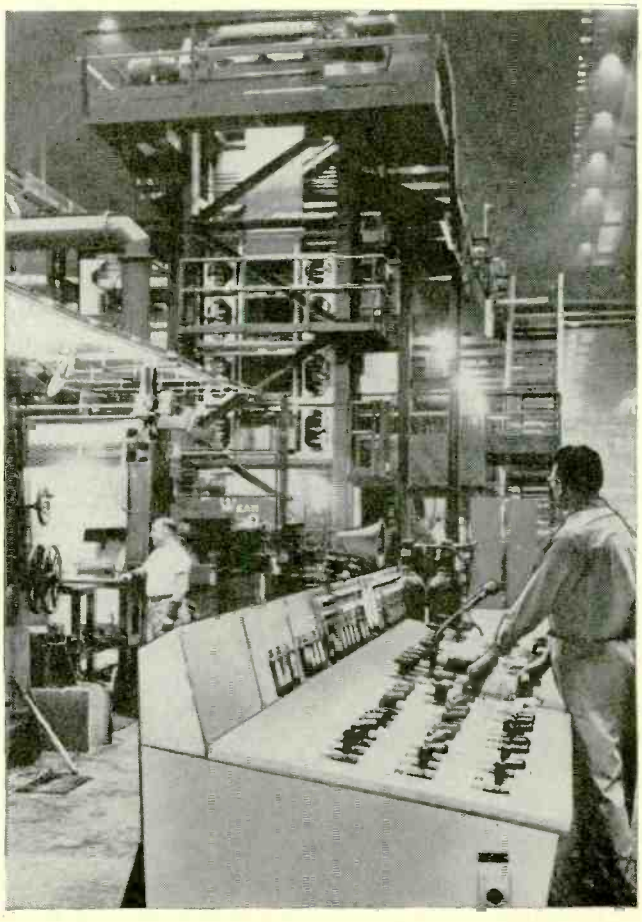


ELECTRONICS AND STEEL

ELECTRONIC equipment plays an increasingly important part in modern industry. An excellent example of industrial electronics at work can be seen at the Weirton Steel Co., Weirton, W. Va., a division of National Steel Corp. In 1955, this firm established an electronics department, responsible for operating and maintaining electronic gear from intercoms to X-rays.

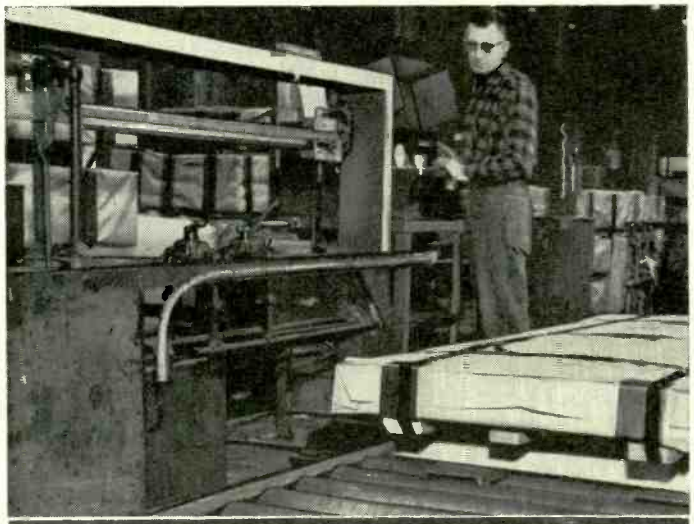
An electronic control and intercommunications system (top) directs operation of electrolytic tin-plating lines. This unit works in conjunction with electronic oscillator units (bottom left) which produce 400,000 watts of rf. The plant's total oscillator capacity is 8,400,000 watts at frequencies of 100–200 kc. This power is used in an induction-heating process to reflow satin-finished tin-plated steel produced by the electrolytic lines, to a mirror-bright finish. The section of the production line where the power developed by the oscillators is used is shown at the bottom right. Power is controlled at the instrument board in the foreground.



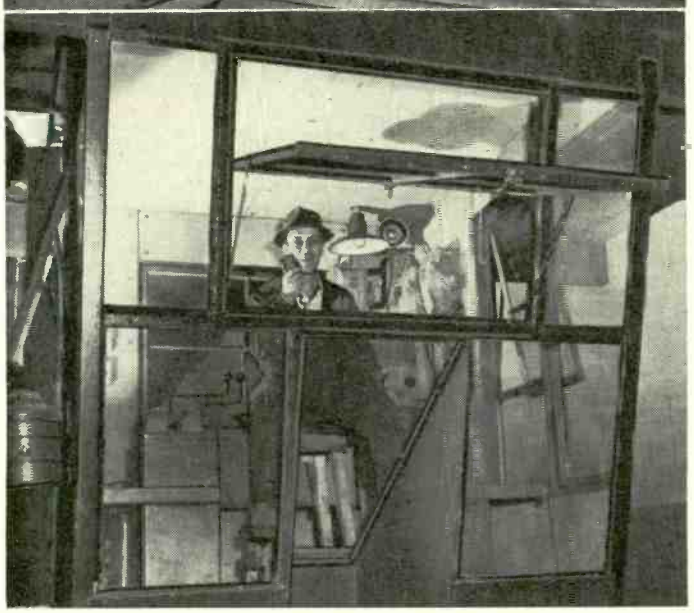


Electronic hole detectors on the Weirton tin mill cutting line detect holes as small as 1 millimeter in diameter (which can't be seen by the eye) and automatically reject defective sheets. The process is controlled by photoelectric cells.

X-ray machine at the No. 7 tandem mill controls the rolling operation of the 54-inch strip-steel department. The device automatically keeps the gauge of the steel being rolled within the desired tolerance.

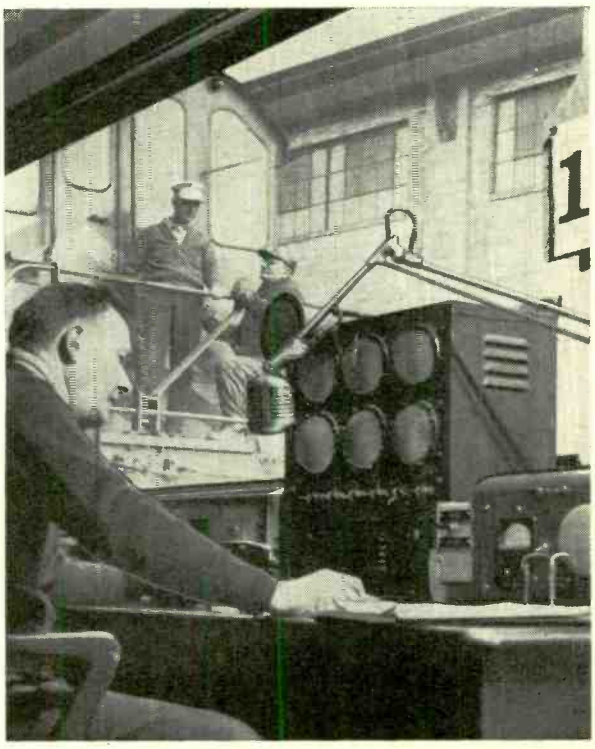


Employee is operating electronic scales, used for quick weighing of all material shipped from the cold-mill shipping department of the 54-inch strip-steel department. The scales have Baldwin-Lima-Hamilton load cells, which are strain-gauge devices. The change in position of the center core registers the weight.



Carrier (wired) radio system used on moving overhead cranes lets operators handling material within the plant talk to other operators and personnel at ground stations to coordinate all crane operations.

The yardmaster, who controls the interplant railroad system, directs the movement of all cars and 14 Diesel locomotives with the radio equipment shown here. Two-way 152.87-mc units are used so the yardmaster can speak to engineers on locomotives anywhere in the plant.



5 relays in ONE

Forward- or reverse-acting photorelay, recycling or straight timer, or a sound-actuated unit

By ED BUKSTEIN*

CERTAIN basic features are common to most types of relay circuits. The voltage drop across a sensing element (phototube, microphone, etc.) is applied to the grid of an amplifier, and the resulting change of plate current operates a relay. For some uses, the circuit should be self-latching: the relay once energized remains energized until the circuit is manually reset. For other applications, a self-repeating circuit may be required. This is one which will recycle or reset itself. These modes of operation were considered in designing the circuit shown in Fig. 1.

With suitable control circuits the relay can be used as a photoelectric control, a timing circuit or a sound-operated relay. When used as a photorelay, the circuit can be made either forward- or reverse-acting. In the former, the relay energizes when the phototube is illuminated. In the latter, the relay energizes when the light beam is blocked.

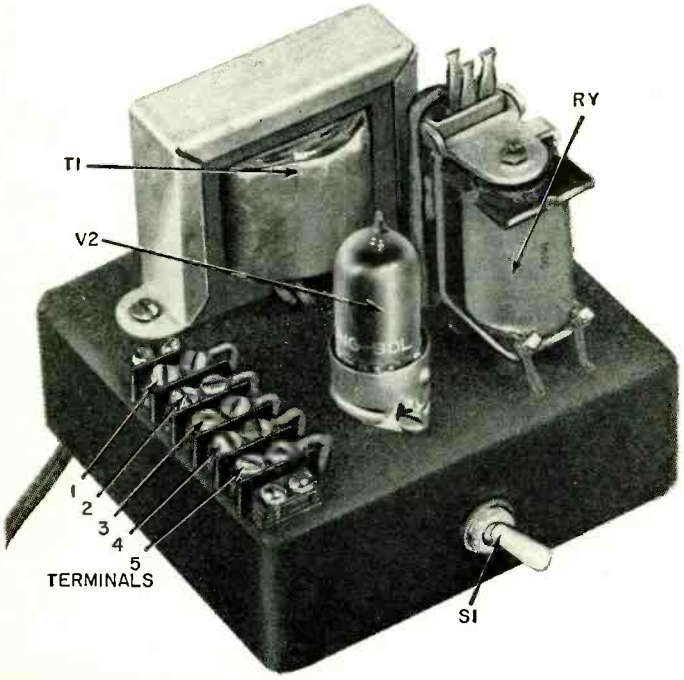
Only one tube, a 12AU7 duo-triode, is used. One triode section is diode-connected and operates as a half-wave rectifier. The other triode section functions as an amplifier to control the relay. The variable cathode resistor (R3) permits adjustment of sensitivity and operating point.

Photorelay circuits

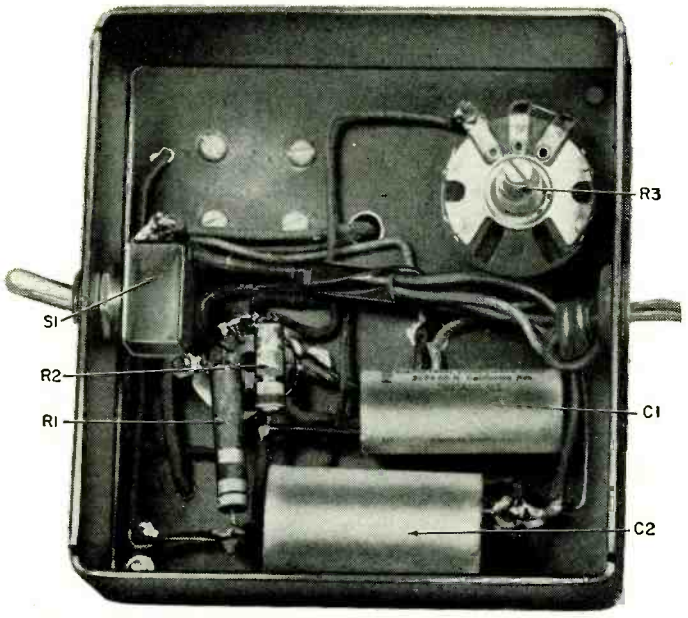
Fig. 2 shows the accessories needed for various circuit applications. In the forward-acting photorelay (Fig. 2-a) the current which flows when the phototube is illuminated produces a voltage drop across resistor R6. This drop is of such polarity that the triode grid becomes positive and causes the relay to energize. A type 930 phototube is shown in the diagram but other types may be substituted.

To convert the circuit to a reverse-acting photorelay (Fig. 2-b), it is necessary only to interchange the positions of the phototube and resistor R6. The relay now energizes when a light beam to the phototube is obstructed. A good light source for this circuit can be made from a 21-candlepower headlight bulb operated from a 5- or 6-volt transformer. Operating the bulb at 5 volts will extend its lifetime without adversely affecting the circuit's sensitivity. A lens placed in front of the light source will increase circuit sensitivity

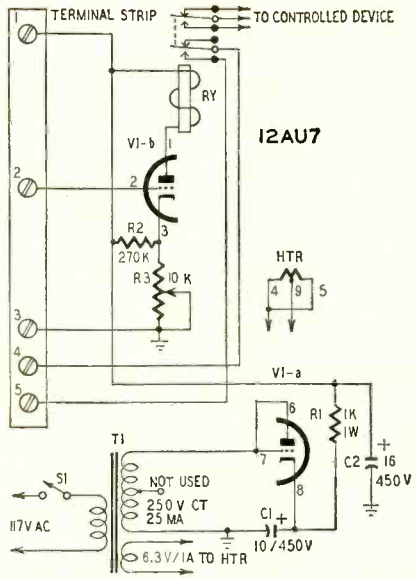
* Northwestern Television and Electronics Institute, Minneapolis, Minn.



Relay chassis without control circuits attached.



Underchassis view. Resistor R3 controls the tube's operating point and circuit's sensitivity.



R1—1,000 ohms, 1 watt
R2—270,000 ohms
R3—pot, 10,000 ohms
R4, 5—47,000
R6—10 megohms
R7—pot, 10 megohms
R8—100,000 ohms
All resistors ½ watt unless noted
C1—10 μf, 450 volts, electrolytic
C2—16 μf, 450 volts, electrolytic
C3—see text
RY—dpdt plate relay, 2,000–10,000 ohms
S1—spst toggle
S2—dpdt toggle
S3—spst, normally closed, microswitch
T1—power transformer; primary, 117 volts; secondary, 250 volts, 25 ma ct; 6.3 volts, 1 amp (Stancor PS8416 or equivalent)
T2—microphone transformer for carbon mike: primary 200 ohms, 5,000 ohms secondary 60,000 ohms (Stancor A3833 or equivalent)
V1—12AU7
V2—930
Chassis
Socket, 9-pin miniature
Terminal strip, 5 contacts, barrier type
Carbon mike
Battery, 3–12 volts
Miscellaneous hardware

Fig. 1—Basic relay circuit.

and the distance over which the control will remain effective. Applications of photorelay circuits include opening garage doors, turning on lights at sundown or during overcast weather, burglar alarms, etc. When the circuit is used as a burglar alarm, an infra-red filter should be placed in front of the light source so the light beam is invisible to the intruder.

The circuit can be converted to a time-delay relay (Fig. 2-c) by connecting a 10-megohm variable resistor (R7) between terminals 1 and 2, and a capacitor (C3) between terminals 2 and 3. A dpdt switch (S2) is used; one section is connected in parallel with the capacitor and the other in series with the power line to the device to be controlled (a photographic printer or enlarger, for example). The time delay is initiated by opening the switch in parallel with the capacitor. The capacitor now charges through the variable resistor. As this charge builds up, the triode grid (V1-b) becomes increasingly positive until the plate current of the tube is sufficient to energize the relay. The normally closed control contacts of the relay open and remove power from the controlled device. Variable resistor R7 controls the charging rate of the capacitor and therefore the length of the time delay. The capacitor's value depends on the range of time delay desired and is determined by experimentation. For most applications, this value will fall between 0.1 and 4 μf.

When the circuit is used as a self-repeating timer, connect terminal 5 to terminal 3, and terminal 4 to terminal 2. With this arrangement, contacts 4 and 5 of the relay short out the capacitator after the time delay is completed. The circuit is restored to its starting condition and the time delay repeats. Such circuits are often used to control flashing signs and window displays.

Contact relay

In another variation of the control circuit (Fig. 2-d), 100,000- and 47,000-ohm resistors are connected across terminals 1–2 and 2–3, respectively. A normally closed snap-action switch (S3) is connected in parallel with resistor R4. If the switch is opened, a positive voltage appears at the triode grid (V1-b) and the relay energizes. The circuit may be used as a burglar alarm by mounting the switch on a door or window. Several entrances may be protected by using more than one switch. The switches should be connected in series. Placing the switch under a spring-supported platform makes the circuit useful as a camera-shutter tripping device for photographing birds, squirrels and other hard-to-photograph subjects.

A carbon microphone connected through a transformer to terminals 2 and 3 will convert the circuit to a sound-operated relay (Fig. 2-e). When sound enters the microphone, a signal is impressed on the triode grid and the relay energizes. Contacts 4 and 5 of the relay short out the cathode bias resistor to keep the relay energized. This circuit may be used as an alarm to indicate to mother that baby is awake. It may also be used to open garage doors when an automobile horn is sounded.

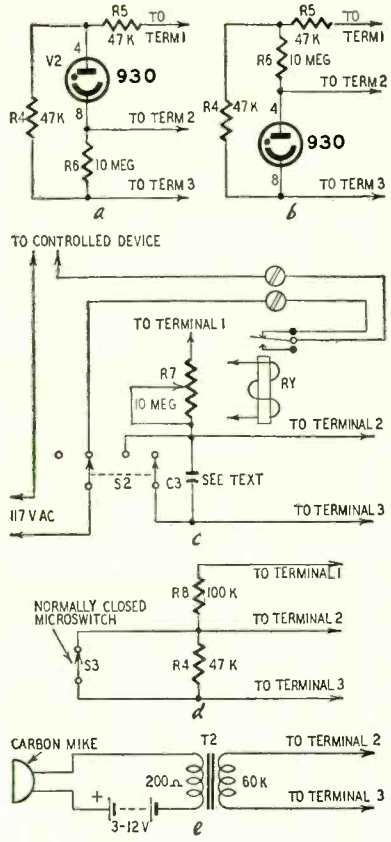


Fig. 2—Control circuits: a—forward-acting photorelay; b — reverse-acting photorelay; c—time delay; d—contact; e—sound-operated.

Other applications are limited only by your ingenuity. In general, the relay and accessory circuits are used in applications where a relay is to operate in response to a change of light, sound, position (mechanical motion), or time.

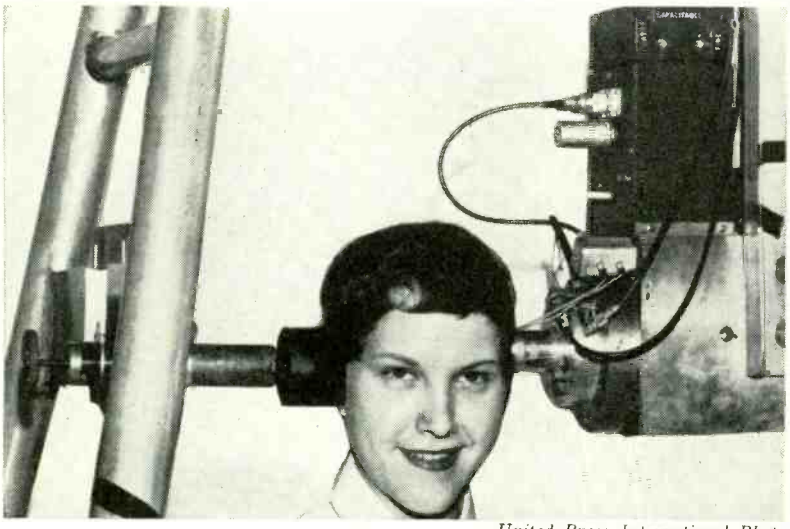
END

ELECTRONIC MAN—WOMAN DETECTOR

An unusual application of electronics, devised to demonstrate advanced infra-red techniques. This device can detect the sex of the person who stands on its platform and pushes a button. Displayed by Farnsworth Electronics Co. (ITT), it flashes a light indicating "man" or "woman." It was displayed at the 1958 Western Electronic Show and Convention (WESCON) in Los Angeles.

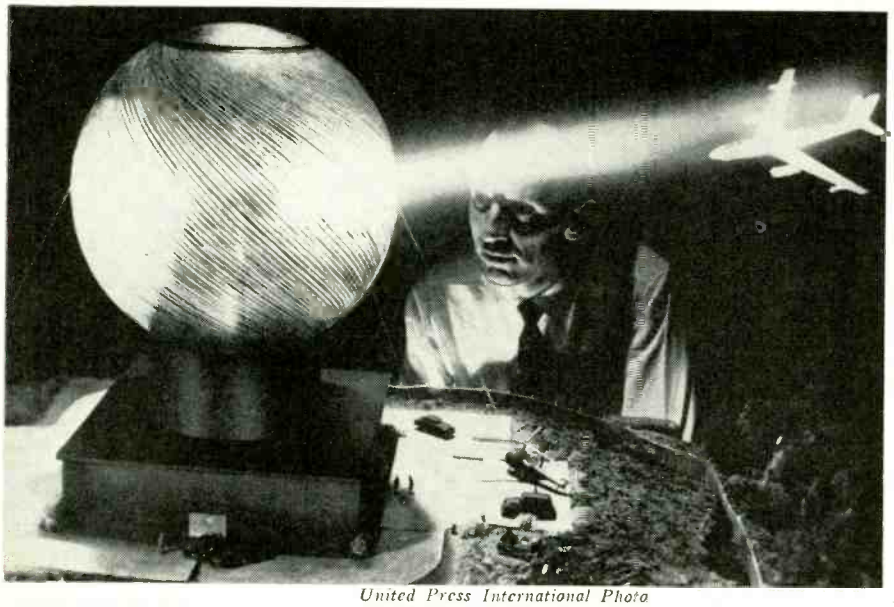
Here's how it works: A detector, located near the base of the unit, reacts to the amount of radiated body heat. Men's trousers inhibit heat radiation reaching the detector; women's stockings do not. Though it's completely reliable within its own frame of reference, all bets are off in the cases of such unsexed individuals as men wearing shorts or women wearing slacks.

what's new?



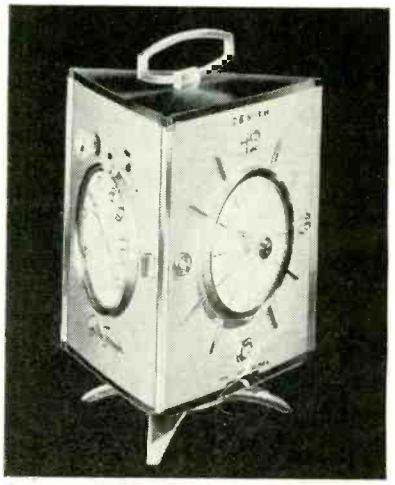
United Press International Photo

HEAD IS HEARD by this laboratory device at the National Bureau of Standards in Washington as part of a program to establish a standard of normal hearing by bone conduction. It measures the sound vibrations transmitted by the bones of the head, and is seen as a means whereby a physician could determine the possibility of correcting a person's hearing loss by surgery.

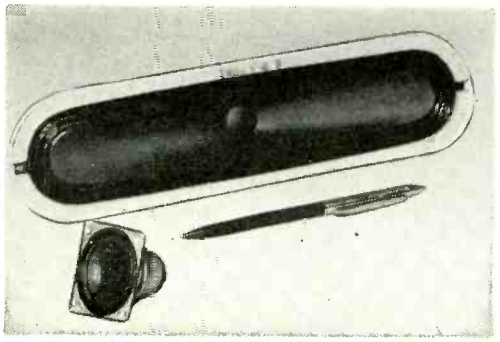


United Press International Photo

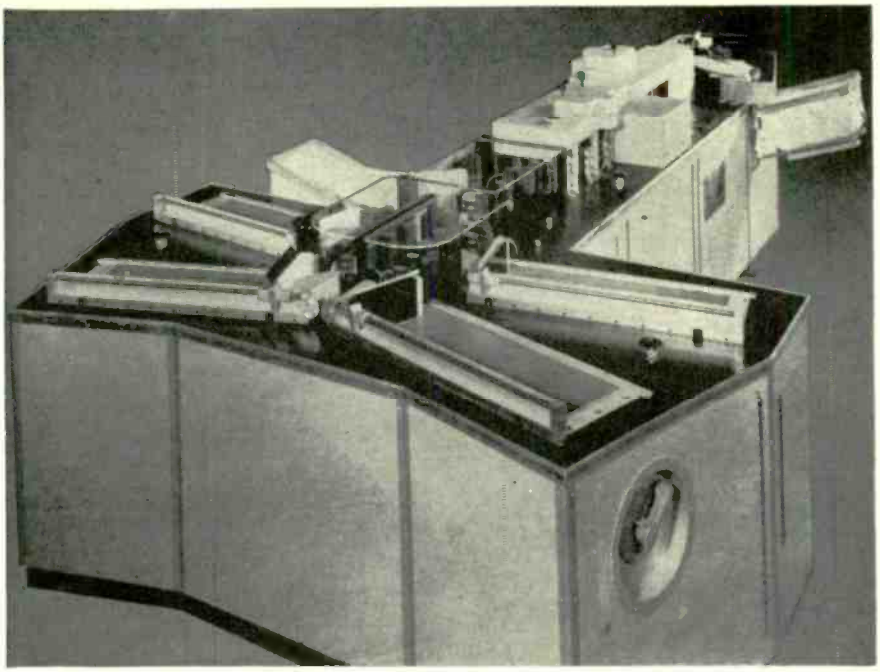
HELISPHERE RADAR ANTENNA, shown here in model form, represents a new concept in which a stationary globe is used as a parabolic antenna. In the photo above, a light beam is used to represent the rf energy emitted by the antenna. Radar waves from a rotating source are sprayed against the inside surface of the stationary globe (shown by brightly lighted section of sphere at left). The waves reflect through the opposite side of the sphere to emerge as an intense, narrow beam (illustrated by the light beam outlining the model plane at right). The antenna was developed at the Westinghouse Research Laboratories.



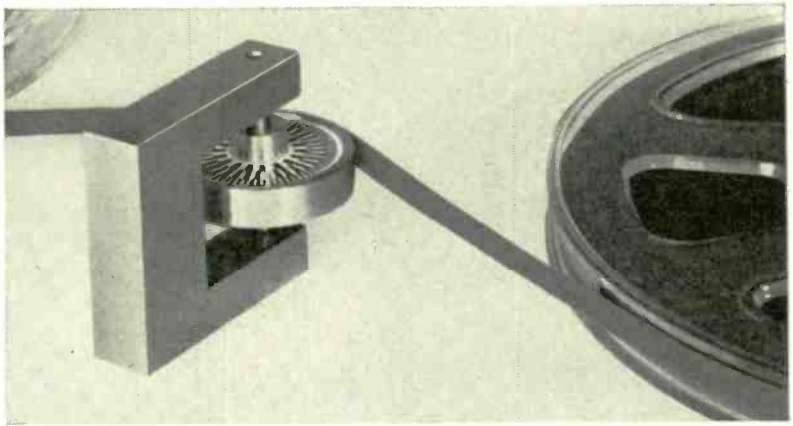
LATEST INNOVATION in radio receiver design is the introduction of cordless transistor clock radios by nearly all manufacturers. This unusual triangular model produced by Zenith has a clock, radio dial and speaker on its three sides. The clock operates for a year on a "D" flashlight cell and the receiver works for up to 400 hours on four mercury flashlight-size batteries.



FRENCH SPEAKER DESIGNS: Double speaker at far left is proposed by *Cabasse* for good wide-angle coverage at high audio frequencies. A 4-inch and a 5-inch speaker are mounted in a molded aluminum casting so that their axes are slightly divergent. The back part of the casting constitutes a shell, and the back radiation is channelized by a simplified double acoustical horn and projected forward through the side openings. The long speaker at right, made by *Audax* (France), is designed for TV sets. It measures 2¾ x 10 inches, with a power rating of 3 watts. In front of it is a speaker for pocket receivers, 1½-inch square, 1 inch deep, rated at 300 milliwatts.



MAIL CANCELLING MACHINE now being tested in the main post office, Washington, D. C., processes 30,000 letters an hour. Shown above is the cancelling and facing section, which positions mail so it is right-side-up, detects presence and position of stamps, actuates the appropriate cancelling head and then guides letters to four different stackers. Flying-spot scanners used for detection can instantly tell the difference between a postage stamp and similar objects such as Christmas seals. The machine was developed by Emerson Research Laboratories, Silver Spring, Md.



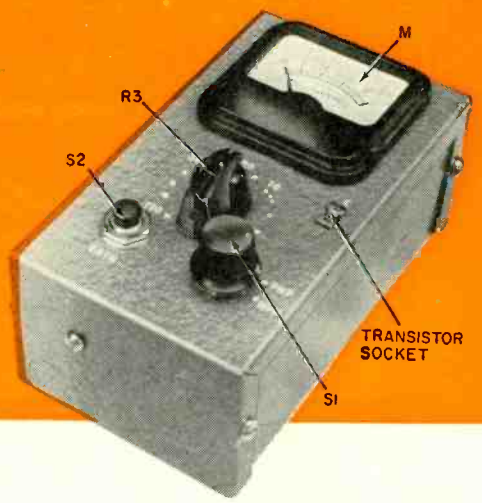
TAPE SPEED may be checked instantly and easily with ***TapeStrobe,*** recently placed on the market. Held on the tape deck so that the strobe wheel makes firm contact with the moving tape, the device shows any deviation from proper speeds under a 60-cycle light source. The outer scale is for checking 7½-ips speed, center for 15 and inner scale for 30 ips. It's manufactured by Scott Instrument Labs, New York.

Courtesy Sankei Shimbun, Tokyo

WORLD'S TALLEST self-supporting TV tower is this new structure in Tokyo. Including antenna, its height is 1,091 feet, compared with the French Eiffel Tower's 984.25 feet. Highest man-made structure is still the 1,610-foot guy-wire-supported tower of KSWS-TV, Roswell, N. M. New York's Empire State Building rises 1,472 feet. The base of the Tokyo tower will house a 6-story studio building and science museum, and a restaurant will be built at the 396-foot level.

Simple circuit gives accurate measure of beta gain, a factor directly related to transistor quality

DIRECT-READING TRANSISTOR TESTER



By ELLIOTT A. McCREADY

ONE of the simplest indicators of transistor quality is its current gain or beta. A transistor's beta is the ratio of output current to input current inducing it, and is a characteristic usually listed in the manufacturer's specifications.

If we find a way to determine quickly a transistor's current gain or beta, we can check it against the spec sheet and end up with a pretty good estimate of how the transistor will perform in a circuit. The transistor beta test, like the emission test of a vacuum tube, is not 100% infallible, but is a fairly reliable indication of quality.

The transistor tester described in this article can be built for less than $10. It not only indicates open, shorted or excessively leaky transistors, but lets the operator read transistor beta directly from a calibrated control.

Test circuit at work

The transistor under test is connected in a common-emitter configuration (Fig. 1) with a milliammeter in the collector circuit. When switch S is open, no current flows from base to emitter and the milliammeter indicates transistor leakage current which, in a good transistor, should be no more than a small fraction of a milliampere.

When switch S is closed, current flows between base and emitter. The amount of current is determined by the resistance of potentiometer R. The meter should now indicate an increased current—the amount of increase depending on the transistor's beta.

We can now calculate beta:

$$\text{Beta} = \frac{I_C}{I_B}$$

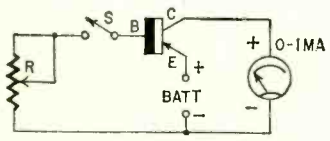


Fig. 1—Simplified circuit of the transistor tester.

where I_C is equal to the *increase* in collector current, and I_B is equal to the base current. In this circuit, the base current, for our purpose, is equal to the battery voltage divided by the resistance of potentiometer R.

Now, if we use a constant value of I_C in all tests and vary R's resistance to produce this predetermined constant, we can calibrate R in units of beta.

For example: suppose we use 1 ma as the constant increase in collector current, and adjust R to induce this value, then:

$$\text{Beta} = \frac{.001}{I_B}$$

But I_B is equal to the battery voltage divided by the resistance of R. We know the battery voltage (let's say 10 volts) and can measure the resistance of R (say 100,000 ohms). For this particular set of values:

$$\text{Beta} = \frac{.001}{10/100{,}000} = 10$$

Knowing this, every time we must set R to 100,000 ohms to get a collector current increase of 1 ma, we know the beta of the transistor we are testing is 10. It is now relatively simple to calibrate R for other values of beta.

Fig. 2 is the transistor tester's circuit. A 0–1 milliammeter is the indicating device, and a collector current increase of 0.5 ma is used in all tests. This much current increase, together with a 4-volt mercury battery, allows a variable resistance of 1 megohm to cover beta values between 5 and 125, which is adequate for all practical purposes.

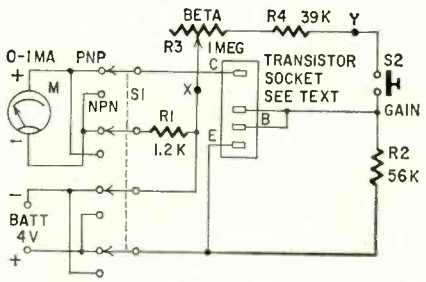
R1 is a current-limiting resistor which keeps the meter from being damaged if the transistor being tested is shorted. R2 is an arbitrary resistance used to approximate actual in-circuit conditions. It gives a more realistic value of transistor leakage current than a floating base would. R4 is a current-limiting resistor which prevents transistor damage when potentiometer R3 is set for minimum resistance.

Switch S1 is a multiple-pole unit used to reverse meter and battery polarities, eliminating the need for separate sockets for p-n-p and n-p-n transistors.

Construction notes

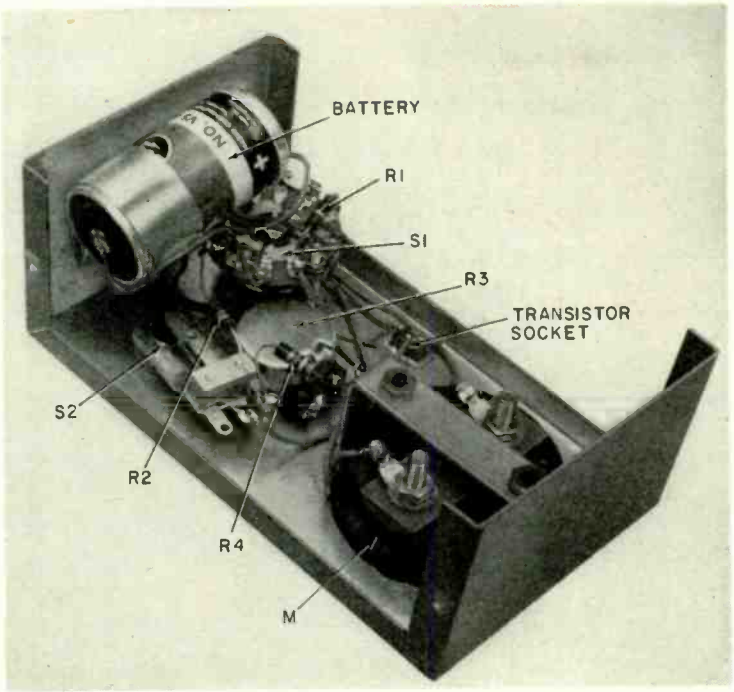
The transistor tester is housed in a two-piece aluminum chassis measuring 5¼ x 3 x 2⅛ inches. All components are mounted on the top half of the chassis, as shown in the photos. While the wiring is not critical, space is limited and all components should be located as illustrated.

Potentiometer R3 is wired so that clockwise rotation lowers the resistance. Although this results in a scale which runs counterclockwise, it agrees with the natural tendency to back off a control to reduce excessive meter readings. Be sure to use a control with the specified taper, as an audio taper will cause crowding at the low end of the scale.



R1—1,200 ohms
R2—56,000 ohms
R3—pot, 1 megohm, reverse log taper (IRC type Q17-137 or equivalent)
R4—39,000 ohms
All resistors ½ watt 10%
M—0–1 ma
S1—4-pole 2-position rotary
S2—spst pushbutton, normally open
Battery, 4 volts (RCA VS400 or equivalent)
Socket, 5-pin miniature hearing aid
Case, 5¼ x 3 x 2⅛ inches
Miscellaneous hardware

Fig. 2—Transistor checker tests n-p-n and p-n-p types. When adapter is used, power transistors can also be tested.



This layout lets you get all the parts into the small case.

The transistor socket is from a miniature hearing-aid socket. Remove pin 4 and plug the hole with a toothpick. Pin 1 is now the emitter connection, pins 2 *and* 3 the base, and pin 5 the collector. This type socket accommodates the two most common transistor bases. Of course, other sockets can be used if desired.

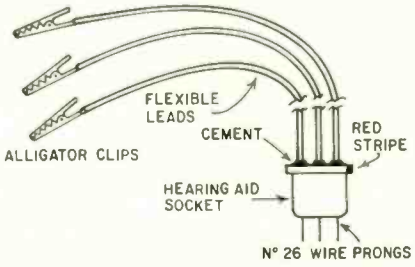


Fig. 3—Construction of the power-transistor adapter.

The power-transistor adapter is shown in Fig. 3. Remove all five contacts from a miniature hearing-aid socket. Solder flexible leads to three short lengths of No. 26 tinned wire and insert them into the socket as shown. *Caution: Wire much larger than No. 26 will spring the tester socket contacts.* I used the clipped excess leads of a transistor.

Clip the wires protruding from the socket base to about ¼ inch and cement the flexible leads to the socket. Solder miniature alligator clips to the free ends of the flexible leads. To eliminate possible confusion, paint a stripe of red fingernail polish on the collector ends of both the tester and adapter sockets.

Calibration and operation

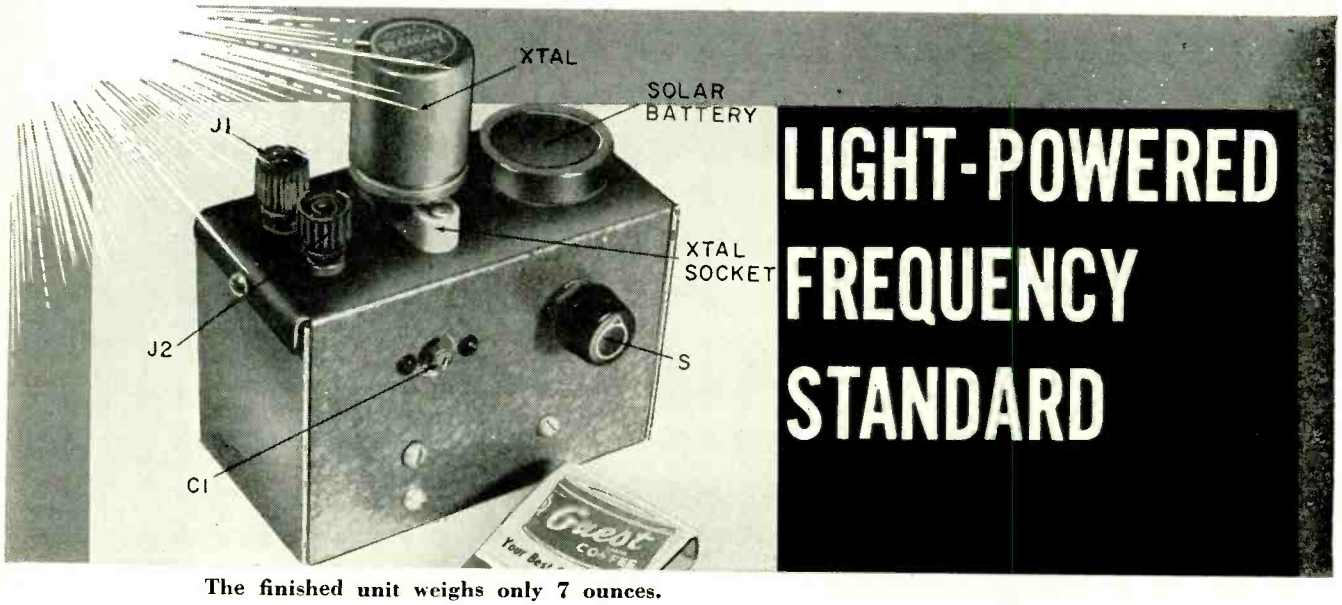
After the transistor tester is wired and checked, connect an ohmmeter between points X and Y as indicated in Fig. 2. Now adjust R3 until the ohmmeter reads 40,000 ohms and mark this point 5 on R3's scale. Other resistance measurements together with their corresponding values of beta are shown in the table. The potentiometer used in my tester has a maximum resistance of 1.2 megohms, so I included this resistance in the table.

Beta	Resistance (X to Y) (Ohms)	Beta	Resistance (X to Y) (Ohms)
5	40,000	30	240,000
6	48,000	40	320,000
7	56,000	50	400,000
8	64,000	75	600,000
9	72,000	100	800,000
10	80,000	125	1.0 megohm
15	120,000	150	1.2 megohms
20	160,000		

When calibration of the unit has been completed, plug a transistor into the socket, first placing switch S1 in either the PNP or NPN position, as necessary. Note the reading on the milliammeter. This reading should be a small fraction of a mil and indicates transistor leakage current. Now depress GAIN switch S2 and adjust R3 until the meter reads 0.5 ma *plus* the value of leakage current noted previously. R3 now indicates the beta of the transistor being tested. Compare this value with the manufacturer's specifications to determine its quality.

If, when the transistor is first plugged in, the meter reads 0.5 ma or more, the unit is either excessively leaky or shorted. An open transistor produces a zero reading when GAIN switch S2 is depressed.

When using the adapter to test power transistors, connect the alligator clips to the transistor before plugging the adapter into the tester. Failure to do this may result in pegging the meter if the clips inadvertently come in contact with each other. END



The finished unit weighs only 7 ounces.

LIGHT-POWERED FREQUENCY STANDARD

By RUFUS P. TURNER

100-kc crystal oscillator is powered by sunlight, artificial light, or an internal battery

USING the 100-kc crystal oscillator described in this article, you can call on the sun to furnish the dc power for frequency check points. Indoors or at night, artificial light will do the job. When you must get along in dim light or darkness, the flip of a switch throws an internal battery into the circuit. Thus, this unit is always at your service, and the run-down battery is not as often a problem.

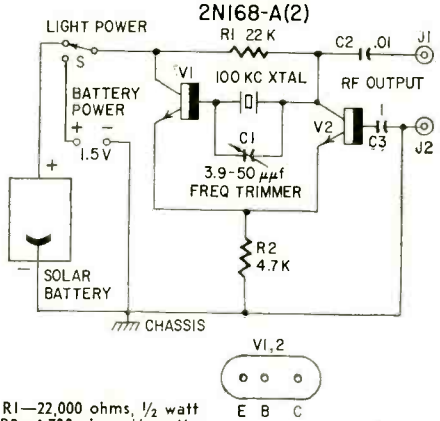
The idea of operating a transistor oscillator from a solar cell is not new. However, the circuit of this instrument (see Fig. 1) is different from most 100-kc crystal oscillators. It is a crystal-controlled multivibrator. No coils are required. The output signal is distorted in shape—it looks like something between a sine wave and square wave. So it is rich in harmonics —always an important point for 100-kc frequency-spotting oscillators, but more so when low dc voltage is used.

Two inexpensive n-p-n rf transistors (General Electric 2N168-A) are used. The circuit is that of an emitter-coupled multivibrator and resembles the cathode-coupled tube circuit. The common-emitter resistor R2 corresponds to the common-cathode resistor in the tube circuit. The 100-kc crystal XTAL forms the transmission path between the output collector and input base and acts as a high-Q, sharply tuned filter. A 3.9–50-$\mu\mu$f air trimmer, C1, connected in parallel with the crystal permits a small amount of frequency variation for setting the oscillator to zero-beat with WWV or standard broadcast stations.

Multivibrator operation

The emitter-coupled multivibrator circuit* is a transistor version of the well-known cathode-coupled tube multivibrator. Fig. 2-a shows the tube circuit and Fig. 2-b the transistor circuit. The common-emitter resistor R_E in the transistor circuit corresponds to the common-cathode resistor R_K in the tube circuit. The grid of tube V1 is grounded. The base of transistor V1 is also grounded, but here a large capacitance, C1, is used to ground the transistor for pulses but not for dc. Both circuits differ from the conventional multivibrator only in that one of the capacitance-coupled paths has been replaced by the common-cathode (common-emitter) coupling.

When dc is applied, both transistors start conducting collector current (I_{C1} and I_{C2}). Both collector currents flow through emitter resistor R_E, across which they produce voltage drop V_E, which is applied to both emitters. As collector current flows, the emitter-to-ground voltage increases. Closing the switch of the dc supply transmits a pulse through capacitor C2 to the base of transistor V2. The resulting current flowing through V2's base–emitter circuit causes the amplified collector current of that transistor to increase. This, in turn, causes an increase in V_E which decreases the collector current I_{C1} of V1. This action reduces the voltage drop across R_C, causing the left side of capacitor C2 to receive a still higher voltage. As C2 approaches the supply potential, its charging current flowing through the base–emitter circuit of V2 increases I_{C2} still further and transistor V1 is emitter-biased higher and higher. This action continues until V1 is cut off and V2 conducts maximum collector current.



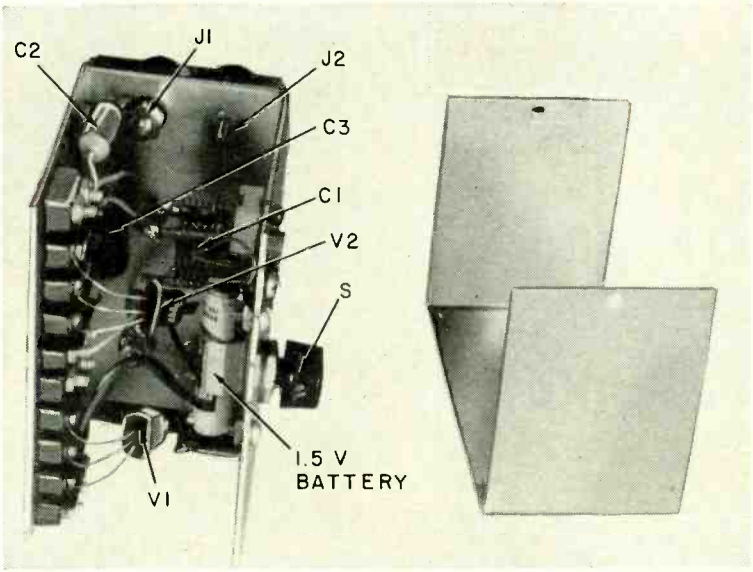
R1—22,000 ohms, ½ watt
R2—4,700 ohms, ½ watt
C1—3.9–50-$\mu\mu$f trimmer (Hammarlund APC-50 or equivalent)
C2—.01 μf, miniature metallized tubular
C3—1 μf, miniature metallized tubular
J1, 2—binding posts
S—spdt miniature rotary
V1, 2—2N168-A
Crystal—100 kc
Solar battery, silicon (Author used International Rectifier SA5-M)
Case, 4 x 2 x 2¾ inches
Crystal socket
Knob
Battery holder
Barrier type terminal strips, 3 terminal (2)
Miscellaneous hardware

Fig. 1—Circuit of 2-transistor unit.

At this point C2 is charged and the charging current through the base–emitter path of V1 ceases. The result is that I_{C2} decreases. This lowers the voltage drop across the common-emitter resistor, and transistor V1 draws more collector current. The voltage drop across R_C also increases, lowering V1's collector voltage. Capacitor C2 is now able to discharge and, as it does so, I_{C2} decreases still further as does its effect on the total emitter voltage. This action continues until transistor V2 is cut off and V1 is drawing maximum current. Thus, conduction has been switched from transistor V2 to V1.

Now, capacitor C2 may again begin charging through resistor R_C and the base–emitter path of V2—and the cycle of events is repeated. In the operation

*Frank C. Alexander, Jr., "Transistors Use Emitter-Coupled Feedback," *Electronics*, December, 1954, page 188.



The few connections make this unit a simple one-evening project.

of this multivibrator, conduction is switched alternately from V1 to V2 as capacitor C2 charges and discharges. The switching rate is governed by the values of R_C, C2, R_E, V2's internal base-emitter resistance and V1's internal collector–emitter resistance. C1 is made large enough so that this unit is a virtual short circuit to ground at the operating frequency and does not figure into the frequency.

In the frequency standard (Fig. 1), capacitor C2 of the basic circuit has been replaced with the 100-kc crystal. This provides a highly selective coupling path and sets the multivibrator frequency to that of the crystal. Variable capacitor C1, shunting the crystal, has the prime purpose of serving as a frequency trimmer.

Power for the oscillator

When switch S is in the LIGHT POWER position, dc operating voltage is supplied by a silicon solar cell (International Rectifier type SA5-M). When switch S is in the BATTERY POWER position, the dc voltage is supplied by an internal 1.5-volt cell. As current drain is low, a penlight cell is used. For longer life and more stable voltage use a mercury cell.

The solar cell is 1¼ inches in diameter and 5/16 inch thick. It has a clear glass window. The crystal can is 1 inch in diameter and 1-5/16 inches high. The cell has two 6-32 terminal screws. The crystal has a pair of pins that match a standard crystal socket. The completed instrument weighs only 7 ounces.

In bright sunlight, the 100-kc rf output (developed across a 500,000-ohm load) is 0.15 volt rms. This output is the same with a 100-watt incandescent lamp 1 foot above the solar cell. Output when the 1.5-volt battery is used is 0.3 volt rms.

Assembly and wiring

The instrument is built in an aluminum chassis box 4 x 2 x 2¾ inches. While a plastic or wooden box could be used, metal is recommended to shield against hum pickup from ac power fields.

The photos show constructional details. The solar cell, crystal socket and output binding posts are mounted on the top of the box. The screwdriver-adjusted trimmer capacitor and the power changeover switch are mounted on one side.

Insulated binding posts are used for the RF OUT terminals. However, only J1 has to be insulated from the box—use a fiber shoulder washer. The ground post is attached directly to the case. A ¼-inch clearance hole must be drilled for the fiber shoulder washer which insulates the top post. Use a flat fiber washer on the other side.

Similarly, the positive screw terminal of the solar cell must be insulated from the case with a fiber shoulder washer inserted into a ¼-inch clearance hole. The negative terminal is fastened directly to the box.

A ⅜-inch-diameter clearance hole is required for the tuning screw of trimmer capacitor C1. The ceramic body of this capacitor insulates it from the box. Two ¼-inch clearance holes are required for the terminal lugs of the ceramic crystal socket. The shank of switch S requires a ⅜-inch clearance hole. A wafer type switch was chosen for its small size. However, a spdt toggle may be used if this type is preferred.

Two three-screw, barrier type terminal strips (Cinch-Jones 3-140) are used for mounting the transistors. Each transistor pigtail is held by one of the screws. This simple arrangement takes the place of soldering to the pigtails, which can be injurious to the transistor. Solder all connections to the strips before inserting the transistors. These terminal strips are mounted end to end along the lower edge of one inner wall of the box.

A bracket type battery holder is fastened to the opposite inside wall to hold the penlight cell. A solder lug on the wall just in front of the transistor-holding terminal strips receives the ground leads of capacitor C3 and resistor R2. Resistor R1 is soldered directly between the collector terminals of adjacent transistor-holding terminal strips. Coupling capacitor C2 is soldered directly between the output collector terminal and the top output binding post.

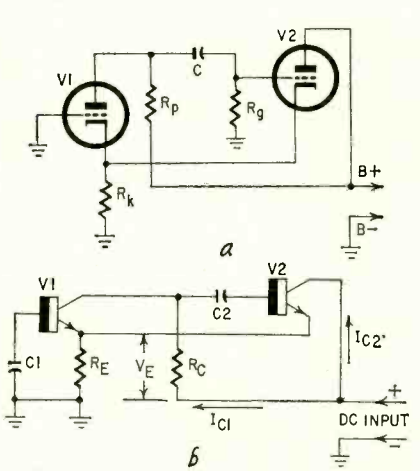


Fig. 2—Multivibrator detail: a—tube type, cathode-coupled; b—transistor type, emitter-coupled.

Initial testing

Carefully check all wiring before slipping the battery into its holder. Be particularly careful of battery, solar cell and transistor polarity. The crystal has no special polarity and will work whichever way it is plugged into its socket.

Connect an ac vtvm (preferably one with a 0.3-volt full-scale range) to the RF OUTPUT terminals. An oscilloscope may be used in place of this meter. Throw switch S to BATTERY POWER and note the rf output voltage as indicated by the meter or scope. Now, throw the switch to LIGHT POWER, expose the solar cell to the sun or to a nearby lamp, and again note the rf output voltage.

To check the signal tune a non-oscillating receiver to WWV or to a standard broadcast station operating on a frequency (such as 600, 700, 1000 kc) which is an exact multiple of 100 kc. Couple the frequency standard to the receiver by connecting the ground RF OUTPUT terminal to the receiver ground terminal and by loosely coupling the top RF OUTPUT terminal to the receiver antenna terminal. This usually can be done successfully by connecting a wire to the top terminal and winding several turns of its insulated length around the receiver antenna lead. With switch S set to BATTERY POWER, adjust trimmer capacitor C1 for zero beat with the WWV carrier (or broadcast carrier) during an interval when the signal is not being modulated. Throw switch S to LIGHT POWER and repeat the test, with the solar cell illuminated. END

How to build an electronic switch and how you can use it in making audio amplifier tests

ELECTRONIC SCOPE SWITCH

By L. B. HEDGE

AUDIO amplifier tests are primarily concerned with comparing the input and output signals of the amplifier under test. The earlier articles of this series have described test instruments for checking gain, frequency response, harmonic distortion, intermodulation distortion and power output. Using an oscilloscope as an accessory to these tests and as the indicator for intermodulation measurements has also been covered. The master control unit described in the last article provides flexible interconnection of the test equipment and the amplifier under test and for switching the oscilloscope connections and those of an electronic switch.

An electronic switch is a device which permits a simultaneous display of two signals on a scope screen. (Special oscilloscopes with multiple-channel displays are made, but they are relatively expensive and complicated.) A scope in combination with an electronic switch provides a simple setup for testing phase-shift characteristics of amplifiers and makes an oscilloscope a more effective visual indicator of distortion and other abnormal amplifier action. The electronic switch also provides a square-wave signal output which can be used for a variety of purposes.

Points to note

The conventional electronic switch (Fig. 1-a) consists of two amplifier channels with paralleled outputs which are alternately switched on and off by a free-running variable-frequency multivibrator. Each channel has its own signal attenuator, and the relative (dc) potential of the zero-signal outputs of the two channels is adjustable.

The unit described here (see Figs. 1-b and 2) differs from the conventional unit that it includes a phase inverter

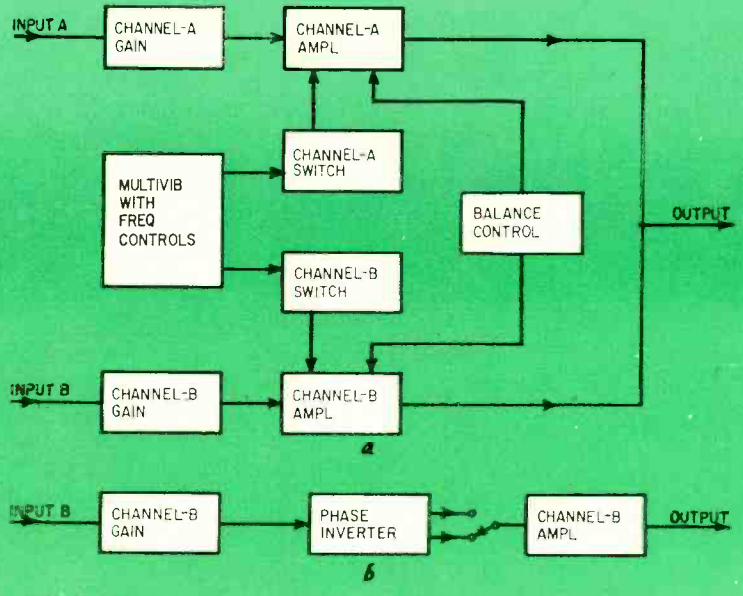
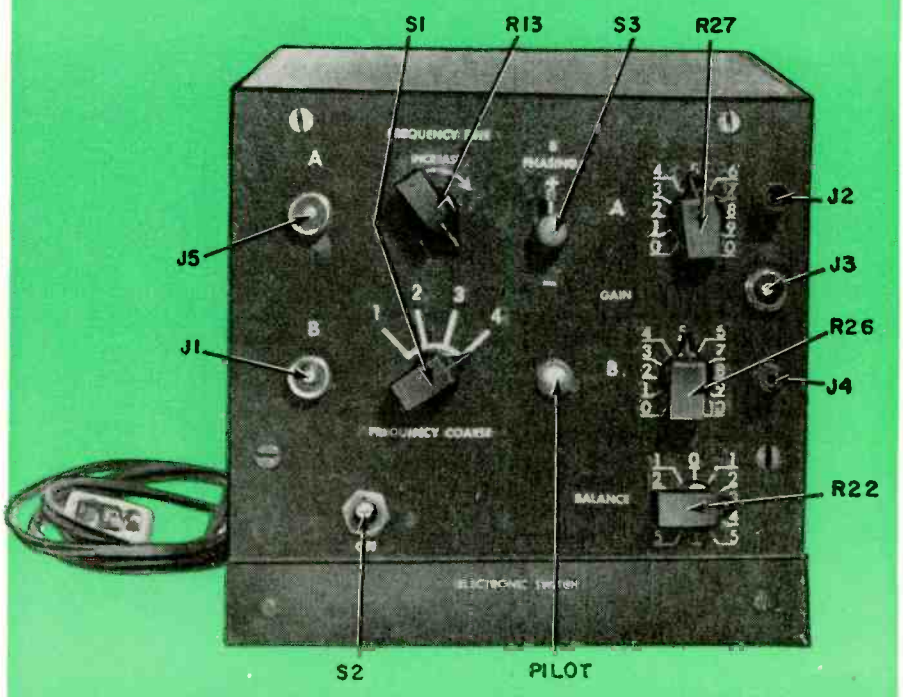


Fig. 1-a—Block diagram of a conventional electronic switch: b—the modified B channel in this unit includes a phase inverter.



Front panel view of the completed unit.

(V5) in the channel-B amplifier which can be switched in or out and a capacitor-coupled output (J2 and J4) as well as the direct-connected one (J3). The phase inverter makes it possible to compare directly the input and output signals of an amplifier whose output is in phase or 180° out of phase with its input. The direct-connected output avoids the distortion induced by capacitor coupling when the scope input includes a series capacitor. The capacitor-coupled output removes the dc plate voltage and is useful when the unit is used as a square-wave signal generator feeding an amplifier without a series input capacitor.

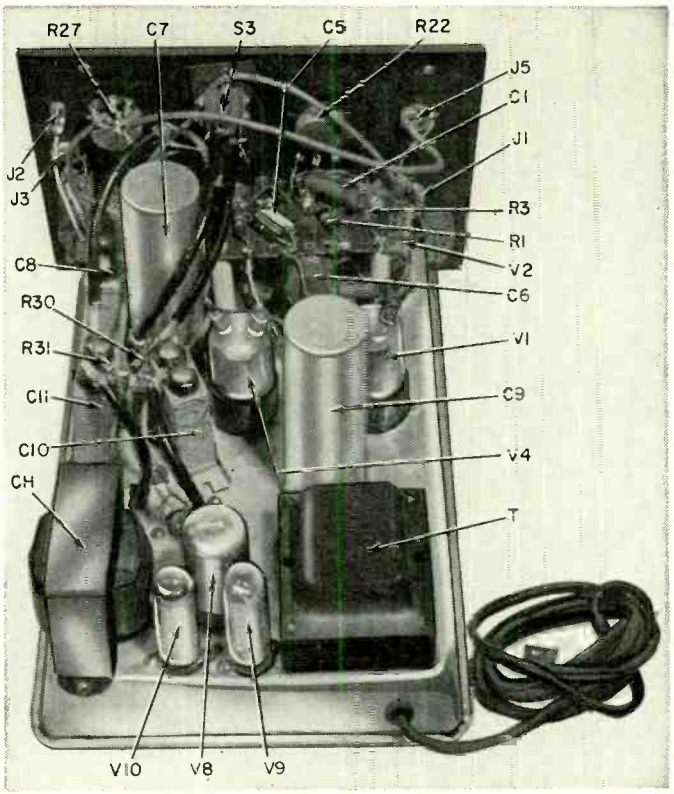
I used 7193's for V1, V2, V3 and V4 because their grid and plate terminals, being top caps, permit assembling the multivibrator and the switching couplings above the chassis. The cathode connections to the switched amplifier tubes (V6 and V7) are made under the chassis. The 954 pentodes (V6 and V7) and the triode-connected 954 (V5) provide above-chassis grid circuitry and below-chassis plate and cathode circuitry. This simplifies shielding and circuit separation problems that can arise in a unit in which circuit functions should be kept separate.

The 7193's and the 954's can be purchased from surplus houses at very low prices. However, current tube types which may be used instead are listed in the chart.

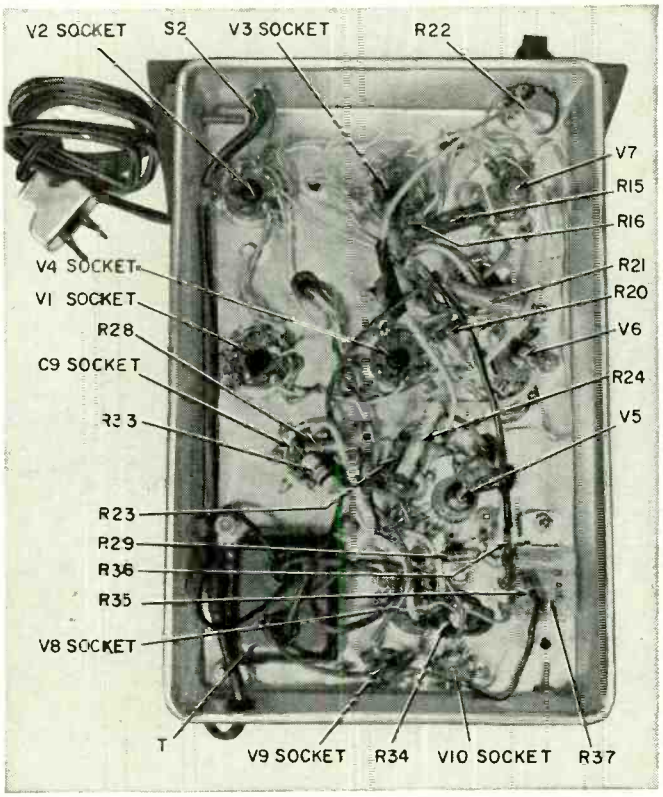
The resistor pairs R1–R2, R3–R4, R5–R9, R6–R10, R7–R11, R8–R12 and R16–R20, and capacitors C1 and C2 may be matched to provide a symmetrical square-wave output and uniform switching periods for the amplifier outputs. For all practical purposes, however, precise matching and exact uniformity of switching times are of little importance. Resistors R28 and R29 should be matched to provide uniform output from the B channel in the "−" and "+" phasing positions of S3.

The voltage regulation provided by R34 and V9 and V10 is an important feature of the circuit, since variations in the multivibrator's plate supply cause erratic variations in switching time. Variations in plate or screen supply voltages to V6 and V7 cause similarly erratic variations in amplitude and alignment of the channel outputs. Resistors R35, R36 and R37 provide a positive heater bias, balanced with respect to the heater supply, that suppresses the tendency toward heater–cathode leakage.

Aside from these elements, the only special feature in the unit's construction is the use of shielded leads from the input terminals (J1 and J5) to the gain-control potentiometers (R26 and R27) and from the phasing switch (S3) to the channel-B tubes (V5 and V6). The shielded leads reduce pickup of stray transients from the multivibrator. Without the shielded leads, pickup is not likely to be large but may tend to blur the channel output images near the switching points.



Grid and plate caps of V1 and V2 permit mounting multivibrator components above the chassis.



The Acorn tubes (V5, V6 and V7) are mounted upside down, under the chassis.

As shown in the photos, the electronic switch is built on a bread-pan chassis.[2] A Masonite panel is attached to one end and the works are enclosed in a cabinet with wood top and bottom and Masonite sides.

Checking the finished unit

When the electronic switch is completed, it can be checked by connecting the A- and B-channel inputs to an audio oscillator and watching the output of the switch on a scope. With the master control unit (March, 1958), connect the AMPLIFIER IN and OUT ungrounded terminals (J12 and J14) together and set the LOAD switch (S4) in the SPEAKER position with the

SPEAKER terminals free. With this setup and with the A- and B-channel gain controls (R26 and R27) of the electronic switch at zero, adjusting the BALANCE control (R22) should provide a single straight horizontal trace at the center position and square waves with the BALANCE control on either side of center position and square waves with is adjustable between approximately 10 and 2,000 cycles. The character of the square-wave images depends on the scope's amplifier and attenuator structure but it should be fairly good with the scope's gain set at maximum and the electronic switch BALANCE control adjusted to give a square wave of moderate amplitude on the screen of the scope.

For comparing the amplifier's channel outputs, the GAIN controls (R26 and R27) can be adjusted to give outputs of identical amplitude and the two patterns aligned (Fig. 3) or separated (Fig. 4) by adjusting the BALANCE control. For stationary patterns of this type, the scope's sync control should be set to the external position and the external sync terminal connected to the AMPLIFIER IN ungrounded terminal (J12) of the master control unit. This permits locking the scope's sweep to the frequency of the signal being observed, because using the internal sync will often lock the sweep to the switching frequency of the electronic switch.

This effect can occur even in the balanced output position, due to small pulses which occur with the switching action. Switching the B PHASING (S3) from "+" to "−" reverses the phase of the B-channel output, providing a simple way to identify the two images being compared. The frequency controls (COARSE and FINE—S1 and R13) can be adjusted to give traces of varying length in each channel image. If the frequency is adjusted to some multiple of the sweep frequency, the switching patttern will be stationary, but slight frequency drifts in the switch multivibrator will usually cause such a pattern to be unsteady. For effective comparison of the output images, a stationary switching pattern is a disadvantage. Adjustment of the FINE FREQUENCY CONTROL (R13) to provide minimum coincidence of switching patterns will give switched images of apparent continuity, with a very dim background haze, formed by the moving switching traces.

The frequency response of the amplifier channels of the electronic switch is moderately limited—approximately uniform from 10–10,000 cycles, and down less than 25% at 25,000 cycles. Although this may seem ineffective for high-quality amplifier checking, it is not—the two channels are essentially identical in response and can be used

TUBE CHART

V1, V2, V3, V4
7193, 6J5, one half 6SN7, one half 6CG7

V5
954 (triode-connected), 6SJ7 (triode-connected), 6J7 (triode-connected), one half 6SN7, one half 6CG7, 6J5, 6C4.

V6, V7
954, 6SJ7, 6J7

R1, 2, 24, 33, 35, 36—47,000 ohms, 2 watts
R3, 4—12,000 ohms
R5, 9—220,000 ohms
R6, 10, 15, 19, 30, 31, 32—1 megohm
R7, 11—3.9 megonms
R8, 12—18 megohms
R13, 22—pot, 100,000 ohms, 2 watts or higher, linear taper
R14, 18—2.2 megohms
R16, 20—2,200 ohms, 1 watt
R17—10,000 ohms, 5 watts
R21, 25—100,000 ohms, 1 watt
R23—22,000 ohms, 1 watt
R26, 27—pot, 500,000 ohms, 2 watts or higher, logarithmic taper
R28, 29—1,500 ohms, 1 watt
R34—1,000 ohms, 5 watts
R37—200 ohms, ct or adjustable with slider, 10 watts
All resistors ½-watt 10% unless noted
C1, 2—.001 μf
C3, 6—0.25 μf
C4, 5—100 μμf
C7—10-10 μf, 450 volts, electrolytic
C9—60-40-20 μf, 450, electrolytic
C8, 10, 11—1 μf, 450 volts
All capacitors 600 volts unless noted
CH—16 h, 50 ma (Stancor C1003 or equivalent)
J1, 3, 5—coaxial connectors
J2, 4—binding posts
S1—2-pole 4-position rotary
S2—spst toggle
S3—spdt nonshorting rotary
T—power transformer: primary 117 volts; secondary 480 volts ct, 50 ma; 6.3 volts, 2.5 amps (Merit P3047 or equivalent)
V1, 2, 3, 4—7193 (see text)
V5, 6, 7—954 (see text)
V8—7Y4
V9—OA2
V10—OB2
Sockets, octal (4)
Sockets, acorn (3)
Sockets, 7-pin miniature (2)
Socket, loctal
Pilot-lamp assembly with No. 47 bulb
Chassis, bread pan 7x11 inches
Miscellaneous hardware

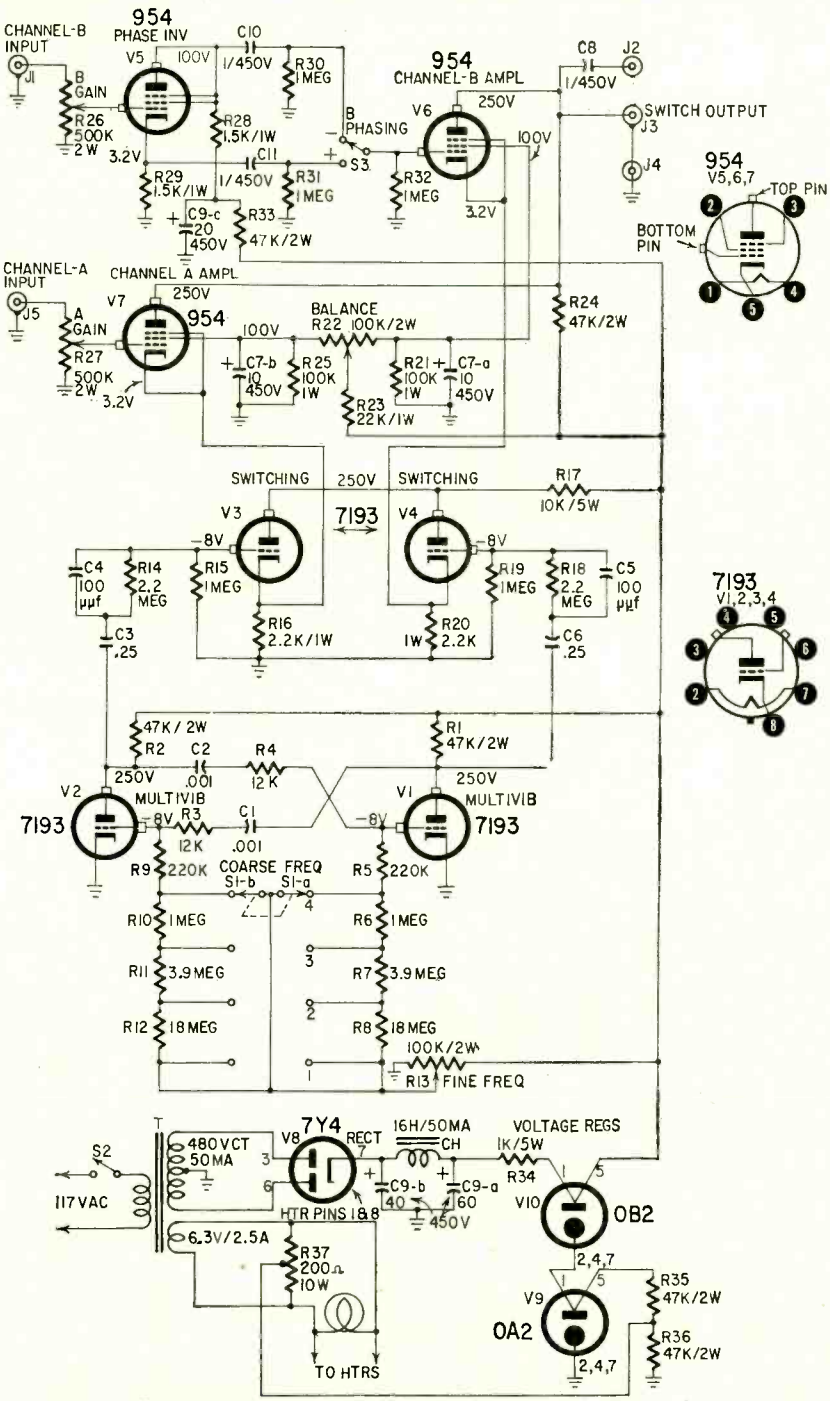


Fig. 2— Circuit of the 9-tube unit is straightforward

effectively for comparative display of sine-wave patterns at frequencies up to 150,000 cycles. Each amplifier channel can be checked by removing the switching tube (V3 and V4) and pentode (V6 or V7) of the channel not being checked. This is the only simple way to set up such a test since, under switched operating conditions, the inactive amplifier is biased to cutoff and the switching tube with its cathode connected to the active amplifier pentode cathode is cut off by a negative grid pulse from the multivibrator.

Using the electronic switch

With the electronic switch completed and checked out, it is incorporated into the amplifier test setup by connecting the CHANNEL A input to the input of the amplifier under test, the CHANNEL B input to the output of the amplifier (across its output load) and the SWITCH OUTPUT to the scope's vertical input. With the master control unit described in the March, 1958, article of this series, these connections are provided by connecting the three cable connection terminals to the corresponding master control terminals and setting the scope switch to the electronic switch position.

During any test, except intermodulation, the electronic switch, with GAIN, BALANCE and PHASING properly set, will provide input and output waveforms for visual comparison superimposed (Fig. 3) or separated (Fig. 4), in phase (Fig. 5) or with opposite phasing (Fig. 6). Distortion introduced by the amplifier—differences in waveform between input and output—are more easily recognized by this comparative display than by alternate viewing.

One basic test of amplifier performance—phase shift introduced by the amplifier—is easily made by using the electronic switch and an oscilloscope. The phase shift, in degrees, introduced at a given frequency is determined by measuring the horizontal displacement between the input and output wave images, dividing this displacement by the wavelength (length of the image of 1 cycle) of the images and multiplying the result by 360. These values are determined by adjusting the GAIN controls of the electronic switch to provide input and output images of identical amplitude, permitting both the wavelength and the displacement to be measured along any horizontal line on the oscilloscope pattern (see Figs. 7 and 8). If nonlinearity of the scope's sweep tends to compress part of the image, sweep frequency should be reduced and amplitude increased to provide patterns running over several cycles, and the measurements made in the portion of the image where sweep nonlinearity is minimum.

Phase shift in itself is of little significance with regard to an amplifier's sound-reproduction quality, but it is a critical element in the use of feedback which most high-quality amplifiers employ. In any amplifier, the phase shift as well as the amplitude response varies with frequency and, to avoid oscillation in the amplifier, gain around the feedback loop (open, not closed loop) must be less than 1 at any frequency at which the phase shift is 180°.[3] For definite stability this gain must remain less than 1 for all frequencies with phase shift above 180°.

Using the electronic switch as a square-wave generator for audio amplifier appraisal is possible with the help of the master control unit. Transfer the amplifier input leads from the master control terminals to the binding-post terminals of the electronic switch and set the OSCILLOSCOPE switch to the VOLTMETER position, and the VOLTMETER switch to the OUT position. No provision was made in the master control unit for switching the square-wave output of the electronic switch into the amplifier input because square-wave testing[4] is essentially qualitative and is less accurate, less definitive and more complicated in interpretation than the specific tests described in this series. END

[1] Prior articles in this series—"Build This Amplifier–Rectifier Vtvm for Audio Testing," October, 1957; "Extended-Range Audio Oscillator," December, 1957; "Wien-Bridge Analyzer," January, 1958; "Master Control Unit for Audio Testing," March, 1958.

[2] L. B. Hedge, "The Bread-Pan Layout," *Audio Engineering*, August, 1953.

[3] F. E. Terman, *Radio Engineers Handbook*, 1943, page 396.
F. Langford-Smith, *Radiotron Designer's Handbook*, 1952, pages 356–59.

[4] E. J. Thompson, "Square-Wave Analysis for Audio Amplifiers," RADIO-ELECTRONICS, July, 1950.
T. F. Crook, "Looking at Square Waves," *Wireless World*, August, 1956.

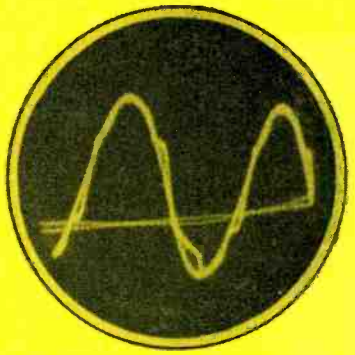


Fig. 3—Sine wave at amplifier input superimposed on distorted output waveform.

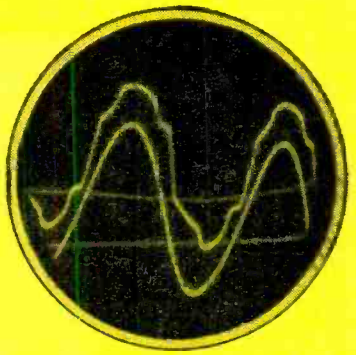


Fig. 4—Separated display of signals shown in Fig. 3.

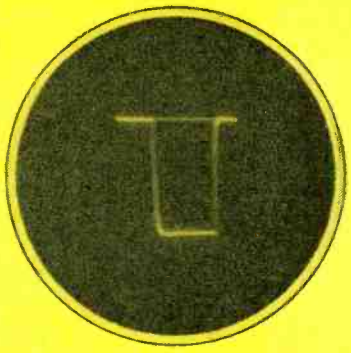


Fig. 5—Two signals exactly in phase appear as one trace.

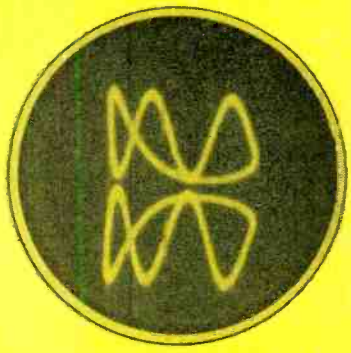


Fig. 6—Flipping the phase switch reverses the B channel signal.

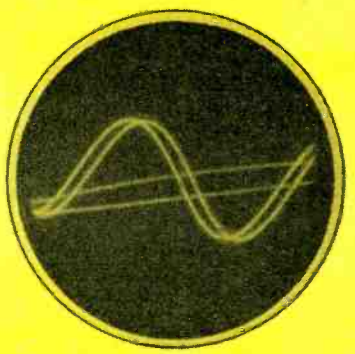


Fig. 7—Phase shift shown in this display is about 25°.

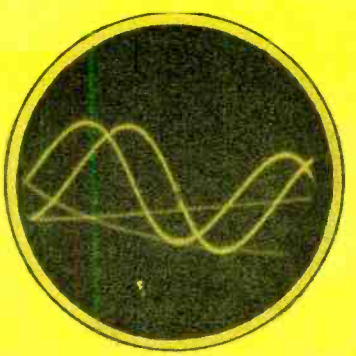
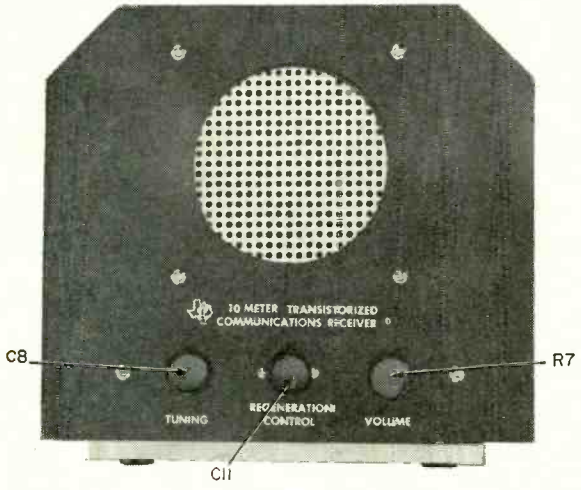


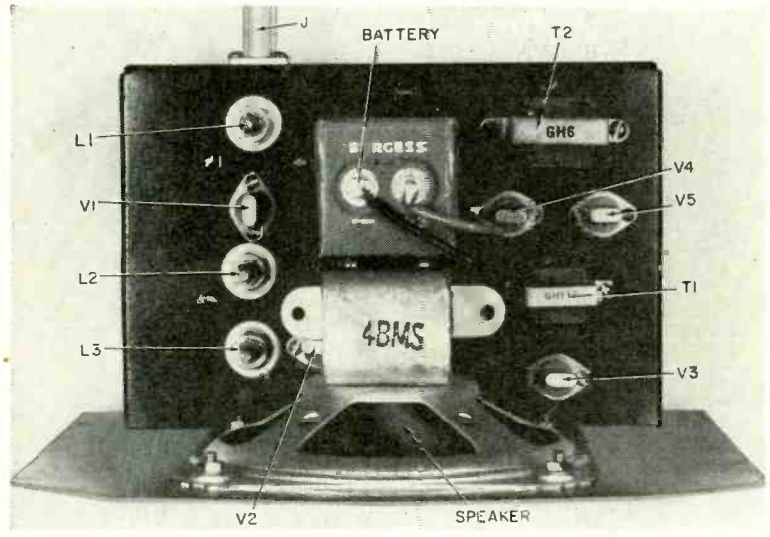
Fig. 8—Another phase-shift test display. The phase shift is about 68°.

TRANSISTORS for 10 meters

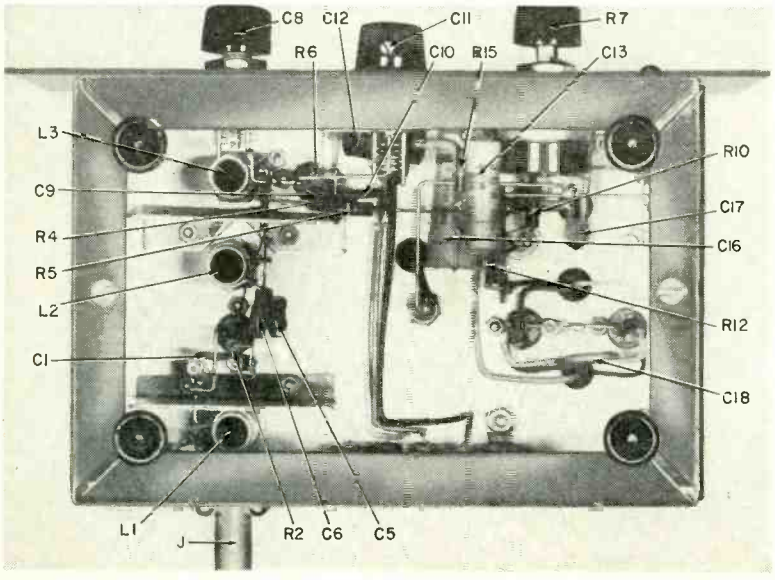
Five-transistor unit puts a portable 10-meter receiver in your hands

By DON HALL, W5OBS*





(Above) The finished unit. ↑ ↓ (Below) The preferred layout.



AFTER being confined to the laboratory, audio and broadcast radio, for the first few years of its life, the transistor is finding its way into the hamshack. Because it is a new device to the ham, many have hesitated to make full use of transistors in their gear.

This article describes a 10-meter receiver that uses low-cost readily available transistors. The set's performance is not equal to that of a large communications receiver, but is good enough to provide the builder with a useful unit. A 5-μv signal is plainly audible, and the inherent limiting action of the superregenerative detector keeps the output constant over a wide range of input signals. Noncritical circuitry and ease of adjustment make this receiver ideal for the ham just getting started with transistor circuitry.

Receiver circuit

A block diagram of the receiver is shown in Fig. 1. Functionally, it is no different than a comparable vacuum-tube set. The receiver consists of an

* Circuit Development Engineer
Texas Instruments, Inc.

BENCH R-E TESTED

When conditions are right, there is no limit to the distance possible on the 10-meter band. Listening tests show that this little set can really reach out. Within a short time after starting it up, phone hams had been picked up coast to coast and from South America.

Selectivity is less favorable. A single strong station can completely blot out several weak ones on other frequencies. Also, the regeneration control affects frequency, so it should not be touched after being set to optimum.

During the tests, a noiselike kind of distortion made it impossible to understand strong stations. It was cured by placing a large electrolytic (250 μf at 25 volts) across the battery.

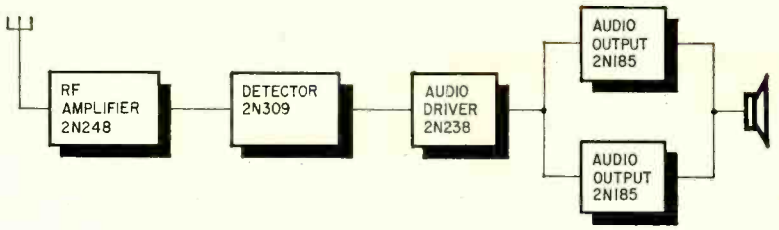


Fig. 1—Block diagram of the all-transistor set.

rf amplifier, superregenerative detector, audio driver and push-pull audio output stages.

Fig. 2 shows the receiver's circuit. The rf stage uses a 2N248 in a common-emitter amplifier circuit. The input from the antenna is connected to a tap on the coil in the base circuit. The coil's tuning is very broad because of the base circuit's input resistance. Resistors R1 and R3 set the base-bias voltage. R2 maintains the desired emitter current. The collector tuned circuit consists of L2 and C5.

Coils L2 and L3 are not inductively coupled. The shield shown in the schematic helps insure this. Capacitor C6 acts as a coupling between the two coils. As its value goes up, the coupling decreases.

The superregenerative detector uses an easily adjusted circuit that is very tolerant of transistors. A 2N309 is used here. Though intended for 455-kc if amplifier circuits, it works well as an oscillator in the 10-meter range. A 2N248 may also be used here if desired, but is more expensive. The circuit is basically a grounded-base oscillator with an R-C timing network (R5 and C9) providing the quench frequency for superregenerative operation. The capacitor from collector to emitter, C11, controls the feedback. It is adjusted to insure oscillation over the entire band. Audio output from this stage is taken across the emitter resistor R6.

The audio signal contains a large amount of the quench frequency, which would tend to overload the following audio stages. A simple filter consisting of R15 and C13 removes most of the quench voltage and allows the desired audio to pass on to the volume control.

The audio driver stage uses a 2N238. Biasing network R8, R9 and R10 operates in the same manner as its counterpart in the rf stage. A transformer couples this stage to the push-pull output. Capacitor C17 helps to attenuate any quench-frequency signal which was not eliminated at the stage's input.

The output stage is operated class B to provide plenty of power when needed, while keeping the average battery drain low. Any size speaker may be used. The maximum audio output is 250 milliwatts, more than adequate for good room volume.

The TUNING, REGENERATION and VOLUME controls are mounted on the front panel. The REGENERATION control could be made a small trimmer capacitor since it is seldom touched in normal operation. A small speaker may be used, but will not be as efficient as somewhat larger ones.

Final steps

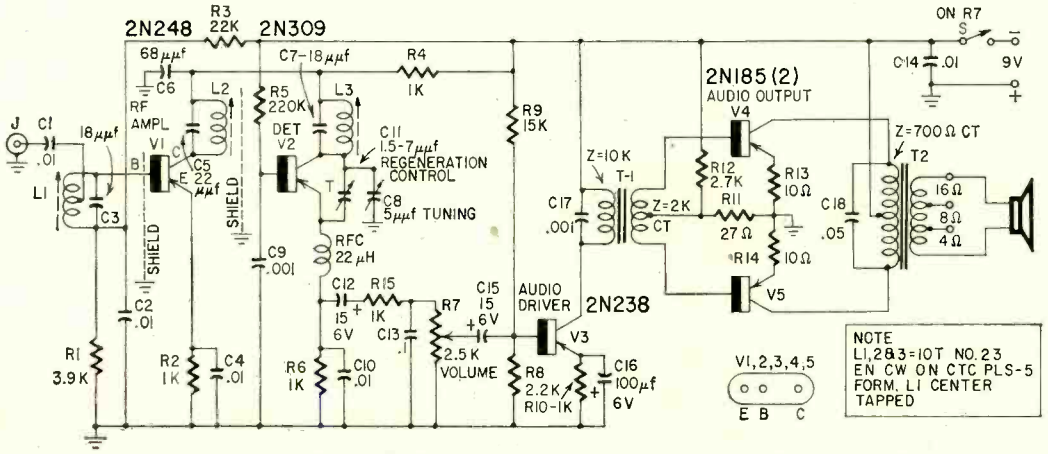
Adjusting of the receiver is simple. With power on, a hiss should be heard from the speaker. If not, vary the REGENERATION control until you hear the hiss indicating the detector is operating. A 28-mc signal from either a grid-dip meter or other signal source should be applied to the antenna input. With C8 set for maximum capacitance, adjust the slug in L3 until the signal is heard. While tuning C8 through its entire range, the hiss should continue, indicating detector operation over the whole band.

Apply a 29-mc signal and tune it in. Adjust the slugs in L1 and L2 for maximum signal. This completes the alignment, making the receiver ready to use. A couple of details might be mentioned at this point. Varying the regeneration control will change the detector's frequency, but once this control is set it need not be changed. The tuning of L1, as mentioned previously, is very broad.

The set's performance is quite startling, considering its size and power consumption. Several types of antennas have been used, ranging from a mobile whip to a pair of TV rabbit ears. Good signals have been heard with all of them. The input is designed for a 50-ohm unbalanced line and the receiver works best with a good antenna.

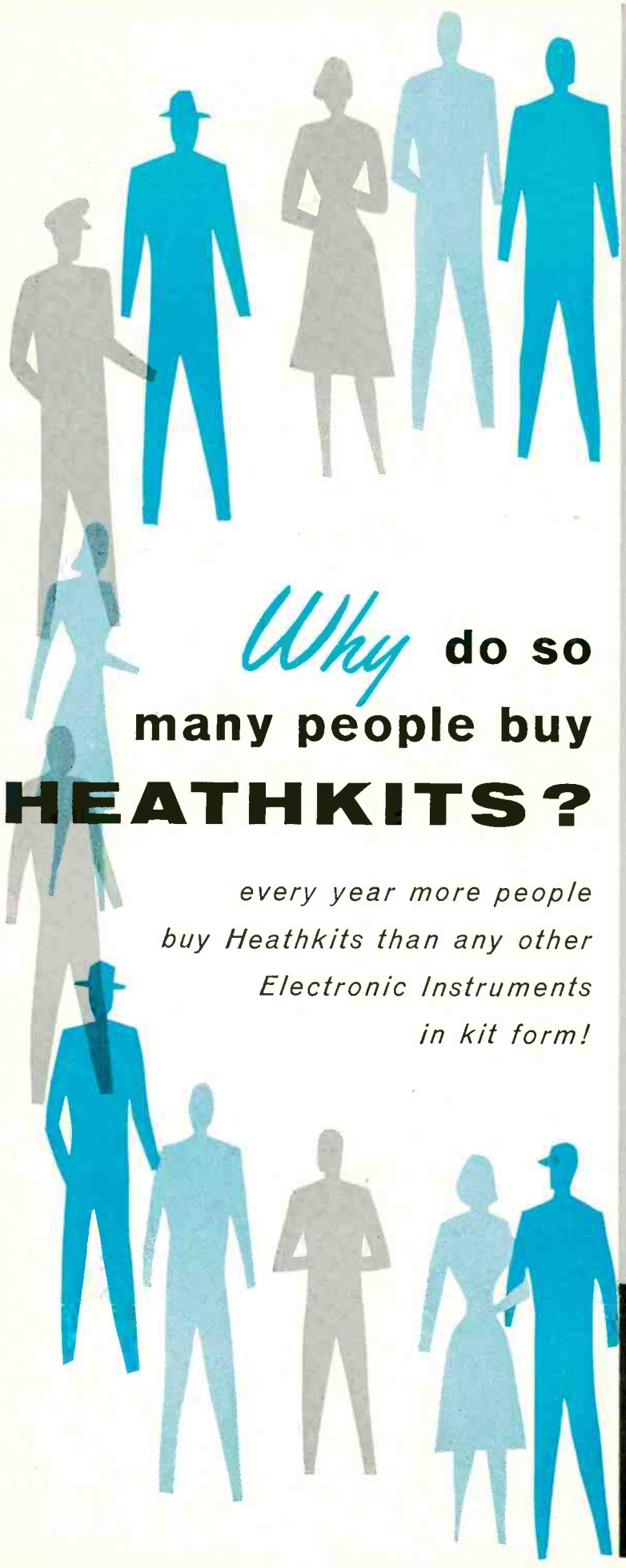
This transistor set cannot compete with a good communications receiver, and loud signals tend to capture the set to some degree. A large amount of limiting gives avc action which keeps very strong stations from "blasting" the speaker.

If you want to gain some experience with transistors and at the same time build a very useful addition to your ham gear, I highly recommend this little receiver. It will provide many hours of good 10-meter listening. END



R1—3,900 ohms
R2, 4, 6, 10, 15—1,000 ohms
R3—22,000 ohms
R5—220,000 ohms
R7—pot, 2,500 ohms, audio taper, with spst switch
R8—2,200 ohms
R9—15,000 ohms
R11—27 ohms
R12—2,700 ohms
R13, 14—10 ohms
All resistors ½-watt 10% unless noted
C1, 2, 4, 10, 14—.01 μf, ceramic
C3, 7—18 μμf, mica or ceramic
C5—22 μμf, mica or ceramic
C6—68 μμf, mica or ceramic
C8—5 μμf, variable
C9, 17—.001 μf, ceramic
C11—1.5-7 μμf, trimmer
C12, 15—15 μf, 6 volts, electrolytic
C13—0.1 μf, paper
C16—100 μf, 6 volts, electrolytic
C18—.05 -f, ceramic
J—coaxial connector
L1—10 turns No. 23 enameled wire, close-wound, tapped at 5 turns, on Cambridge Thermionic PLS-5 form with green slug
L2, 3—10 turns No. 23 enameled wire, close-wound on Cambridge Thermionic PLS-5 form with green slug
T1—driver transformer: primary, 10,000 ohms; secondary, 2,000 ohms ct (Gramer-Halldorson GH117 or equivalent)
T2—output transformer: primary, 700 ohms ct; secondary, 4, 8 or 16 ohms (Gramer-Halldorson GH6 or equivalent)
V1—2N248 (Texas Instruments)
V2—2N309 (Texas Instruments)
V3—2N238 (Texas Instruments)
V4, 5—2N185 (Texas Instruments)
Speaker
Metal shields (2)
Transistor sockets (5)
Battery, 9 volts (Burgess 2N6 or equivalent)
Miscellaneous hardware

Fig. 2—Low power drain makes portable battery operation practical.



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Only top quality components go into Heathkits, assuring you of a finished product that is unsurpassed in performance, dependability and endurance. Rigid quality control standards are maintained at the Heath factory to see that each component lives up to its advertised specifications. Heathkits are conservatively rated. No performance claims are made that are not thoroughly proven and tested under the most stringent laboratory conditions.

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Benton Harbor 20, Michigan

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TRANSISTOR PORTABLE RADIO KIT

Fun for the whole family, this easy-to-build 6-transistor portable radio is ready to go wherever you go. The modern molded plastic case with pull-out carrying handle and fully enclosed back add beauty and convenience to this splendid kit. Six name-brand (Texas Instrument) transistors are used for good sensitivity and selectivity. The 4" x 6" PM speaker with heavy magnet provides "big set" tone quality. Use of this large speaker and roomy chassis make it unnecessary to crowd components adding greatly to the ease of construction. Transformers are prealigned making the radio ready for use as soon as kit is assembled. A built-in rod-type antenna assures good reception in all locations. Six standard flashlight batteries are used for power, providing extremely long battery life (between 500 and 1,000 hours) and they can be purchased anywhere. Stylish cabinet is two-tone blue molded plastic with gold inlay and measures 9" L. x 7" H. x 3¾" D. Shpg. Wt. 6 lbs.

MODEL XR-1L: Identical to XR-1P except in handsome leather case instead of plastic case. Leather carrying strap included. Shpg. Wt. 7 lbs.

LEATHER CASE: Can be purchased separately if desired. Fits all XR-1P and earlier XR-1 chassis. No. 93-1. Shpg. Wt. 3 lbs. **$6.95.**

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MODEL XR-1L **$34.95**

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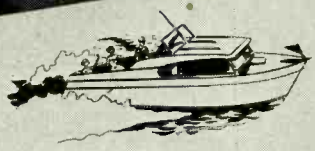
HEATHKIT MODEL DF-2 **$69.95**



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Enjoy the safety, convenience and entertainment of this self-contained, self-powered, six-transistor superheterodyne radio direction finder. It receives aeronautical and marine beacons as well as standard band broadcasts with startlingly clear tone reproduction over a long range. Covering the beacon band from 200 to 400 kc and broadcast band from 540 to 1620 kc, the DF-2 is designed to take directional "fixes" on both aircraft and marine beacons as well as standard broadcast stations, while providing the entertainment of a high quality transistor portable radio. You are able to receive aircraft weather reports every thirty minutes and constant Coast Guard beacons on the 200 to 400 kc band. A dial light is provided for night operation. Power is supplied by six standard flashlight batteries which will last you up to one year under normal operation. Shpg. Wt. 9 lbs.

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POWER CONVERTER KIT

Now you can operate your TV set, radio, razor, and other AC electrical equipment directly from your 12-volt boat or car battery. With the Heathkit Power Converter you can enjoy the convenience of home electricity whether boat cruising or on automobile trips. Two power transistors are employed for years of trouble-free, dependable service. No moving parts to wear out, no tubes to replace. Shpg. Wt. 8 lbs.

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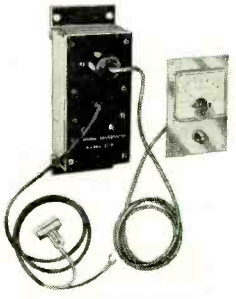
Ideal for use on automobiles, boats, aircraft engines, etc., the IA-1 checks ignition systems with the engine in operation (400 to 5,000 RPM). Shows the condition of coil, condenser, points, plugs and ignition wiring. Shows complete engine cycle or just one cylinder at a time. Two test leads are supplied, each 10' long, which will enable you to reach either the breaker points or the spark plug wires. Shpg. Wt. 20 lbs.



MODEL TI-1 **$25.95**

ELECTRONIC TACHOMETER KIT

Useful on inboard and outboard boats, as well as in automobiles, the TI-1 operates directly from the spark impulse of the engine. Use on any spark ignited 2 or 4 cycle engine of any number of cylinders. Completely transistorized, it works with 6, 8, 12, 24 or 32 volt DC systems. Indicates revolutions-per-minute from 0 to 6,000. Calibration control provided for adjusting to engine type. Easy-to-build and easy-to-install. Shpg. Wt. 4 lbs.

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Laboratory quality at utility scope price makes this instrument an unusual value. The Heath patented sweep circuit functions from 10 CPS to better than 500 kc in five steps, giving you five times the usual sweep obtained in other scopes. Vertical frequency response extends from 3 CPS to 5 mc +1.5 db —5 db without extra switching. An automatic sync circuit with self-limiting cathode follower provides excellent linearity and lock-in characteristics. Extremely short retrace time and efficient blanking action are characteristic of this scope. Frequency response of the horizontal amplifier is within ±1 db from 1 CPS to 200 kc. Horizontal sensitivity is 0.3 volts RMS-per-inch. Construction is simplified through the use of two etched metal circuit boards and precut, cabled wiring harness. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. An ideal scope for all service applications as well as in standard or color TV servicing. Shpg. Wt. 22 lbs.

MODEL SG-8 **$19.50**

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A "must" for any beginning serviceman, this indispensable instrument is used for aligning tuned circuits quickly and tracing signals in faulty RF, IF and audio circuits. Covers 160 kc to 110 mc on fundamentals in five bands and from 110 mc to 220 mc on calibrated harmonics. Coils are prewound and calibrated. Complete with output cable and instructions. Shpg. Wt. 8 lbs.

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This unique generator uses three rotary switches to select two significant figures and a multiplier to determine audio frequency, allowing return to the exact frequency previously measured when making multiple frequency measurements. Covers 10 CPS to 120 kc with less than .1 of 1% distortion between 20 and 20,000 CPS. Shpg. Wt. 10 lbs.

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TV service technicians will appreciate the outstanding features found in this sweep generator. Provides essential facilities for aligning FM, monochrome TV or color TV sets. The all-electronic sweep circuit employs a trouble-free controllable inductor which varies frequency by magnetic means. An unusual buy at this low price. Shpg. Wt. 16 lbs.

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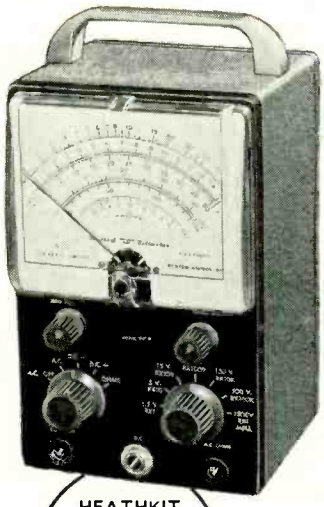

HEATHKIT MODEL V7-A **$25.95**

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HANDITESTER KIT

Ideal for use in portable applications when making tests away from the work bench or as an "extra" meter in the service shop. The combination function range switch simplifies operation. Measures AC or DC voltage from 0 to 10, 30, 300, 1,000 and 5,000 volts. Direct current ranges are 0 to 10 ma and 0 to 100 ma. Ohmmeter ranges are 0 to 3,000 and 0 to 300,000. Top quality, precision components used throughout. Small and compact, take it with you wherever you go. Very popular with home experimenters and electricians. Test leads and 1½ volt size C battery are included with the kit. Shpg. Wt. 3 lbs.

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20,000 OHMS/VOLT VOM KIT

Portable and accurate, this kit features a 50 ua 4½" meter and 1% precision multiplier resistors for high accuracy. No external power required. Provides a total of 25 meter ranges on a two-color scale. Sensitivity is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1,500 and 5,000 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. Covers —10 db to +65 db. Housed in an attractive bakelite case with plastic carrying handle. Batteries and test leads included. Shpg. Wt. 6 lbs.

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Brand new in every respect, the TC-3 features outstanding performance and ease of operation. Sockets are provided for 4-pin, 5-pin, 6-pin, 7-pin, large, 7-pin miniature, 7-pin sub-miniature, octal, loctal, and 9-pin miniature tubes. Protection against obsolescence is provided by a blank socket to facilitate modification for checking newly added tube types. A 10-lever switch makes it possible to connect any element to any other element regardless of the pin numbers involved. A neon bulb indicator shows filament circuit continuity and leakage or shorts between elements. A specially designed spring loaded roll chart mechanism permits the roll chart to run freely throughout its entire length without binding. Thumb wheel drive knobs are provided on both sides of the panel to accommodate the left handed operator. Compact and small in size, the TC-3 is ideally suited for portable applications. Both the roll chart and the meter are illuminated to facilitate use in darkened areas. Shpg. Wt. 12 lbs.

HEATHKIT MODEL TC-3 **$39.95**

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This vacuum tube volt meter emphasizes stability, broad frequency response and sensitivity for accurate measurement of critical AC voltages. Features a large 4½" 200 ua meter with increased damping in the meter circuit for stability in low frequency tests. Measures AC from a low value of 1 millivolt to a maximum of 300 volts AC (RMS). Voltage ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover —52 to +52 db. 1% precision multiplier resistors used for maximum accuracy. Frequency response is essentially flat from 10 CPS to 200 kc. Shpg. Wt. 6 lbs.

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This handy kit checks capacitors for "open" or "short" right in the circuit. Detects open capacitors from about 50 mmf, not shunted by an excessive low resistance value. Checks shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). Checks all bypass, blocking and coupling capacitors of the paper, mica or ceramic types. (Does not detect leakage nor check electrolytic condensers.) Electron beam "eye" tube is used for quick indication. A 5-position function switch is featured which controls the power to the instrument and selects the test being made. Easy to build and easy to use. Test leads included Shpg. Wt. 5 lbs.

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Completely up to date the BE-5 will power all the newest transistor circuits requiring 0 to 12 volts DC, and the new hybrid automobile radios using both transistors and vacuum tubes. An extra low-ripple filter circuit is employed holding AC ripple down to less than .3%. Doubles as a battery charger or marine converter. Shpg. Wt. 21 lbs.

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New in every respect the T-4 features a built-in speaker and electron beam "eye" tube for signal indication, and a unique noise locator circuit. Ideal for use in AM, FM and TV circuit investigation. Transformer operated for safety and high efficiency. Complete with test leads and informative construction manual. Shpg. Wt. 5 lbs.

MODEL C-3 **$19.50**

CONDENSER CHECKER KIT

Check unknown condenser and resistor values quickly and accurately as well as their operating characteristics with this fine instrument. All values are read directly on a calibrated scale. An electron beam "eye" tube indicates balance and leakage. A valuable addition to any service shop or lab. Shpg. Wt. 7 lbs.

"APACHE" HAM TRANSMITTER KIT

HEATHKIT MODEL TX-1 **$234.95**

- Built-in cooling fan
- Rotating Slide Rule Dial
- Compact, Stable, VFO
- Provision for SSB Adapter

$50.00 required on C.O.D. orders. Shipped motor freight unless otherwise specified.

This beautifully styled transmitter has just about everything you could ask for in transmitting facilities. The "Apache" is a high quality transmitter operating with a 150 watt phone input and 180 watt CW input. In addition to CW and phone operation, built-in switch selected circuitry provides for single-sideband transmission through the use of a plug-in external adapter. A completely redesigned, compact and stable VFO provides low drift frequency control necessary for SSB transmission. A slide rule type illuminated rotating VFO dial with full gear drive vernier tuning provides ample bandspread and precise frequency settings. The bandswitch allows quick selection of the amateur bands on 80, 40, 20, 15 and 10 meters (11 m with crystal control). This unit also has adjustable low-level speech clipping and a low distortion modulator stage employing two of the new 6CA7/EL34 tubes in push-pull class AB operation. Time sequence keying is provided for "chirpless" break-in CW operation. The final amplifier is completely shielded for greater TVI protection and transmitter stability. A formed one-piece cabinet with convenient access hatch provides accessibility to tubes and crystal socket. Die-cast aluminum knobs and front panel escutcheons add to the attractive styling of the transmitter. Pi network output coupling matches antenna impedances between 50 and 72 ohms. A "spotting" push button is provided to allow tuning of the transmitter before switching on the final amplifier. This feature also enables the operator to "zero-beat" an incoming frequency without placing the transmitter on the air. Equip your ham shack now for top transmitting enjoyment with this outstanding unit. Shpg. Wt. 110 lbs.

New Styling...
New Features

HEATHKIT

HEATH COMPANY
Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

HEATHKIT MODEL SB-10 **$89.95**

SINGLE SIDEBAND ADAPTER KIT

Designed as a compatible plug-in adapter for the model TX-1 it can also be used with transmitters similar to the DX-100 or DX-100-B by making a few simple circuit modifications and still retain the normal AM and CW functions. Easy to operate and tune, the adapter employs the phasing method for generating a single sideband signal, allowing operation entirely on fundamental frequencies. The critical audio phase shift network is supplied, completely preassembled and wired in a sealed plug-in unit. Features include single-knob bandswitching for operation on 80, 40, 20, 15 and 10 meters, an easy-to-read panel meter, built-in electronic voice control with anti-trip circuit. Enjoy the advantages of SSB operation by adding this fine kit to your ham shack now. Shpg. Wt. 14 lbs.

MODEL DX-100-B **$189.50**

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

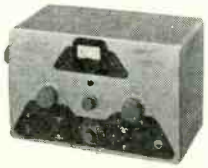
DX-100-B PHONE & CW TRANSMITTER KIT

The same fine performance of the time proven DX-100 is retained in the DX-100-B with improvements in the crystal and loading circuits. The one-piece formed cabinet has convenient access hatch for changing crystals, etc. and the chassis is punched to accept sideband adapter modifications. Features a built-in VFO, modulator and power supply, complete shielding to minimize TVI, and a pi network output coupling to match impedances from 50 to 72 ohms. RF output is in excess of 100 watts on phone and 120 watts on CW. Covers 160 through 10 meters. Single-knob bandswitching and illuminated VFO dial and meter face. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. Designed for easy assembly. Measures 11⅝" H. x 19½" W. x 16" D. Shpg. Wt. 107 lbs.

MODEL DX-40 **$64.95**

DX-40 PHONE & CW TRANSMITTER KIT

Operates on 80, 40, 20, 15, 11 and 10 meters, using a single 6146 tube in the final for 75 watt plate power input CW, or 60 watts phone. Single-knob bandswitching, pi network output, complete shielding, provision for three crystals and VFO. D'Arsonval movement panel meter. Shpg. Wt. 25 lbs.



MODEL DX-20 **$35.95**

DX-20 CW TRANSMITTER KIT

This fine unit covers 80, 40, 20, 15, 11 and 10 meters with single-knob bandswitching. Features a 6DQ6A tube in the final for 50 watt plate power input, pi network output, complete shielding to minimize TVI. Easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

"MOHAWK" HAM RECEIVER KIT

Designed for ham band operation and for maximum stability and accuracy, the Heathkit "Mohawk" receiver will let you enjoy ham activities to the utmost. This 15-tube receiver features double conversion with IF's at 1682 kc and 50 kc and covers all the amateur frequencies from 160 through 10 meters on seven bands. An extra band is calibrated to cover 6 and 2 meters using a converter. The "Mohawk" is specially designed for single-sideband reception with crystal controlled oscillators for upper and lower sideband selection. A completely pre-assembled, wired and aligned front end coil /bandswitch assembly assures ease of construction and top performance. Many more important features are provided in this outstanding receiver for dependable and effective amateur communications. Ruggedly constructed with well rated components throughout. Shpg. Wt. 66 lbs. Matching accessory speaker kit; optional extra. Model AK-5. $9.95. Shpg. Wt. 8 lbs.

- **Prewired and Aligned Coil/Bandswitch Assembly**
- **Crystal Controlled Oscillators for Drift-Free Reception**

HEATHKIT MODEL RX-1 **$274.95**

HEATHKIT MODEL AR-3 **$29.95**

(LESS CABINET)

ALL-BAND RECEIVER KIT

A fine receiver for the beginning ham or short wave listener. Frequency coverage is from 550 kc to 30 mc in four bands. Features include bandswitch, bandspread tuning, phone-standby-CW switch, antenna trimmer, noise limiter, RF and AF gain controls and headphone jack. Easy to build. Shpg. Wt. 12 lbs.

MODEL QF-1 **$9.95**

"Q" MULTIPLIER KIT

Use with any receiver with IF frequency between 450 and 460 kc to add additional selectivity for separating two signals or to reject one signal and eliminate heterodyne. A great help on crowded phone and CW bands. Not for use with AC-DC type receivers. Simple to connect with cable and plugs supplied. Shpg. Wt. 3 lbs.

"SENECA" VHF TRANSMITTER KIT

Brand new in every respect, the model VHF-1 "Seneca" is the latest addition to our line of ham transmitters. This self-contained 6 and 2 meter transmitter features built-in VFO, modulator, and dual power supply. A pair of 6146 tubes are employed in the push-pull final amplifier stage and features up to 120 watts input on phone and 140 watts input on CW in the 6 meter band. Slightly less in the 2 meter band to prolong amplifier tube life. Panel controls allow VFO or crystal control, phone or CW operation on both amateur bands. Four switch-selected crystal positions. Complete RF shielding to minimize TVI. Spotting push-button provided. The VFO slide rule type dial features edge-lighting and vernier tuning. An ideal transmitter for the ham who wants to extend operation into the VHF region. Shpg. Wt. 56 lbs.

HEATHKIT MODEL VHF-1 **$159.95**

MODEL CA-1 **$13.95**

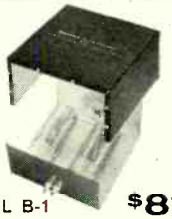
"AUTOMATIC" CONELRAD ALARM KIT

This easy-to-build device gives instant warning and cuts AC power to your transmitter when a monitored station goes "off-the-air". Use with any radio receiver having an AVC circuit. A sensitivity control adjusts to various AVC levels. Incorporates a heavy duty six-ampere relay and manual "reset" button to reactivate the transmitter. Complete instructions provided for connection to receiver. Shpg. Wt. 4 lbs.

MODEL AM-2 **$15.95**

REFLECTED POWER METER KIT

Check the match of your antenna transmission system by measuring the forward and reflected power or standing wave ratio from 1:1 to 6:1. Handles a peak power of well over 1 kilowatt and may be left in antenna feed line. No external power required. 160 through 6 meters. For 50 or 75 ohm lines. Shpg. Wt. 3 lbs.



MODEL B-1 **$8.95**

BALUN COIL KIT

Unbalanced coax lines can be matched to balance lines of either 75 or 300 ohms by using this balun coil kit. Use without adjustment from 80 through 10 meters at power up to 200 watts. May be located any distance from transmitter or antenna. Protective cover included. Shpg. Wt. 4 lbs.

MODEL VX-1 **$23.95**

ELECTRONIC VOICE CONTROL KIT

This unique device lets you switch from receiver to transmitter merely by talking into your microphone. Provision is made for receiver and speaker connections and also for a 117 volt antenna relay. Adjustable to all conditions by sensitivity and variable time delay controls provided. Shpg. Wt. 5 lbs.

MODEL VF-1 **$19.50**

VARIABLE FREQUENCY OSCILLATOR KIT

Far below the cost of crystals to obtain the same frequency coverage this VFO covers 160, 80, 40, 20, 15, 11 and 10 meters with three basic oscillator frequencies. Better than 10 volts RF output on fundamentals. Requires only 250 volts DC at 15 to 20 ma, and 6.3 VAC at 0.45 a. Illuminated dial reads direct. Shpg. Wt. 7 lbs.

Beautifully Styled With Plenty of Room For The Most Complete Stereo System

MODEL SE-1 (center unit) **$149.95** Shpg. Wt. 162 lbs.

MODEL SC-1 (speaker enclosure) **$39.95** each Shpg. Wt. 42 lbs.

STEREO EQUIPMENT CABINET KIT

This superbly styled cabinet ensemble is designed to hold your complete home stereo hi-fi system, consisting of a "stereo equipment center" flanked by two individual "stereo wing speaker enclosures". The unit has room for all the components required for stereo sound. Although designed to hold Heathkit stereo components, it is not frozen to this arrangement. The kit is supplied with mounting panels precut to accommodate Heathkits, but interchangeable blank panels are also furnished so you can mount any equipment you may already have. The precut panels accommodate the Heathkit AM-FM tuner (PT-1), stereo preamplifier (SP-1 & 2), and record changer (RP-3). Record changer chassis pulls out easily for convenient loading and unloading. Adequate space is provided for record storage and a pair of matching Heathkit power amplifiers (from 12 to 70 watts). The stereo wing speaker enclosures are open backed, cloth grilled cabinets designed to hold the Heathkit SS-2 or similar speaker systems. The cabinets are available in beautifully grained ¾" solid core Phillipine mahogany or select birch plywood suitable for the finish of your choice. The matched grain sliding tape deck access door on top pops-up flush when closed. Entire top features a shaped edge. Hardware and trim of brushed-brass and gold finish. Rich toned grille cloth is flecked in gold and black. No woodworking experience required. All parts precut and predrilled for easy assembly. Maximum overall dimensions (all 3 pieces): 82¾" W. x 36½" H. x 20" D. Center Cabinet: 47½" W. x 36½" H. x 20" D.

CHAIRSIDE ENCLOSURE KIT

Combine all of your hi-fi equipment into one compact control center and, at the same time add a beautiful piece of furniture to your home. The CE-1 is designed to house AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier along with the majority of record changers which will fit in the space provided. Changer compartment measures 17¾" L. x 16" W. x 9⅜" D. Adequate space is provided in the rear of the unit to house any of the Heathkit amplifiers designed to operate with the WA-P2. Good ventilation is achieved through properly placed slots in the bottom and back of the enclosure. Overall dimensions are 18" W. x 24"H x 35½" D. All parts are precut and predrilled for easy assembly. The Contemporary cabinet is available in either mahogany or birch, and the Traditional cabinet is available in mahogany suitable for the finish of your choice. Beautiful hardware supplied. Shpg. Wt. 46 lbs.

Plan your own Hi-Fi System...

HEATHKIT

HEATH COMPANY • Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

HIGH FIDELITY RECORD CHANGER KIT

Every outstanding feature you could ask for in a record changer is provided in the Heathkit RP-3, the most advanced changer on the market today. The unique turntable pause during the change cycle saves wear and tear on your records by eliminating the grinding action caused by records dropping on a moving turntable or disk. Record groove and stylus wear are practically eliminated through proper weight distribution and low pivot point friction of the tone arm. Clean mechanical simplicity and precision parts give you turntable performance with the automatic convenience of a record changer. Flutter and wow, a major problem with automatic changers, is held to less than 0.18% RMS. An automatic speed selector position allows intermixing 33⅓ and 45 RPM records regardless of their sequence. Four speeds provided: 16, 33⅓, 45 and 78 RPM. Changer is supplied complete with GE VR II cartridge with diamond LP and sapphire 78 stylus, changer base, stylus pressure gauge and 45 RPM spindle. Shpg. Wt. 19 lbs.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

The popularity of this modestly priced speaker system attests to its high fidelity performance. The SS-2 provides an ideal basic speaker for your home hi-fi system. Flexibility of design allows it to be used as a table top model or as an attractive consolette with optional legs. May also be used as a supplementary speaker in more advanced systems or as replacement speaker for TV sets, etc. The specially designed tweeter horn rotates 90 degrees allowing you to use the speaker in an upright position if desired, as in the Heathkit stereo wing speaker enclosures. Total frequency range is from 50 to 12,000 cycles-per-second. An 8" mid-range woofer covers from 50 to 1,600 CPS while a compression-type tweeter with flared horn covers 1,600 to 12,000 CPS. Both speakers are by Jensen. A variable balance control allows level adjustment of the high frequency speaker. Power rating is 25 watts. Constructed of ½" veneer-surfaced plywood suitable for light or dark finish. All wood parts are precut and predrilled for simple, quick assembly. An added feature of the SS-2 is that, although an outstanding performer in its own right, it may be combined with the SS-1B "range extending" speaker system later to extend the frequency range at the high and low ends of the audio range. Build in just one evening for many years of listening enjoyment. Shpg. Wt. 26 lbs.

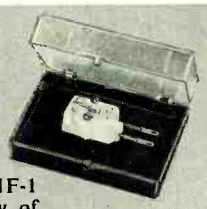
ATTRACTIVE BRASS TIP ACCESSORY LEGS convert SS-2 into handsome consolette. 14" legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. No. 91-26. **$4.95.**

Assemble it in

Just One Evening

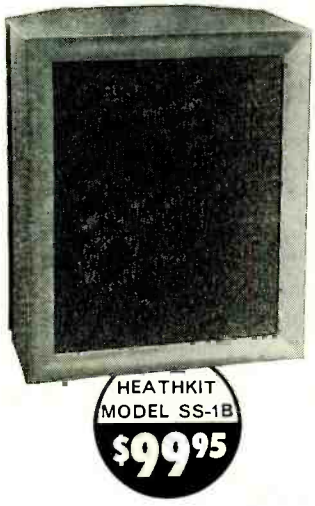
OPTIONAL LEGS
NO. 91-26 **$4.95**

DIAMOND STYLUS HI-FI PICKUP CARTRIDGE



MODEL MF-1 **$26.95**

Replace your present pickup with the MF-1 and enjoy the fullest fidelity your library of LP's has to offer. Designed to Heath specifications to offer you one of the finest cartridges available today. Nominally flat response from 20 to 20,000 CPS. Shpg. Wt. 1 lb.



Extended Frequency Range for Your SS-2

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

Designed exclusively for use with the SS-2, the SS-1B employs a 15" woofer and a super tweeter horn to extend the range of the SS-2 to an overall response of ±5 db from 35 to 16,000 CPS. When used together the two units form an integrated four-speaker system and are designed to combine into a single piece of attractive furniture. Impedance of the SS-1B is 16 ohms and power rating 35 watts. A control is provided to limit the output of the super tweeter. Constructed of beautiful ¾" veneer-surfaced plywood suitable for light or dark finish of your choice. All parts are precut and predrilled for simple assembly. No woodworking experience required. All hardware included. Shpg. Wt. 80 lbs.

"LEGATO" HI-FI SPEAKER SYSTEM KIT

It is difficult to describe in words the performance of this magnificent speaker system. You may never find absolute perfection in reproduced sound, but the Legato comes as close to achieving it as anything yet devised. Perfect balance, precise phasing, and adequate driver design combine to produce the superb quality of reproduction inherent in this instrument. The crisp, clear high frequencies and rich full bass engulf you in a sea of life-like tone. Two 15" Altec Lansing low frequency drivers cover frequencies from 25 to 500 CPS while a specially designed exponential horn with high frequency driver covers 500 to 20,000 CPS. The unique crossover network is built-in making electronic crossovers unnecessary. The legato emphasizes simplicity of line and form to blend with modern or traditional furnishings. Constructed of ¾" veneer-surfaced plywood in either African mahogany or white birch suitable for light or dark finishes of your choice. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

Easy to buy...

Easy to build

Easy to use...

HEATHKIT

HEATH COMPANY

Benton Harbor 20, Michigan

High Fidelity AM and FM reception in a Single Set

HEATHKIT MODEL PT-1 **$89.95**

Professional Stereo-Monaural AM-FM Tuner Kit

Enjoy stereophonic broadcasts as well as outstanding individual AM and FM radio reception with this deluxe 16-tube AM-FM-stereophonic tuner combination. Features include three etched circuit boards for high stability and ease of construction, prewired and prealigned FM front end, built-in AM rod antenna, tuning meter, FM-AFC (automatic frequency control) with on-off switch, and flywheel tuning. A multiplex jack is also provided. AM and FM circuits are tuned individually making it ideal for stereo applications since both AM and FM can be used at the same time. A switch selected tuning meter functions on either AM or FM. Cathode follower outputs with individual level controls are provided for both AM and FM. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. Anywhere from 1 to 4 limiters or IF's assure smooth, non-flutter reception on weak or strong stations alike. The silicon diode power supply is conservatively rated and is fuse-protected assuring long service life. Flywheel tuning combined with new edge-lighted slide-rule dial provide effortless tuning. Use of three printed circuit boards greatly simplifies construction. Vinyl-clad steel cover is black with inlaid gold design. Shpg. Wt. 20 lbs.

MODEL FM-3A **$26.95**

HIGH FIDELITY FM TUNER KIT

The Heathkit FM-3A Tuner will provide you with years of inexpensive hi-fi enjoyment. Features broadbanded circuits for full fidelity and better than 10 uv sensitivity for 20 db of quieting. Covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures neglible drift after initial warmup. Employs a high gain cascode IF amplifier and has AGC. Power supply is built-in. IF and ratio transformers are prealigned as is the front end tuning unit. Two outputs provided, one fixed, one variable, with extra stage of amplification. Shpg. Wt. 8 lbs.

MODEL BC-1A **$26.95**

HIGH FIDELITY AM TUNER KIT

The BC-1A incorporates many features not usually expected in an AM circuit particularly in this low price range. It features a special detector using crystal diodes and broad band-width IF circuits for low signal distortion. Audio response is ±1 db from 20 CPS to 9 kc with 5 db of pre-emphasis at 10 kc to compensate for station rolloff. Covers the complete broadcast band from 550 to 1600 kc. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs and built-in power supply. Shpg. Wt. 9 lbs.

MODEL W-6 **$109.95**

"HEAVY DUTY" 70 WATT HI FI AMPLIFIER KIT

Designed for "rugged duty" called for by advanced hi-fi systems and P.A. networks. Silicon diode rectifiers assure long life and heavy duty transformer provides excellent power supply regulation. Variable damping control provides optimum performance with any speaker system. Quick change plug selects 4, 8 and 16 ohm or 70 volt output and the correct feedback resistance. Shpg. Wt. 52 lbs.

MODEL W-5 **$59.75**

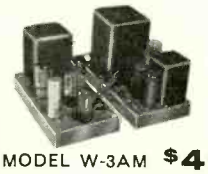
25 WATT HI FI AMPLIFIER KIT

Enjoy the distortion-free high fidelity sound from one of the most outstanding hi-fi amplifiers available today. Features include a specially designed Peerless output transformer and KT66 tubes. Frequency response is ±1 db from 5 to 160,000 CPS at 1 watt and within 2 db 20 to 20,000 CPS at full 25 watts output. Hum and noise are 99 db below 25 watts. Shpg. Wt. 31 lbs.

MODEL W-4AM **$39.75**

SINGLE CHASSIS 20 WATT HI FI AMPLIFIER KIT

A true Williamson-type high fidelity circuit, the W-4AM features 5881 push-pull output tubes and a special Chicago-Standard output transformer to guarantee you full fidelity at minimum cost. Harmonic distortion is 1.5% and IM distortion is below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps for 4, 8 or 16 ohm speakers. Shpg. Wt. 28 lbs.



MODEL W-3AM **$49.75**

DUAL CHASSIS 20 WATT HI FI AMPLIFIER KIT

Another famous Williamson-type high fidelity circuit, the W-3AM features the famous Acrosound TO-300 "ultralinear" output transformer and 5881 tubes. The power supply and main amplifier are on separate chassis for installation flexibility. Harmonic distortion is less than 1% and IM distortion is less than 1.2% at 20 watts. Shpg. Wt. 29 lbs.

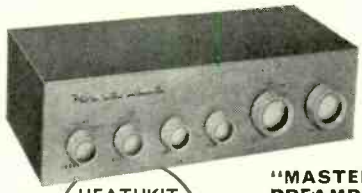
HEATHKIT MODEL SP-2 (STEREO) **$56.95**

MODEL SP-1 (MONAURAL)
$37.95 Shpg. Wt. 13 lbs.

MODEL C-SP-1 (CONVERTS SP-1 TO SP-2)
$21.95 Shpg. Wt. 5 lbs.

Monaural-Stereo Preamplifier Kit (2-Channel Mixer)

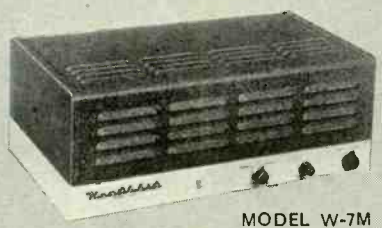
This unique kit allows you to purchase it in the monaural model if desired and then add the second or stereo channel later. The SP-2 features 12 separate inputs, six on each channel, with input level controls. Six dual concentric controls consist of: two 8-position selector switches, two bass, two treble, two volume level and two loudness controls, a scratch filter switch and a 4-position function switch. A separate on-off switch is provided. The function switch provides settings for stereo, 2-channel mix, channel A or B for monaural use. Inputs consist of tape, mike, mag phono and three high-level inputs. NARTB equalization and RIAA, LP, 78 record compensation are provided. A remote balance control is included. Printed circuit boards for easy assembly. Built-in power supply. Shpg. Wt. 15 lbs.



HEATHKIT MODEL WA-P2 **$19.75**

"MASTER CONTROL" PREAMPLIFIER KIT

Control your hi-fi system with this compact unit. Features 5 switch-selected inputs to accommodate a record changer, tape recorder, AM tuner, FM tuner, TV receiver, microphone, etc., each with level control. Provision also for a tape recorder output. Equalization for records through separate turnover and rolloff switches for LP, RIAA, AES and early 78's. Shpg. Wt. 7 lbs.



MODEL W-7M
$54.95

"EXTRA PERFORMANCE" 55 WATT HI FI AMPLIFIER KIT

Enjoy this high fidelity power amplifier at less than a dollar per watt. Full audio output and maximum damping is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Features famous "bas-bal" circuit, EL-34 output tubes and special 70 volt output. Shpg. Wt. 28 lbs.

MODEL XO-1
$18.95

ELECTRONIC CROSSOVER KIT

This unique instrument separates high and low frequencies and feeds them through 2 amplifiers into separate speakers. Located ahead of the main amplifier, it virtually eliminates IM distortion and matching problems. Note: Not for use with Heathkit Legato speaker system. Shpg. Wt. 6 lbs.

MODEL UA-1
$21.95

"UNIVERSAL" 12 WATT HI FI AMPLIFIER KIT

The versatility and economy of this fine kit make it a truly "universal" hi-fi amplifier. An ideal basic amplifier for any hi-fi system or a perfect addition to gear your present hi-fi system to stereo sound. Uses 6BQ5/EL84 push-pull output tubes for less than 2% harmonic distortion throughout the entire audio range. Shpg. Wt. 13 lbs.

MODEL A-9C **$35.50**

GENERAL-PURPOSE 20 WATT AMPLIFIER KIT

Designed for home installation as well as for PA requirements, the A9-C combines a preamplifier, main amplifier and power supply all on one chassis. Four switch-selected inputs are provided as well as separate bass and treble tone controls offering 15 db boost and cut. Detachable front plate allows for custom installation. Shpg. Wt. 23 lbs.

MODEL SW-1 **$24.95**

SPEEDWINDER KIT

A real timesaver, the SW-1 leaves your tape recorder free for operation while rewinding tape at the rate of 1200 feet in 40 seconds. Prevents unnecessary wear to the tape and recorder. Handles up to 10½" tape reels. Handles 800' reels of 8 and 16 millimeter film as well. Automatic shutoff prevents whipping at end of rewind. Shpg. Wt. 12 lbs.

NO. 401-6
$7.50

12" UTILITY SPEAKER KIT

Replace inferior speakers in radio or TV sets to obtain better tone quality or set up an auxiliary speaker for testing purposes with this convenient, high quality speaker. The speaker will handle up to 12 watts with a frequency response of ±5 db from 50 to 9,000 CPS. Speaker impedance is 8 ohms and has a 6.8 oz. magnet. An outstanding dollar value. Shpg. Wt. 7 lbs.

MODEL TK-1 **$9.95**

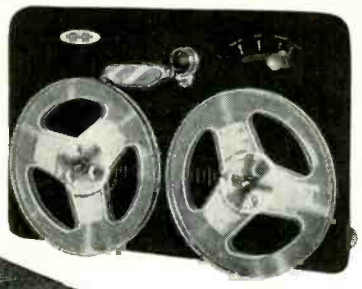
COMPLETE TOOL SET

These basic tools are all you need to build any Heathkit. The pliers, diagonal side cutters, 2 screwdrivers, and soldering iron are all of top quality case hardened steel for hard duty and long life. Pliers and side cutters are equipped with insulated rubber handles for safety. A good example of just how easy Heathkit building really is. Shpg. Wt. 3 lbs.

HIGH FIDELITY TAPE RECORDER KIT

The model TR-1A tape deck and preamplifier combination provides all the facilities you need for top quality monaural recording/playback with fast forward and rewind functions. 7½ and 3¾ IPS tape speeds are selected by changing belt drive. Flutter and wow are held to less than 0.35%. Frequency response at 7½ IPS ±2.0 db 50-10,000 CPS, at 3¾ IPS ±2.0 db 50-6,500 CPS. Both units may be mounted together or separately affording high flexibility in every application. Features include NARTB playback equalization —separate recording and playback gain controls —cathode follower output and provision for mike or line input. Signal-to-noise ratio is better than 45 db below normal recording level with less than 1% total harmonic distortion. A filament balance control allows adjustment for minimum hum level. Complete instructions provided for easy assembly. Overall dimensions of tape deck and preamp is 15½" W. x 13½" H. x 8" D. Shpg. Wt. 24 lbs.

HEATHKIT TR-1A
$99.95



Includes tape deck assembly, preamplifier and roll of tape.

HEATHKIT TE-1
$39.95

Tape preamplifier sold separately if desired. Shpg. Wt. 10 lbs.

Many more Heathkits to choose from

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test: Oscilloscopes—Voltmeters—RF Signal Generators—AF Generators—Analyzers—Battery Eliminators—Tube Checkers—Condenser Checkers—Computer—Color Bar & Dot Generator—Sweep Generator—Impedance Bridge—Power Supplies—Probe Kits—R/C Decade & Substitution Kits.

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COVER FEATURE

The VARIABLE Reactance Amplifier

Now an experimental laboratory development, this may become the practical amplifier for the uhf's and beyond.

By **FRED SHUNAMAN**
MANAGING EDITOR

THE variable-reactance—often called parametric—amplifier is possibly today's most important development in the electronic field. It is so named because it uses a variation in one of the (reactive) elements, or parameters, of the circuit. A descendant of magnetic and dielectric amplifiers—which also amplify by means of a variable reactance—it offers promise of amplification with less noise than can be obtained with tubes. This is especially true at the ultra-high and super-high frequencies, where it becomes difficult to make low-noise tubes, and it is at these frequencies that the greatest amount of research is being done.

The amplifier will work at lower frequencies, and an experimental one has been built to operate at 1 megacycle. At this frequency, tubes are more effective, both electronically and economically, and it is likely that practical uses of parametric amplifiers will be confined to frequencies above the ultra-high. The amplifier on our cover was designed to operate at 900 mc. It was developed by ITT Labs (research division of International Telephone and Telegraph Corp.) and is pictured with William Sichak, director of the radio communication laboratory, who was responsible for the research on and development of the amplifier.

What is a parametric amplifier? Let us look first at a dielectric amplifier, one of its simpler ancestors (Fig. 1). Looking at the right half of the figure, we see an ac supply, a nonlinear capacitor (one whose capacitance varies as the voltage across it is increased or decreased) and a load resistor. The amount of current — and therefore power—in the load depends on the voltage of the ac supply and the amount of capacitance in series with it.

Note that the capacitor is biased by a battery in the left half of the circuit. Its voltage is applied across the capacitor through the signal source (which must obviously offer little resistance to dc) and the two choke coils, which confine the ac to the right side of the circuit.

If we vary the bias with a signal low enough in frequency (compared with

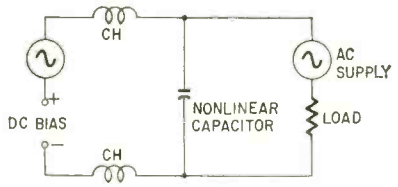


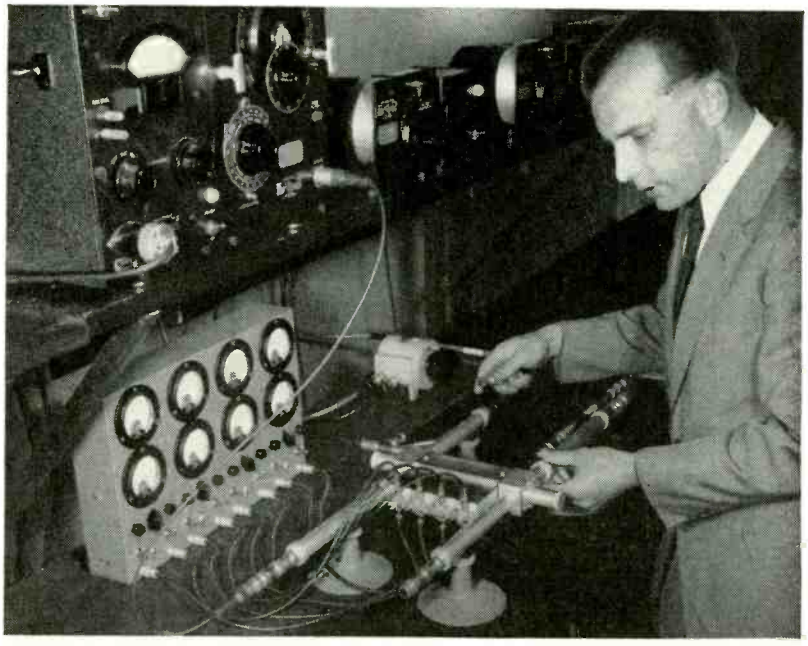
Fig. 1—A dielectric amplifier circuit.

that of the ac supply) to meet no significant opposition from the choke coils, we can *modulate* the higher-frequency ac supply.

As the signal voltage becomes more positive, the capacitance becomes larger and more current flows through the load. On the negative half of the signal cycle, the capacitance becomes smaller and the load current goes down. Thus—within the limits set by the nonlinearity of the capacitor—the load current is modulated in the form of the signal voltage. If the ac voltage is high enough, this modulated output power is greater than the input power, and the circuit amplifies.

The dielectric amplifier, then, am-

Assembling equipment for testing a four-stage reactance amplifier.



Studying the amplifying properties of a capacitor diode.

Photos by Bell Telephone Labs.

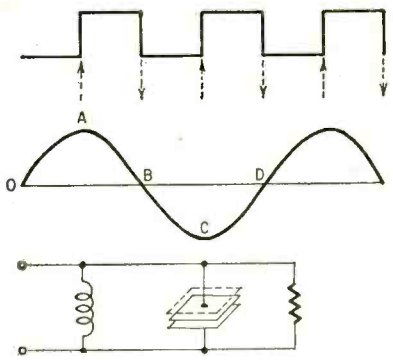


Fig. 2—A varying capacitance can be made to amplify a signal.

plifies by causing an alternating current to flow through a variable reactance, the value of which is changing at the modulation frequency, considerably lower than that of the supply. The parametric amplifier uses very similar circuitry, but the effect reminds one more of the transconductance gain in a superheterodyne converter than of simple modulation.

In the modulator type (the magnetic or dielectric amplifier), the signal is the active factor. It varies the impedance of the reactive element to the considerably higher supply frequency. In the parametric amplifier, it is the supply voltage that varies the reactive element, at a frequency related to and higher than the signal frequency. In the dielectric or magnetic amplifier, power in the output load increases as the reactive element offers less opposition to the supply voltage; in the parametric amplifier, output power is increased by increasing the reactance of the variable element.

How is this done? One way to visualize it is to assume a capacitor of two plates, with one plate so mounted that the distance between it and the other—and thus the capacitance—can be varied mechanically. For example, the upper plate could be mounted on a crankshaft so its spacing from the lower plate could be varied at a fixed rate.*

Let us suppose we are trying to amplify the sine-wave signal of Fig. 2. As the signal reaches point A, the charge on the capacitor becomes greatest. At this point the top plate is suddenly lifted (top waveform of Fig. 2), increasing the spacing from the bottom plate and decreasing the capacitance. The voltage increases, since the voltage across a capacitor is equivalent to the charge (in coulombs, for example) divided by the capacitance

$$(Q = CE, \text{ or } E = \frac{Q}{C}).$$

As C becomes smaller with Q constant, E increases. The higher voltage with the same charge represents greater power in the circuit — the result of work done in separating the plates

* The explanations following draw largely for information on a paper, "A Review of Solid State Parametric Amplifiers," read by E. D. Reed of the Bell Telephone Laboratories, at a recent conference on electron devices.

against the mutual attraction due to the opposite charges on them.

To get the greatest power increase, it would of course be desirable to pull the plates apart when the voltage across them is greatest. A in Fig. 2 is one of those points, C another. But we have to get the plates back to their original separation if we are to pull them apart again, and this must be done without returning to the circuit the energy gained by separating them. We can do this by bringing the plates together when there is no voltage across them, as at points B and D.

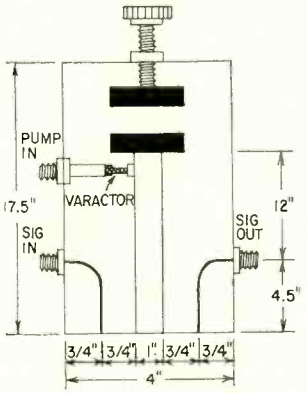


Fig. 3—Drawing of a parametric amplifier used on the 144-mc band.

Fig. 2 shows us that the pulling and pushing (called pumping) frequency should be twice that of the signal. And, of course, the "pump" that moves the plates back and forth will have to be electronic. A crystal diode with its bias varied at the right frequency by a "pumping" voltage will act as the type of variable capacitor we need. (See "Using the Varicap," RADIO-ELECTRONICS, May, 1958, page 57, and —for the theory underlying the variation of capacitance—*Electrons and Holes in Semiconductors*, by Shockley, page 100.) Biased in the reverse direction, an increase in voltage decreases the capacitance. Thus, it is necessary only to have a pumping frequency act on such a diode capacitor, to which the signal is also applied, to have a true parametric amplifier.

While all diodes vary in capacitance with variation in the voltage across them, some are more applicable to the job than others. Silicon diodes are universally used, and research workers at Bell Laboratories and other places are attempting to tailor new types of diodes to this special application.

A practical amplifier?

This simple type of parametric amplifier is described rather as an example of fundamental principles than as a practical circuit. Yet it will work after a fashion, and practical amplifiers have been built up on it. One such was described by W1FZJ (F.S. Harris, Medfield, Mass.) in the November, 1958, issue of *CQ*. A drawing and the dimensions of the amplifier are shown in Fig. 3. It is built around a coaxial tuner or line filter, and is intended to

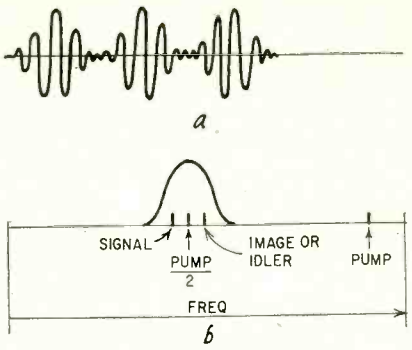


Fig. 4-a—Effect of pump frequency not exactly twice that of signal; b—position of image or idler signal.

operate on the 144-mc amateur band. The *varactor*, or voltage-sensitive diode, is a Microwave Associates MA-450. Amplification was reported as 10 db, with a very low noise figure. The author pointed out that a pumping frequency of exactly twice the signal frequency (2s) is not the only one that will work, and states that he has used 3s and 5s with even better results than 2s.

A look at the waveforms of Fig. 2 indicates that, as soon as we leave a pumping frequency of 2s, we cannot expect maximum efficiency. Part of the time the reduction in capacitance will occur at exactly the signal peak, then the pump will get out of time and a little later will change capacitance while the signal is zero. From here it will catch up until it is again changing capacitance at the best point of gain. This will introduce a beat effect (Fig. 4-a), another point reminiscent of the superhet. Another even more reminiscent note is that, as soon as the pump departs from 2s, we find an image—or *idler*—frequency (Fig. 4-b) at p − s. (The pump frequency of 2s is just a special form of this situation, s and p − s being equal.) The idler frequency is just as strong as the signal frequency, and cannot be suppressed without suppressing the entire amplification.

The up converter

Another type of amplification—one which bids fair to become the practical parametric amplifier circuit—uses the sum frequency of pump and signal, as did the ancient Remler *Infradyne* broadcast receiver and some recent European broadcast and shortwave circuits. This type of amplifier is called an *up converter* and the sum frequency is referred to as the *upper sideband*. The circuit of Fig. 5 was built up by Dr. B. Salzberg and E. W. Sard of the Airborne Instruments Laboratory, Mineola, N. Y., to demonstrate this type of amplification. It is especially interesting in that it operates on the very low (for this type of amplifier) input signal frequency of 1 mc, and thus uses the coils and capacitors more familiar to many electronic technicians than the waveguide circuitry found in most of these amplifiers. Output is 21 mc.

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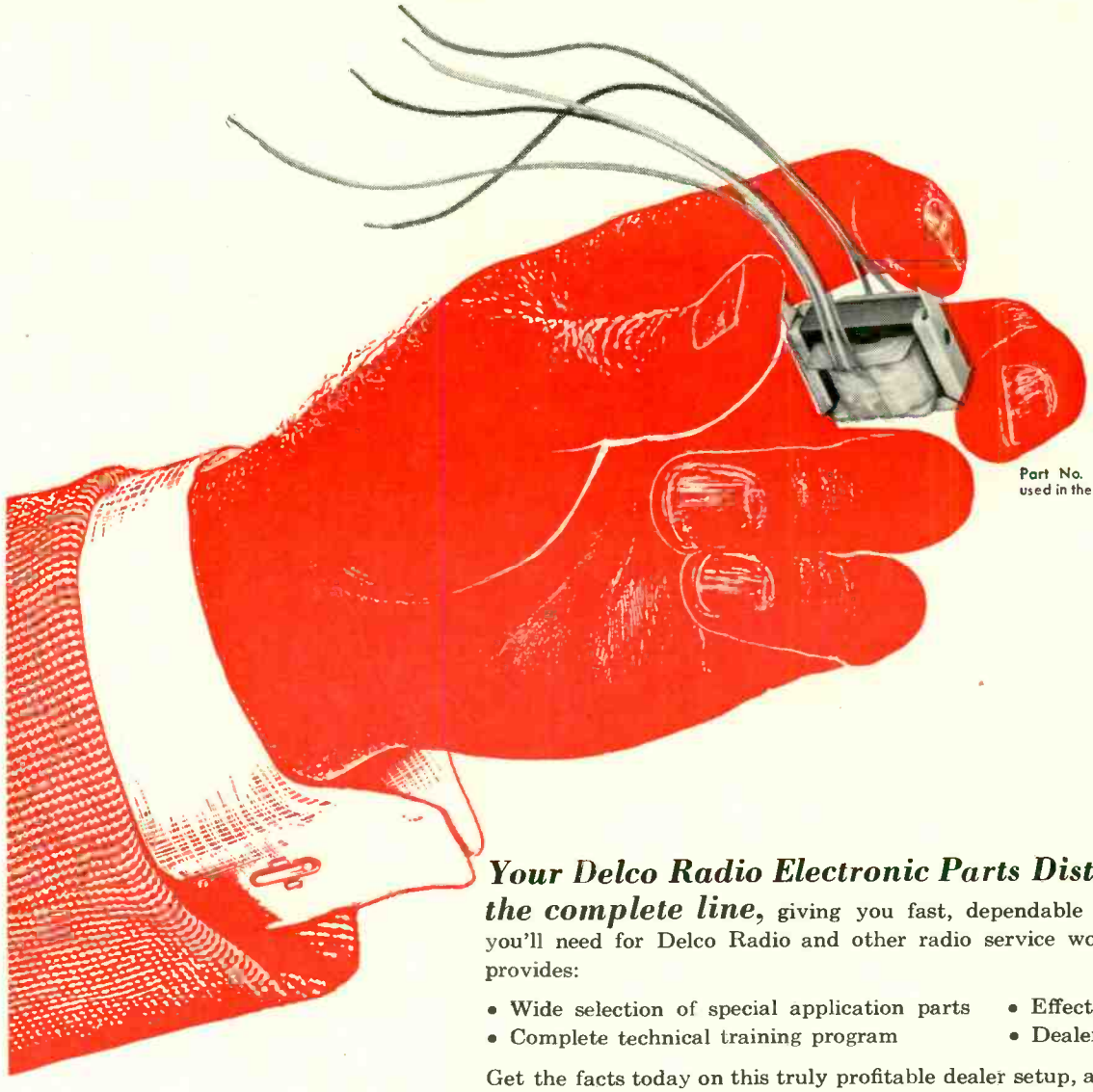

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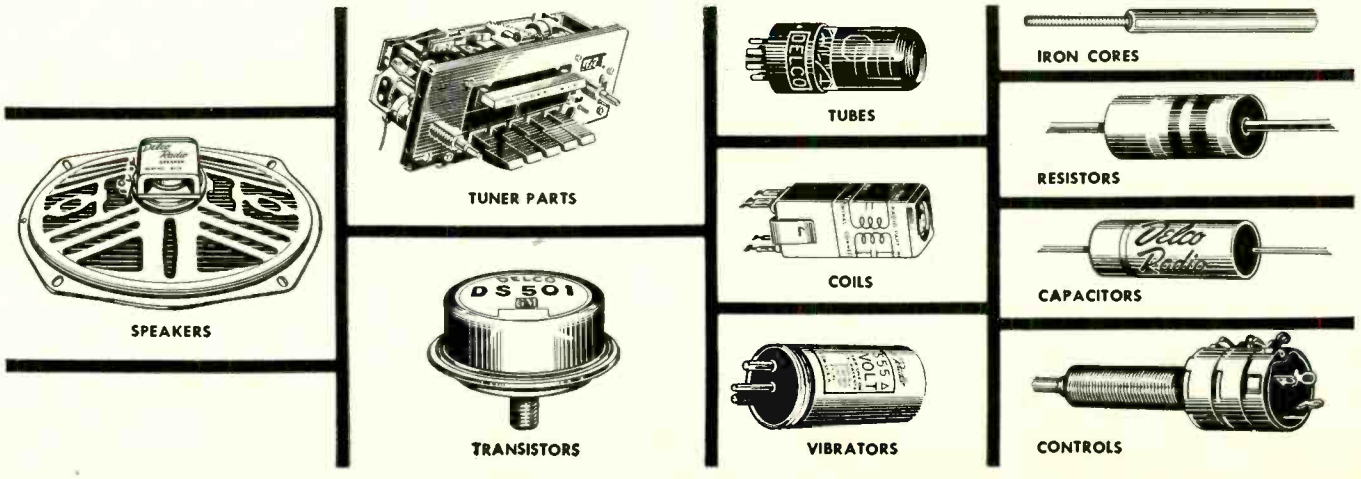

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Complete constants are given in the diagram. The designers, however, suggest that it might be optimistic to expect to build a working model of this reactance amplifier simply by following the circuit, and supplied a number of

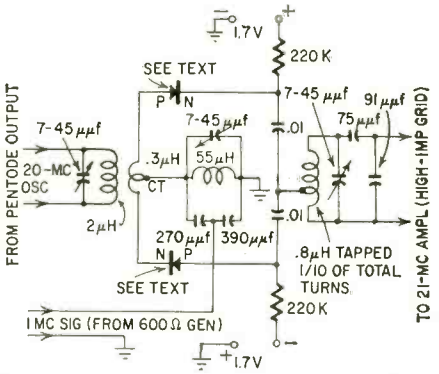


Fig. 5—Experimental amplifier with 1-mc input and 21-mc output.

comments that might help any experimenters who would like to attempt it.

The diodes are the most important part of the circuit, and should be a matched pair. Either Pacific Semiconductor type V39 Varicaps or Hughes type HC 7008 silicon capacitors are suggested. For the Varicaps, two in parallel are required on each side, giving a net capacitance of about 110 μμf. The (reverse) dc bias should be about 1.7 volts and the amplitude of the 20-mc input—critically related to the dc bias—about 1.1 volt to ground from each end of the secondary of the 20-mc transformer.

Inductances should be good—very low-noise operation requiring low-loss input and output circuits with unloaded Q's in the order of 300. A swept frequency input signal and a scope on the (detected) output are valuable in alignment. If the output should be tuned to the difference frequency of 19 mc rather than the sum of 21 mc, the amplifier will regenerate and may even oscillate at 1 and 19 mc with only the 20-mc pump applied. In true sum-frequency operation the amplifier behaves like a double-tuned transformer with the 1- and 21-mc tuning adjustments interacting.

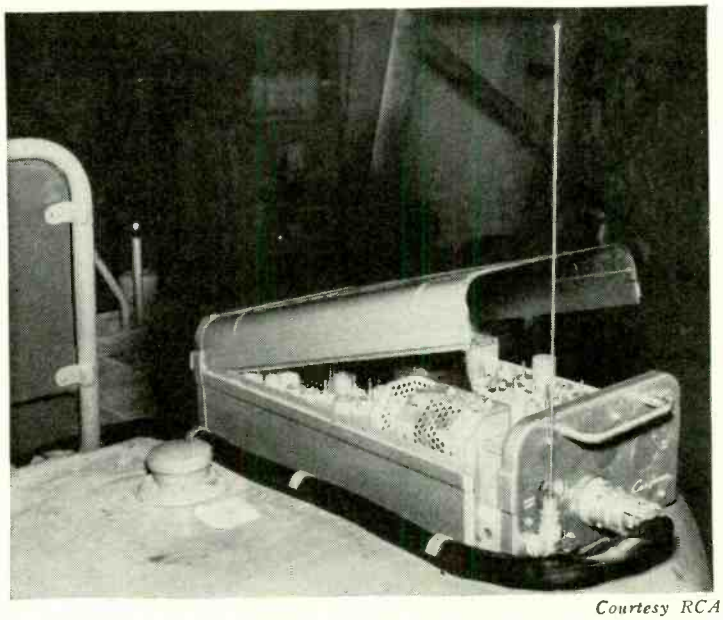
In the up converter, the gain is equivalent to the ratio of the upper sideband to the signal frequency. Thus the amplifier of Fig. 5 would have a gain of 20.

The reactance amplifier is fairly new, and still other forms have been announced, including one by RCA in which the pumping frequency can be lower than that of the signal. Another interesting development is a parametric amplifier *tube*, designed by Dr. Robert Adler of Zenith, which gives promise of being able to amplify with less noise than any other tube. The future may see variations, in directions unthought-of today, but enough is known to make it certain that the variable reactance (parametric) amplifier will be one of the most important semiconductor devices of the future. END

ABC's of MOBILE RADIO

Part II—Frequencies, range, and licensing

LEO G. SANDS



Courtesy RCA Carphone

152–162-mc band mobile unit mounted on a materials handling truck. Note the plug-in antenna.

AT present, nongovernment mobile radio systems operate in the 25–50, 152–162, 450–460 and 460–470-mc Citizens bands. Certain commercial operations use frequencies between 1.6 and 5 mc. Mobile radio systems licensed for ground communications in the aviation radio services at airports can operate on frequencies between 118 and 132 mc. The spectrum between 132 and 144 mc and 162 and 174 mc is reserved for use by the Government.

The 72–76-mc band, while allocated for use by the same kinds of services as are eligible in the other mobile radio bands, is restricted to point-to-point service. This band can be used only in certain geographical areas and only when the license applicant can show that harmful interference to television reception on channels 4 and 5 will not be caused.

Communicating range

Range depends upon frequency, transmitter power, receiver sensitivity, antenna elevation and noise conditions. Base-to-mobile communication over 800 miles and mobile-to-mobile communication between vehicles 200 miles apart have been reported by operators of mobile radio systems in the 1.6–5-mc band. Such a great range is made possible by skip transmission, which occurs mostly after dark. Ordinarily, reliable daytime range is in the order of 25–50 miles. Operation at these relatively low frequencies is reserved for specific industries and is not open for general mobile communications.

The former so-called 30–40-mc band has been expanded and is now known as the 25–50-mc band. It is generally used where regional or county-wide coverage is required. Communicating range varies from 10 to 60 miles, and in some instances may extend farther. However, this band is subject to skip interference, particularly during periods of heavy sunspot activity. Signals from stations on the same frequency located on the other side of the continent sometimes blast in like a local station. Because of the 2-to-1 frequency spread of this band, the low end generally gives longer range.

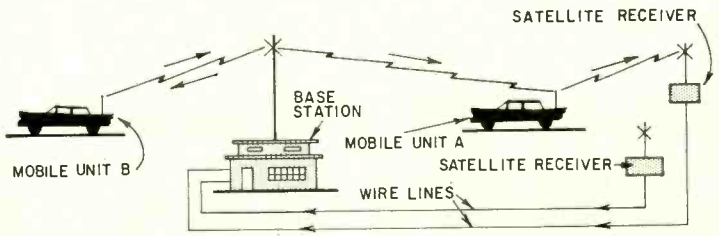
The radio spectrum between 118 and 132 mc is used by the aeronautical radio services. Mobile radio systems are operated on channels assigned to aviation services for land communication at airports. For example, the airport control tower can communicate with crash, maintenance, fire and other radio-equipped vehicles at an airdrome. Since the airport towers use AM equipment, only AM mobile units can be employed.

The communicating range in the 118–132-mc aeronautical and the 132–144-mc Government bands is approximately the same as in the popular 152–162-mc band—from 5 to 30 or more miles. This is the band in which taxi radio systems, city police and other services which require city-wide coverage generally operate. Communication range is generally considered line-of-sight, but because of the reflection characteristics of radio signals at these frequencies, greater range and communication behind intervening objects are ordinarily attained.

Hams can operate mobile radio systems in the 144–148-mc band, using standard 152–162-mc mobile radio equipment which is tunable to the ham frequencies.

In the 450–470-mc band, communi-

(*Continued on page* 88)



For adequate coverage, satellite receivers are sometimes needed. The base-station transmitter blankets the area. Mobile units, which do not have as great a range, are picked up by the nearest satellite, from which the signal is relayed by wire line to the base station.

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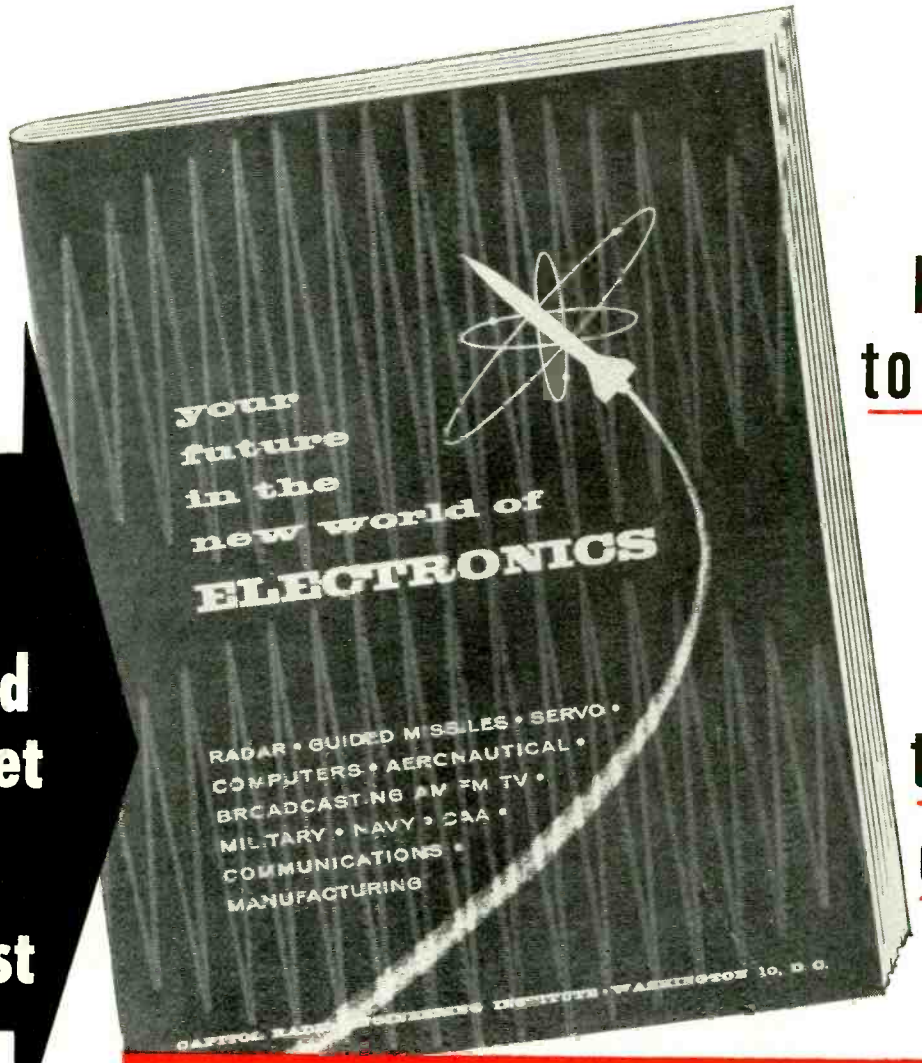

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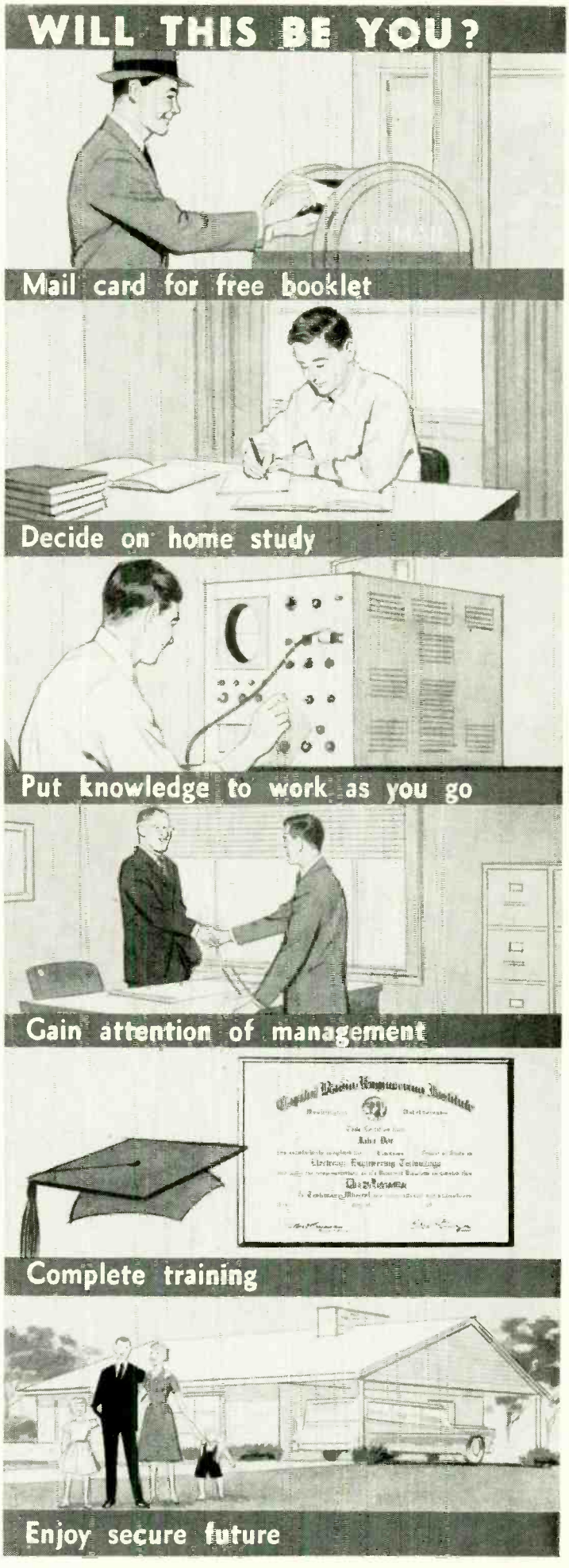


Airport maintenance firms use two-way radio for communicating with the control tower. Maintenance vehicles obtain clearance to cross busy runways as well as instructions.

Photos by Cyril Glunk

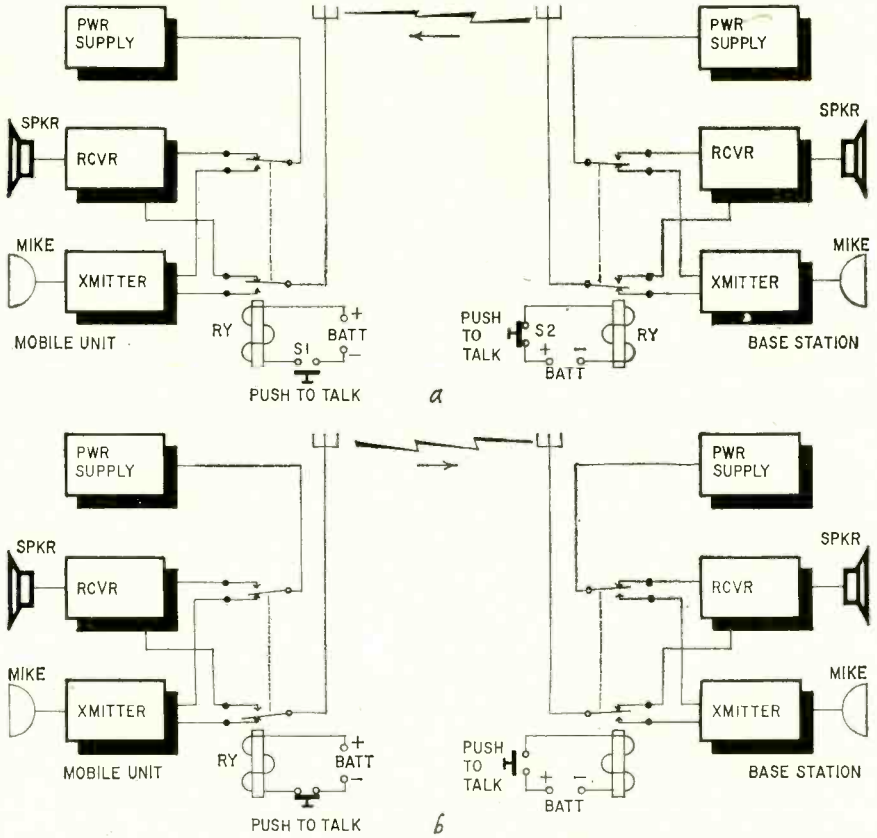
Low-power industrial base station at a Los Angeles paper container plant. System consists of two base stations and four radio-equipped fork-lift trucks.

(*Continued from page* 83)

cating range is generally considered to be about two-thirds as great as in the 152-162-mc band. This is not always true. Sometimes the range is less, sometimes greater. At these frequencies, range is essentially line-of-sight. However, it is decreased by hills and foliage and often increased by reflections. The range is often difficult to predict, particularly in hilly terrain, and a field survey may be required to determine what coverage can be attained.

Pet theories and guesswork are sometimes proved wrong when it comes to estimating the anticipated range of a 450–470-mc mobile radio system. While it is considered to be shorter than when operating in the 152–162-mc band, a taxi operator in a large Eastern city who switched from the 152–162-mc vhf band to the 450–470-mc uhf band found that he could communicate with his cabs in some spots at the extreme limits of his service area which the lower frequency band could not reach. Sometimes the opposite was true.

Uhf signals are more readily reflected by hard surfaces. This makes it possible to communicate with radio-equipped vehicles inside of tunnels, for a short distance at least. Usually, when a 152–162-mc mobile unit goes inside a tunnel, communication with a base station outside of the tunnel ceases. In the 450–470-mc uhf band, it has often been reported that communication under similar circumstances continues. Tests conducted in the Lincoln Tunnel, which joins New York City with New Jersey, revealed that communication in the 450-mc band could be maintained between two mobile units for distances up to 0.4 mile while both vehicles were inside the tunnel. This leads to the conclusion that subway trains and other vehicles regularly operated underground could use uhf radio for base-to-mobile and mobile-to-mobile communications over limited and controllable ranges.



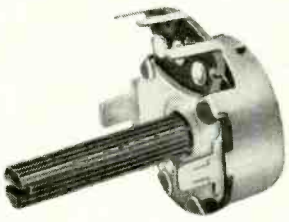
a—Circuit conditions when the base station is transmitting and the mobile unit is receiving. b—Circuit conditions when the mobile unit is transmitting and the base station is receiving.

Mobile-to-mobile range

Ordinarily, the direct communicating range between mobile units is considerably shorter than the base-to-mobile range because of the lower effective antenna elevation of both stations. Car-to-car range may be only 2 to 5 miles. However, a mobile unit on a hilltop can sometimes communicate with another mobile unit 50 or 60 miles away because of the elevation of the antenna of the mobile unit on the hill.

A *relay* or *repeater* station is sometimes used to increase the mobile-to-mobile communicating range. Two-channel operation is required since the relay station picks up radio signals on one channel and retransmits the intercepted intelligence on another channel. The relay station consists of a receiver and a transmitter connected so that

ready, willing and able



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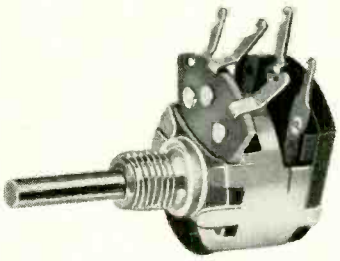

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CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE

the audio output of the receiver is fed to the audio input of the transmitter. The transmitter is turned off until activated by a carrier-operated relay which is energized when a signal is picked up by the receiver.

The relay station is an automatically operated base station and, because of its better antenna system (higher effective antenna elevation) its signal may be picked up by mobile units 10 to 30 miles or farther away. Suppose that mobile unit A is located 30 miles west of the relay station. Ordinarily, it could not communicate with mobile unit B, 60 miles to the east and 30 miles east of the relay station. However, if the relay station-to-mobile range is 30 miles, mobile unit A can communicate with B through the relay station.

Licenses

A radio-station license is required for all transmitters except those with extremely limited range which do not exceed the limits of the FCC low-power rule. Generally, a single license covers both the base station and the mobile units. At present, there is no charge for radio-station licenses.

A license is not required for a transmitter whose total electromagnetic field does not exceed 15 microvolts per meter at a specified distance which varies with frequency. The distance in feet is computed by dividing the wavelength by 2μ, $\left(\frac{\lambda}{2\mu}\right)$, or by dividing 157,000 by the frequency in kilocycles, $\left(\frac{157{,}000}{F}\right)$.

For example, at 157 kc, the distance is 1,000 feet; at 1,570 kc, 100 feet; at 15,700 kc, 10 feet, and at 157 mc, 1 foot. There are other FCC restrictions which should be carefully studied since low-power transmitters must not interfere with licensed stations.

Such low-power transmitters have very few practical applications. Most are used as remote controls or in wireless record players. The rule also covers wire-line carrier transmitters which power were used.

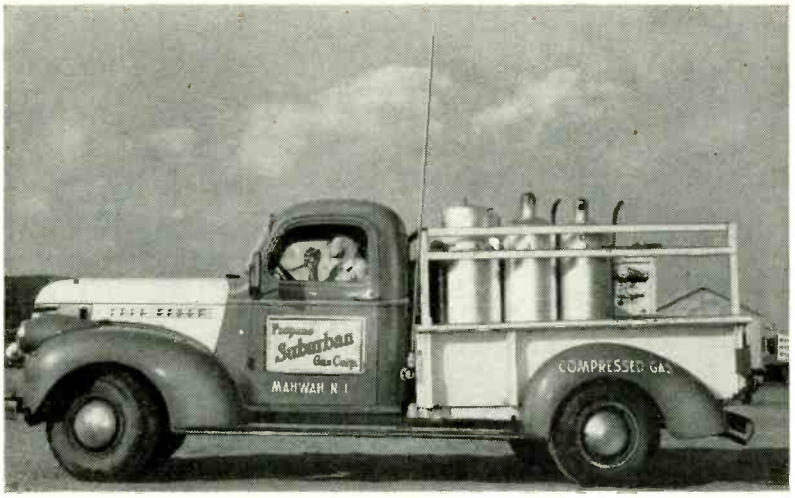
An operator's license is not required by persons using radiotelephone transmitters licensed in the Citizens Radio Service. In other mobile radio services, operators of mobile units do not require operator's licenses. However, the base-station operator must hold a restricted radiotelephone permit. To qualify for this license, the applicant must be familiar with FCC rules regarding the proper operation of a radio station and must be able to read and write some language that can be readily translated into English. Railroad employees, specifically appointed to serve as base-station operators, do not have to possess an operator's license.

A first- or second-class radiotelephone operator's license is required by persons who make adjustments to radio transmitters. However, an unlicensed person may work on transmitters when under the direct supervision of a licensed operator. To qualify for these licenses, an applicant must pass a written test which covers electron theory and FCC rules and regulations.

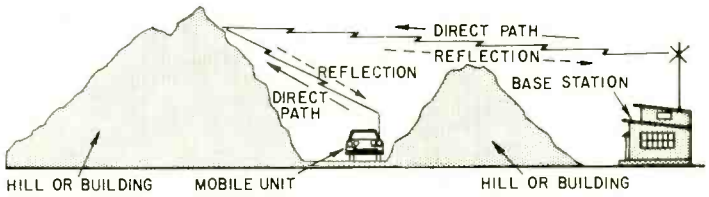
At the end of the fiscal year 1957, the FCC reported 1,304,300 commercial operators' licenses outstanding. Of these, 1,119,228 were restricted permits.

Frequencies Available to Mobile Radio Services

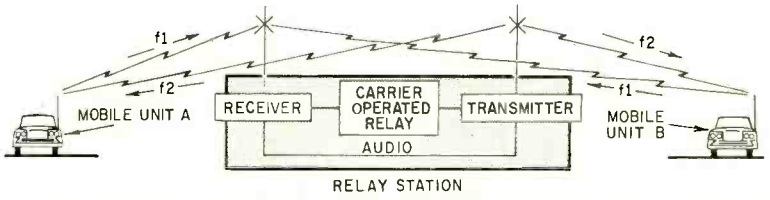
Band (mc)	Communicating Range (miles)	Eligible Services
1.6–5.0	50 (often more)	Highly restricted
25–50	30–60	Land transportation Industrial Public safety
26.965–27.225	1-5	Any citizen over 18 years of age.
118–132	15–25	Airport services
152–174	15–25	Land transportation Industrial Public safety
450–470	10–15	Land transportation Industrial Public safety Remote broadcast pickup
460.05–460.95 462.55–466.45	10–15	Any citizen over 18 years of age
465	100 feet to several miles (power limited to 5 watts input)	Any citizen over 18 years of age



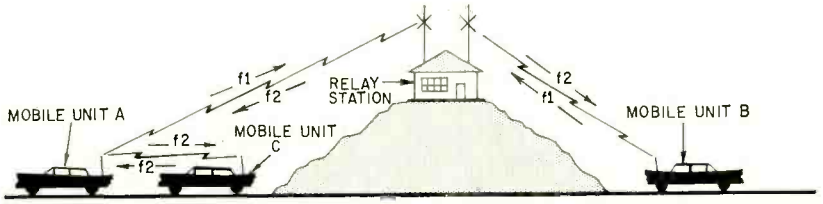
Suburban bottled-gas companies may have their trucks out all day. Mobile radio lets the main office tell a driver "Mrs. Jones, 555 Eight Street is out of gas. Drop off a bottle."



While vhf and uhf signals generally travel a line-of-sight path, communication in normally dead spots can exist. Signal reflections off some solid surface, such as a building or side of a hill, are used.



When a relay station is used to extend mobile-to-mobile range, mobile units transmit on f1 and receive on f2. The relay station picks up signals on f1 and retransmits the intercepted message on f2.



When mobile unit A cannot communicate directly with B because it is out of range and behind a hill, A can get in touch with B via the relay station. If mobile units are equipped with two-channel transmitters, A can communicate with C by switching his transmitter to f2, without going through the relay station. Mobile unit C also switches to f2 for contact with A.

Time-Saver of the MONTH!

by Herb Bowden*

TRC4 TRANSISTOR and RECTIFIER CHECKER

The transistor is now ten years old and is fast becoming the most talked about and used component in the electronic industry. Nearly everyone involved in electronics is finding it necessary to associate himself with the transistor and to equip his shop or laboratory with a limited amount of transistor testing equipment. The first tester that enters one's mind is one that will accurately test the transistor.

Is a Transistor Tester Necessary?

Probably the first question that you ask is whether or not a Transistor Tester is really necessary.

Actually, the answer to this is that, a serviceman or engineer can get by without a transistor tester in much the same manner as one can get by without a tube tester. You can do without it, but is saves a world of time if you have it.

Firstly, if you do not have a transistor tester, you must know the circuit that you are working on very thoroughly. Secondly, you must understand the characteristics of the transistors that are in this circuit. Thirdly, you must have the characteristic curves of each transistor that you are working on.

The TRC4 Sencore transistor tester does all of these things for you. You only need to know the number of the transistor that you want tested. The $17.95 paid for this tester can be saved after using it only a few times by preventing this wasted time.

Can an Ohmmeter or Voltmeter Be Used to Check a Transistor?

Many articles and service notes have been written on how to check transistors with an ohmmeter and others on how to check circuit voltages to determine whether or not the transistor is operating properly. The only difficulty in these procedures is that the precautions are about as lengthy as the steps themselves.

Also, the results must be interpreted properly or the checks mean nothing. Transistors can easily be ruined by accidentally applying 22½ volts to the transistor or by applying the voltage in reverse on ohmmeter checks.

Both ohmmeter and voltmeter checks are difficult to make on small portable radios. It is much easier to test the transistors first to be sure that the circuit is faulty, and not the other way around.

How Should a Transistor Be Tested?

The most scientific way to test a transistor is under a complete dynamic check with signal applied. This is impractical in many respects. To be absolutely accurate, the transistor must be checked over the range of frequencies that it is to be operated at. These frequencies may vary greatly, thus making this test very time consuming.

Also, this type tester would be very costly compared to the TRC4 shown above at only $17.95 dealer net.

FIG. 1. SENCORE TRC4 Transistor Rectifier Checker. Used and recommended by leading distributors and dealers all over the world.

In the early days of television, many TV engineers insisted that the same type check was necessary for all vacuum tubes used in TV receivers. Time has proved this theory to be obsolete as no service type tube tester was ever designed that would check tubes at their operating frequency.

The TRC4 tester works in the same manner as a quality tube tester. It applies the proper operating currents (can be considered voltage) to the transistor and measures the current gain. A second check for leakage results in a complete check of the transistor. Opens or shorts in any segment of the transistor are clearly indicated during the leakage or gain checks.

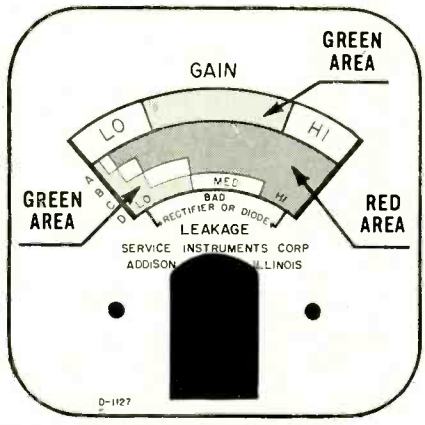


FIG. 2. Full size TRC4 meter scale.

Will the TRC4 Test All Transistors?

The TRC4 transistor and rectifier checker is designed to accurately test all types of transistors for opens, shorts, leakage and current gain. This includes the High Power transistors as used in car radio output stages as well as the small transistors as used in hearing aids. The TRC4 is the only tester designed to test all transistors both large and small.

How to Check Transistors

1. Preset the SELECTOR switch and GAIN SET controls according to the charts in the rear. See Fig. 1
2. Preset the RANGE switch to the position as indicated in the chart.
3. Plug the transistor into the socket or, if necessary, connect the test leads as shown in the base diagram at the lower right of the panel.
4. Read leakage on the scale indicated in the chart. An average transistor should read in the green area of the scale indicated. See Fig. 2
5. Depress the Gain button. An average transistor should indicate in the green area of the GAIN scale.
6. A shorted transistor will be indicated by maximum leakage reading. An open transistor will be indicated by zero gain.

   Unfavorable readings for both leakage and gain should be indicated before rejecting a transistor.

How to Check Rectifiers and Crystal Diodes

1. Set the SELECTOR Switch to RECT-DIODE position and the RANGE switch to the ALL OTHER TESTS position.
2. Connect the red lead to the positive end of the rectifier or diode and the black lead to the negative end.
3. A rectifier or diode with good forward current will indicate to the right of the arrow on the lowest scale on the meter. See Fig. 2
4. Depress the GAIN button. A good rectifier or diode will read to the left of the left arrow. A shorted rectifier or diode will read about mid scale. An open rectifier or diode will not read on either test.

   The new dual silicon diodes should be checked with both sections in parallel. If either section is bad, the checker will detect it.

Why the TRC4 Uses a Set-Up Chart

The TRC4 uses a set-up chart in the same manner as a tube tester uses a set-up chart for different tubes. Transistors with higher current gain are biased with less base current so as to provide the same average collector current for every transistor. In this way, a single Gain scale can be used to indicate low, medium, or high gain.

The TRC4 is the only commercially available transistor tester using a set-up chart and therefore, the only tester designed to test all transistors accurately.

How to Get New Charts

New charts are printed periodically. Sencore will mail charts directly to the user upon request. A more satisfactory system of distribution is available through a registration service. If you send one dollar to Sencore, Addison, Illinois, you will receive the next six mailings of the latest transistor set up charts. This means that you will get them before your distributor.

Where to Buy a TRC4 Checker

The TRC4 Checker is available from electronic parts distributors throughout America, Canada and other parts of the world. Three out of four Industrial and Service type distributors in America have it in stock.

Over 100 are sold every working day. You can recognize them by the blue and yellow cartons and by the colorful Sencore time saver displays. Price is $17.95 Dealer Net.

*PRESIDENT SENCORE
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RADIO

There were, as of that date, 61,502 first-class and 40,803 second-class licensed radiotelephone operators.

What the future holds

At present, operators of mobile radio systems as well as equipment manufacturers are keenly interested in the movement to make more communications channels available by splitting the present fairly wide channels. This means that much of the equipment now in use will be modified or replaced by equipment which will meet the operating requirements of the tightened technical standards. Some manufacturers offer conversion kits which users can install in existing mobile-radio equipment to make it suitable for split-channel operation.

Other technological improvements are hurrying the replacement of older models with new equipment designed for split-channel operation. All-transistor power supplies, for example, which eliminate the need for vibrators and dynamotors, offer the user greater reliability and lower operating cost. While the eventual introduction of low-cost, all-transistor mobile radio equipment looms on the horizon, sales of equipment using both tubes and transistors are not lagging for fear of early adolescence.

Interest in selective calling has zoomed during the past year. Before the mobile radio channels became so congested, only token interest in selective calling was apparent. Now, however, the privacy and convenience of the dial telephone has accelerated interest in dial and pushbutton selective calling systems. Base-station operators can dial mobile units individually without alerting any of the others. They can also dial mobile units in groups, or all at once, when necessary. In addition, mobile units can dial other mobile units as well as alert specific base-station control points without disturbing others. Already, mobile units can dial into land-based telephone systems as simply as dialing long-distance calls without the aid of a human operator.

The next article in this series will discuss the circuitry and technical aspects of equipment used in mobile radio systems. TO BE CONTINUED

[Because March RADIO-ELECTRONICS will be a SPECIAL STEREO ISSUE, Part III of "ABC's of Mobile Radio" will appear in April.]

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SUDDENLY ... the whole world discovers there's NO FINER TWEETER than RADIO SHACK'S $27.50 "Realistic" ELECTROSTAT-3!

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REALISTIC CROSSOVER NETWORK KIT

Includes coils, condensers and L pad; with simple assembly instructions and diagram.

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16 OHMS — Order No. R-4851 **$4.95**

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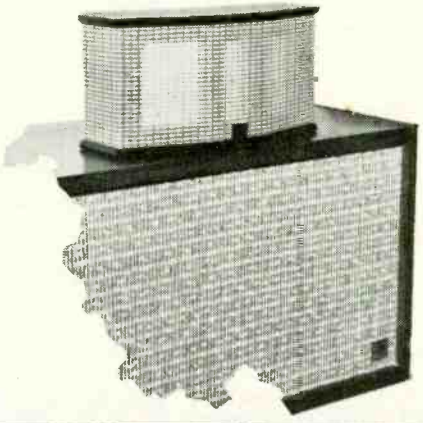

AR-2 WITH ELECTROSTAT-3

SPECIAL LOW PRICE for AR-2 system! Includes unfinished AR-2 speaker, unfinished ELECTROSTAT-3 and 8-ohm crossover network kit.

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FABULOUS AR-1 system includes unfinished AR-1 speaker in cabinet, unfinished ELECTROSTAT-3 and 8-ohm crossover network kit.

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Radio Shack Introduces an Unbelievable Tuner Bargain!

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16" Tone Arm, G-E GC-7 Diamond Cartridge, Mark-VII Turntable, Maple Base, Regular $101.87.

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	AR-1 with Elec. 3	70 lbs.	RX20029Y	189.50
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	Stereo Master with 2-15-Watt Amps.	33 lbs.	R-7243CAF15	89.95
	Mark VII Trntble.	16 lbs.	R-7903	49.50
	St. Mark VII Sys.	30 lbs.	RX-TS16Y	79.50

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☐ Radio Shack 1959 Hi-Fi Buying Guide

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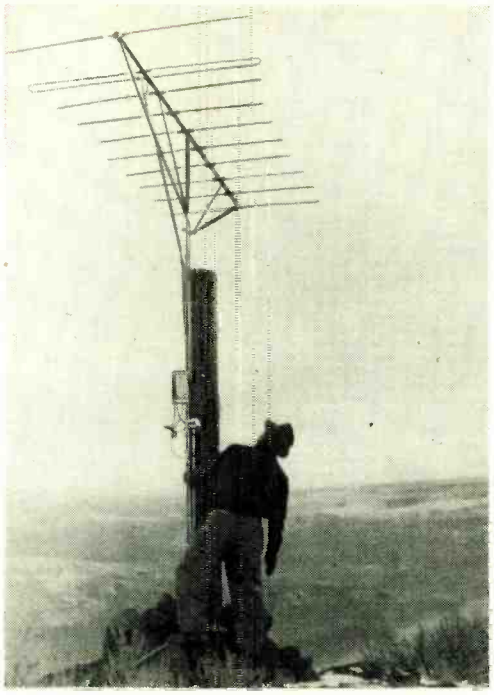
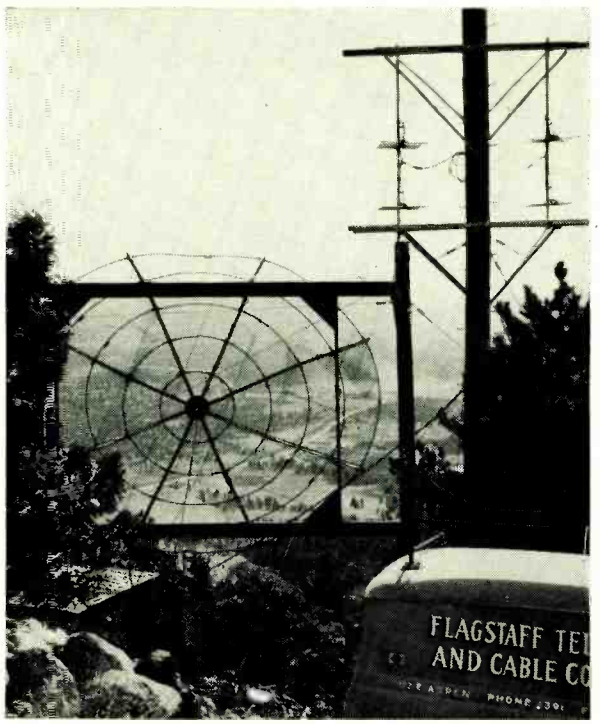
WHO owns the Signal?

Growth of television in small communities is being hampered by the question of signal "ownership." Legislation may be needed to break this roadblock



Unlicensed boosters bring television to isolated areas despite the FCC's efforts to close them down. They rebroadcast the programs of other stations without regard to legal niceties.



Community antenna systems distribute programs by cable for a monthly fee. Since they're not classed as "broadcast services," they need not obtain permission to repeat station's signals

By DAVID LACHENBRUCH

A second-hand television picture looks just like a first-hand one. The signal's electronic characteristics are identical. But there's an important difference—and this difference is stunting the growth of television service in some small communities.

Most people, of course, receive their TV signals first-hand from one or more of the 550 stations now operating in the US—that is, from station to TV set without any intermediate electronic steps. But many isolated areas, distant or shadowed from TV stations, are forced to use in-between devices to soup up or repeat the signal. If they want TV at all, they must get it second-hand.

Three techniques are used to bring second-hand television from hilltop reception points to communities which otherwise would have little or no TV:

1. Uhf translators. There are now nearly 175 of these 10- to 100-watt repeaters on the air. Licensed and carefully regulated by the FCC, they receive signals from distant TV stations, "translate" them (without demodulation) to uhf channels between 70 and 83 and rebroadcast them.

2. Boosters or "reflectors." Perhaps 1,000 of these are in operation, despite efforts of the FCC to shut them down and keep them off the air. These unlicensed stations bring their communities bootleg TV—even though they are often constructed and operated by civic-minded individuals or cooperative groups—as they operate without regard to FCC standards or licensing. A booster receives and amplifies programs of one or more distant stations and beams them to the community on the same channel as the originating station.

The FCC objects to boosters because —being on the transmitter's own frequency—they often cause interference to direct reception of TV stations. Usually the booster installations are of the most rudimentary type and, according to FCC officials, may emit radiation which could interfere with vital radio services such as aircraft beacons.

3. Community antenna TV (CATV) systems. Charging subscribers for installation and monthly service, these privately owned systems use hilltop receiving antennas or microwave relays to bring in the signal, which is distributed to subscribers' homes by cable.

All three systems bring programs to families which otherwise would not have TV. They result in business for TV manufacturers, retailers and service technicians. A recent FCC survey of 102 translators showed that 72 were owned by nonprofit cooperatives set up for the purpose, 8 by TV broadcasting stations to improve their coverage, 8

Non-profit translator stations, encouraged by the FCC, are required by law to obtain permission from the stations they rebroadcast. An economic squeeze sometimes forces stations to withhold permission.

by private individuals or firms as a public service and 14 by local civil governments. TV technicians and dealers often are prime movers in the translator cooperatives. Obviously, the more people reached by TV, the more TV sales and service business.

It's FCC policy to encourage the construction of translators to extend free, lawful TV service to small and remote communities. But community-minded groups in several areas have hit a stone wall in their efforts to put translators on the air. In at least one town, a large sum raised by public subscription may have to be refunded.

The roadblock: "Ownership" of TV signals.

There's only one Federal law which directly regulates pickup and redistribution of TV programs—the Federal Communications Act, under which the FCC operates, and which was written long before the advent of television. Among its many provisions, it bans the rebroadcasting of television or radio programs without permission of the originating station.

"Rebroadcasting" is the key word.

How does this apply to each of the three types of "second-hand" television systems?

Community antenna systems don't need permission. They don't "rebroadcast." State courts have ruled that CATV is merely "an extension of the receiving set." The FCC has not assumed jurisdiction over CATV and commission members and staff experts informally agree that community antenna distribution can't be considered "rebroadcasting" by any stretch of the imagination.

Unlicensed boosters rebroadcast without permission. They're already regarded as outside the law—so what difference does another violation make?

Translators *must* have permission to rebroadcast or lose their authority to operate—it's written into their FCC charter.

All of the translators now in operation have permission from the originating stations, of course. But plans for many a translator have been scuttled by withholding of rebroadcast rights.

Stations refusing rebroadcast rights usually do so for economic reasons which are hard to pin down—sometimes because of friendly relations with a CATV system in the area, sometimes because TV film program distributors or broadcast unions want additional payment for "rebroadcasts." Often there are more complex, sometimes personal—or even political—reasons.

In the long run, it pays a station to have its programs rebroadcast by translators. Since both stations and program owners are paid according to the size of the audience reached, anything that increases their audience also boosts their revenues.

How to break the log jam?

Borrowing from another field of Federal regulation, one possible solution is suggested by a law which already exists in the patent field. A patent owner *must* license others to use his invention (for a reasonable fee) if withholding it would tend to produce monopoly.

A somewhat similar regulation could be added by Congress to the Communications Act. It would require telecasters to permit rebroadcasting of their programs by nonprofit repeaters in communities which have no TV stations of their own.

Such a law would take the broadcasters off the hot seat—and many of them would be happy to be relieved of the stigma of responsibility for denying TV service to small communities.

But more important, it would give equal program access to the only "second-hand" TV system which is both free and legal. END

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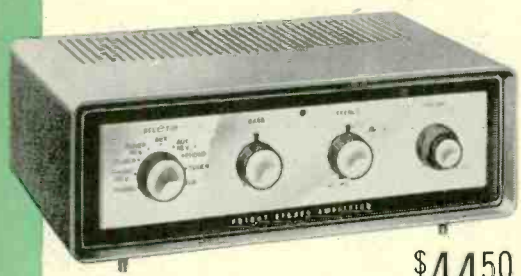

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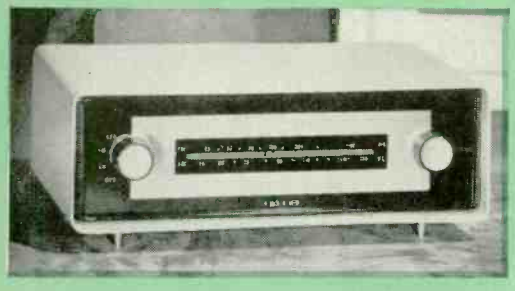

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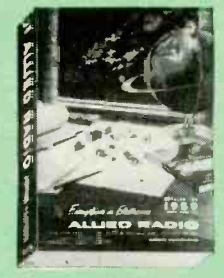

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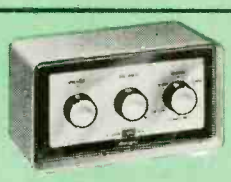

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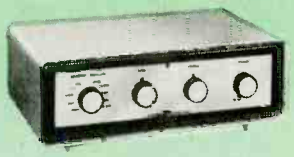

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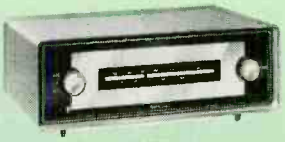

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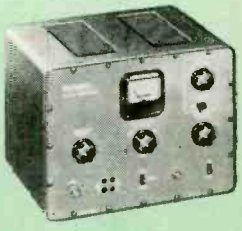

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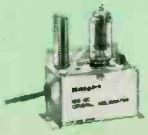

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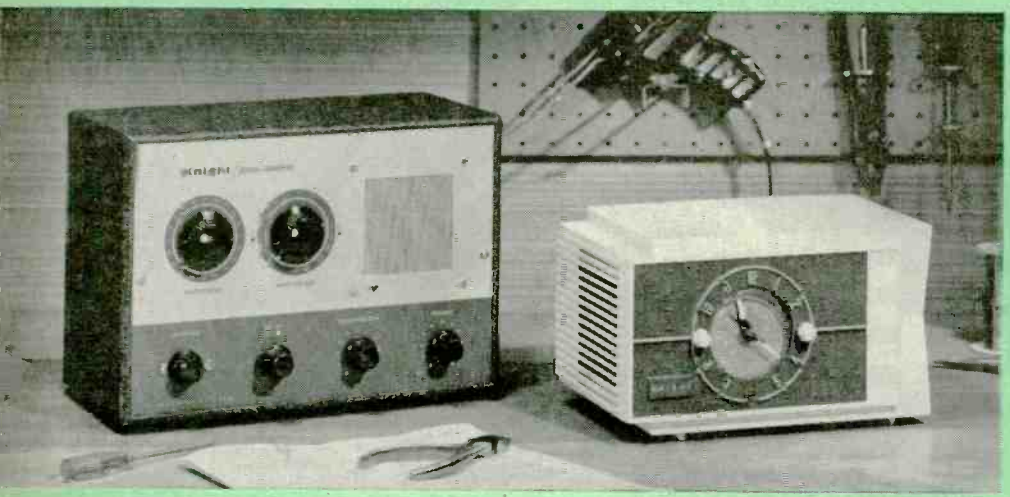

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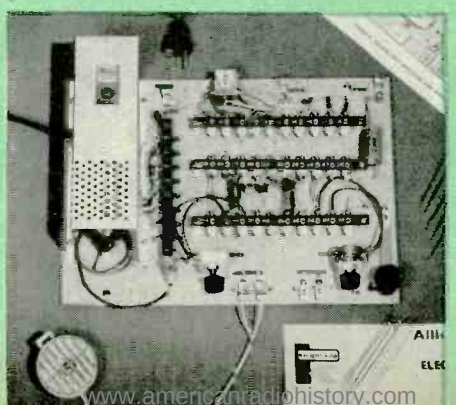

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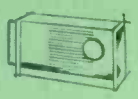

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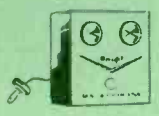

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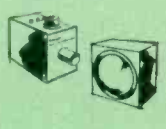

Ultra-sensitive relay at very low cost. Fine for automatic control of lights, door openers, as a burglar alarm, etc. Shpg. wt., 3½ lbs.
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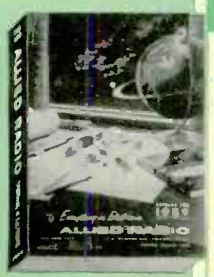

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CAUSES of poor picture quality have been pointed out in previous Clinic columns, but the mailbag indicates that this is a continuing bench problem. Hence, we are going a bit farther into this subject.

Poor picture quality is often seated in the video amplifier. This circuit looks simple. On the other hand, a sweep-frequency check often shows that off-value or faulty components are causing peaked response or loss of low- or high-frequency response.

Fig. 1 shows how excessive shunt capacitance across a point in the video amplifier circuit causes loss of high-frequency response. Leads to the picture tube are a case in point. Press the video signal lead against the chassis or lengthen it arbitrarily, and you will see high-frequency response slump off. Pictures lose their sharpness and become blurry.

Loss of high-frequency response is also caused by load resistors too high in value or by faulty decoupling capacitors. Loss of low-frequency response is caused by load resistors too low in value or by grid-coupling (also screen-bypass) capacitors which are too small. (See Fig. 2.)

Sharp peaks in the video amplifier frequency response cause circuit ghosts in the picture. Peaks result from faulty bypassing or from careless replacement of peaking coils. Improperly spaced peaking coils couple into each others' fields and cause peaks in the response curve.

Defective decoupling capacitors often permit the entry of spurious ac voltages into the video amplifier. This not only shows up as interference in the picture background, but can also cause loss of interlacing, which is generally blamed on the integrator. Fig. 3 shows a well-interlaced raster, compared with line pairing from spurious video voltages.

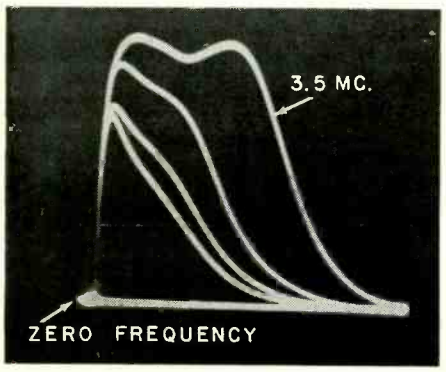

Fig. 1—If the video signal lead to the picture tube is progressively lengthened, the video frequency response curve slumps off at the high-frequency end.

630 conversion

I would like to convert an RCA 630 to use a 21AMP4-A picture tube. I have a Merit HVO-55 flyback, MFD-91 yoke and a Stancor A-8150 vertical output transformer. What circuit should be used in making this conversion?—S. W. F., Camden, N. J.

We would not advise this conversion as a paying proposition. However, as a hobby project, in which cost is not the governing factor, it can be done. It would be advisable to rewire the sweep circuits and sync section in accordance with the circuit used in the RCA KCS-92 receiver. Tube changes will be required. We would point out that several versions of the 630 were on the market, some of which had no age. If yours is of this vintage, it would be advisable also to wire in a keyed-age circuit as in the KCS-92 diagram. A better solution, making for a much simpler job, is to use a 21EP4 as in the following item.

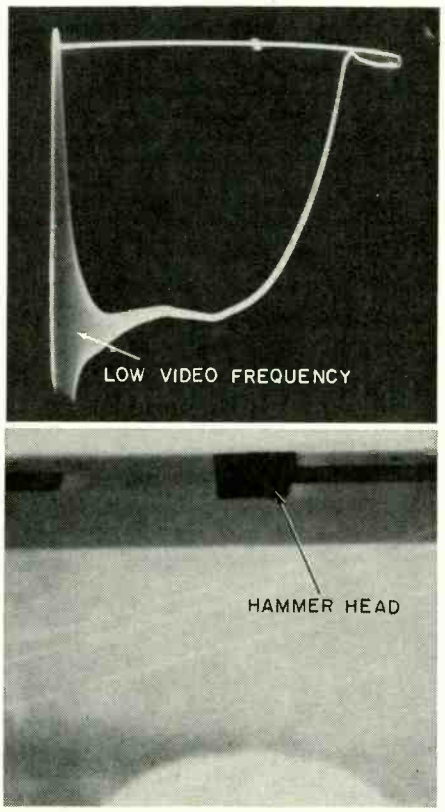

Fig. 2-top—Scope pattern showing poor low-frequency response; bottom — a good hammer head, blacker than the background, indicates good low-frequency response in video circuits.

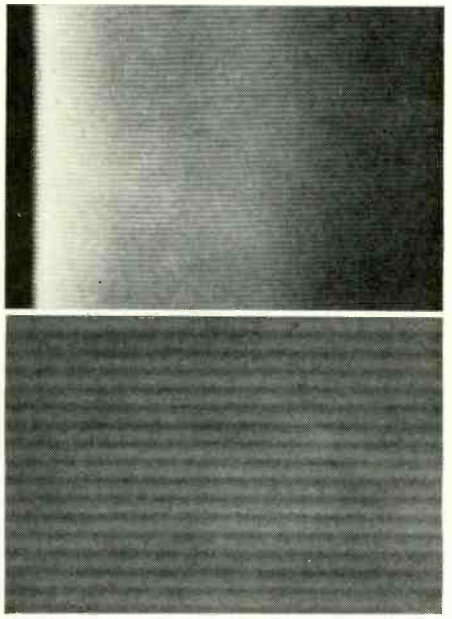

Fig. 3—(Top) Good interlacing; (bottom) line pairing.

21-inch conversion

I would like to convert a 10-inch RCA 630-TS receiver to a 21-inch tube. What is the best picture tube to use?—B. C., New York, N. Y.

We would suggest a 21EP4 for this conversion. It is relatively easy to sweep and is economically priced. You will have to get a matching yoke and flyback. Your present vertical output transformer will probably serve OK. If there is insufficient height, try shunting a 50-μf capacitor from cathode to chassis in the 6K6 vertical output circuit.

Aluminized substitute

What aluminized tube could be substituted for a 21KP4-A?—J. D. K., Gary, Ind.

A 21FP4-C can be used here. Note however, that unless rated second-anode voltage is available, there will be no advantage in contrast and brightness. The 21FP4-C has "automatic" focus. A 100,000-ohm resistor between its cathode and focus electrode will probably give good focus. However, for sharpest

focus, wire in a 500,000-ohm pot and adjust for best results.

Adjacent-channel rejection

I would like to obtain greater adjacent-channel rejection on a Zenith 22R20. I have tried adding another 47.25-mc trap in parallel with the trap

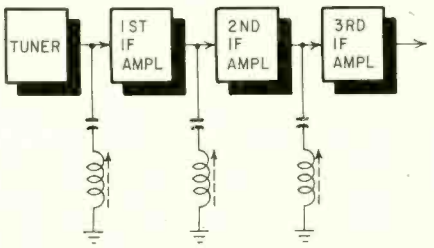

Fig. 4—Correct method of adding traps to boost adjacent-channel rejection.

at the first if grid, but rejection is not increased. A strong channel 3 signal interferes with a fringe station on channel 4. Other sets with higher rejection perform satisfactorily.—(initials withheld by request)

Adding another trap in parallel with one of the same frequency is not an effective method of obtaining increased rejection at a given frequency. The second trap should be added at the grid of the second if amplifier (see Fig. 4). Tune this trap to the picture-carrier frequency of channel 3. If interference still persists, use another trap at the grid of the third if amplifier. Tune the trap to either the picture-carrier or sound-carrier frequency of channel 3, as required. A good sweep and marker generator will be very useful here.

No high voltage

I have an unusual problem with a Philco 52T1810. It came in for no high voltage. The width coil was burned out. I used a Merit MWC2 width coil and the set worked OK. On a callback next day, the trouble was identical. I replaced the coil with a Philco 33-4486-6 unit, but it runs too hot. The coil takes 35 ma dc, which is normal for another receiver. All associated capacitors have been replaced. The 6CD6 cathode current is OK. The flyback and yoke have been replaced. Operating voltages are normal. Can you give me any help with this problem?—M. S., Saddle River, N. J.

This is evidently a problem of excessive alternating-current flow through the width coil and flyback, rather than too much direct current. Excessive ac results from unfortunate stray parallel resonances in the system. The condition should be investigated with a scope. A simple and effective method of correcting the condition would be to operate without the width coil, or with a considerably larger width coil, to "kill" this apparent resonance. Then, if the picture is too wide, slide an aluminum-foil sleeve under the yoke.

Slow warmup?

An RCA 7T122 has a very dull picture for the first 5 minutes after being

TELEVISION

turned on. Contrast and brightness controls have no effect. Then the receiver suddenly starts operating properly. The picture tube is old. Would you suspect the picture tube, or look for some kind of circuit trouble?—W. W. S., New York City

A quick check can be made by monitoring the voltages at the picture-tube socket, with the socket unplugged from the tube. If these voltages are normal when the receiver is turned on, the picture tube is causing the trouble. Otherwise, the fault will be found in the circuit (or circuits) which are supplying the incorrect picture-tube voltages.

Self-oscillation

On a Muntz 17B6, when I make a service call, all I need to do is to touch the top of the 1B3 or the 6BQ6, and the picture comes in OK. It works for about 4 months and the same condition returns. Do you have any suggestions that may help?—C. F. W., Detroit, Mich.

This is a typical condition of self-oscillation of the sweep section with other receiver sections. First, shunt

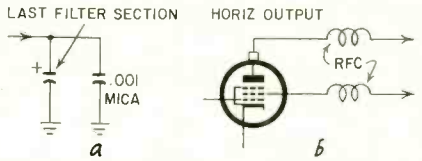

Fig. 5—Marginal instability caused by electrolytic capacitors can be corrected by shunting with .001-μf mica capacitors; b—rf chokes at plate and screen of the horizontal output tube often help. Use about 100 μh.

the large electrolytic in the flyback section with a .001-μf capacitor. Also shunt a .001-μf capacitor across the output filter capacitor. This will probably kill the marginal feedback causing the trouble. However, should further attention be required, connect rf chokes in series with the plate and screen terminals of the horizontal output tube (see Fig. 5).

Color trouble

I have had somewhat the same problem as J. H. C. (RADIO-ELECTONICS, *August, 1958, page 49) on an RCA CT-100 color receiver. It is a fault which shows up only on color reception. Large red areas appear green, with severe trailing greens on the entire picture. Also, after 2 hours there is vertical sync drift. Your help will be appreciated.—E. M., Jr., Rochester, N. Y.*

The trouble appearing as green in large red areas, with trailing smear, should be analyzed with a scope and low-capacitance probe. The CT-100 is an I–Q receiver. Since there is no evidence of blue chroma trouble, start checking at the red and green matrices, with a standard NTSC color bar signal applied to the receiver. The circuit at fault will show up as a long-drawn-out

decay of the square wave corresponding to the red bar. You may also find this fault in the green matrix. Follow the distorted waveforms back through the I and Q channels with the probe and scope. Note the first point at which this distorted square wave appears. Then, check out the individual circuit components in the faulty circuit.

Poor picture

A Sentinel 3V500 came into the shop with a complaint of poor picture. The if strip is out of alignment. I can adjust the if coils to get a peaked response curve with about a 2-mc bandwidth, but picture and sound are not good (see Fig. 6). I find it impossible to align according to specifications. All if components check out OK.—S. H., Arlington, Minn.

This is a fairly common difficulty, and there are several possible causes which must be eliminated one by one.

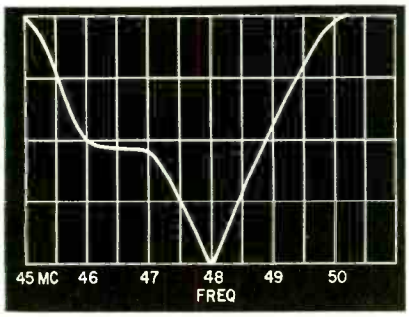

Fig. 6—The if response curve has a stubborn, sharp peak and inadequate bandwidth. Possible causes of regeneration should be checked.

A sharp peak in the response curve points to regeneration. If the override bias is increased during alignment, the peak usually disappears and a fairly normal curve can be obtained. But when the bias is reduced, the peak pops right up again. It can be caused by use of incorrect high-frequency grounding points when replacing bypass capacitors or if coils. Poorly soldered ground connections or disturbed high-frequency lead dress can also be responsible. Bypass capacitors which are not open but which have low capacitance are sometimes the culprit. Sometimes the leads on replacement capacitors are left too long. Heater wiring is critical in some cases. It should be dressed closely against the chassis. Sometimes a replacement tube has been used which has too high g_m for the circuit.

Sync buzz

A Motorola TS-174-B has a stubborn sync buzz. The brightness and contrast controls must be full on to get a fair picture, and some channels are washed out. The buzz changes with the setting of the fine tuning. Traps were adjusted and a new crystal diode installed. Tubes, including the picture tube, are presumably good.—J. R. Z., Aliquippa, Pa.

Sync buzz is often caused by misalignment. It is advisable to use a

(*Continued on page* 108)

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, 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.

Model TW-11—TUBE TESTER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months if satisfactory. Otherwise return, no explanation necessary!

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

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SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

Model 82A — TUBE TESTER . . . Total Price $36.50 — Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

(1) **Turn the filament selector switch to position specified.** (2) **Insert tube into a numbered socket as designated on our chart (over 600 types included).** (3) **Press down the quality button —**

THAT'S ALL! Read emission quality direct on bad-good meter scale.

Primarily, the difference between the conventional tube tester and the multi-socket type is that in the latter, the use of an added number of specific sockets (for example, in Model 82A the noval is duplicated eight times) permits elimination of element switches thus reducing testing time and possibility of incorrect switch readings.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch—THAT'S ALL! Read quality on meter. Inter-element leakage, if any indicates automatically.

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

....*FEATURES*....

- Tests over 600 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82A comes housed in handsome, portable, Saddle-Stitched Texon case. Only .....

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SEE PAGE 107 FOR COMPLETE DETAILS

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES

Model 83—C.R.T. TUBE TESTER . . . Total Price $38.50—Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

Test ALL picture tubes—in the carton—out of the carton—in the set!

- Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only **$38.50**

SUPERIOR'S NEW MODEL TV-12

TRANS-CONDUCTANCE TUBE TESTER

Model TV-12—TUBE TESTER . . . Total Price $72.50—Terms: $22.50 after 10 day trial, then $10.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

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%.
- ★ SAFETY BUTTON — protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.
- ★ 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.

TESTING 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.

ALSO TESTS TRANSISTORS!

Model TV-12 housed in handsome rugged portable cabinet sells for only **$72.50 NET**

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SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Model 77—VACUUM TUBE VOLTMETER . . . Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, No explanation necessary!

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Model 77 uses new improved SICO printed circuitry.
- Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.
- Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

SPECIFICATIONS

• **DC VOLTS** — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)** — 0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak) — 0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER** — 0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBEES** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER** — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only .....

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SUPERIOR'S NEW MODEL 79

SUPER-METER — WITH NEW 6" FULL-VIEW METER

A Combination VOLT-OHM MILLIAMMETER.

Plus CAPACITY, REACTANCE, INDUCTANCE AND DECIBEL MEASUREMENTS.

Also Tests SELENIUM AND SILICON RECTIFIERS, SILICON AND GERMANIUM DIODES.

Model 79—SUPER-METER . . . Total Price $38.50—Terms: $8.50 after 10 day trial, then $6.00 per month for 5 months if satisfactory. Otherwise return, no explanation necessary!

The Model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development.

In 1938 Superior Instruments Co. designed its first SUPER-METER, Model 1150. In 1940 it followed with Model 1250 and in succeeding years with others including Models 670 and 670-A. All were basically V.O.M.'s with extra services provided to meet changing requirements.

Now, Model 79, the latest SUPER-METER includes not only every circuit improvement perfected in 20 years of specialization, but in addition includes those services which are "musts" for properly servicing the ever increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

Specifications

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
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.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
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The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. **All Germanium Diodes.**
All Silicon Rectifiers. **All Silicon Diodes.**

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SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!

- √ R.F. Signal Generator for A.M.
- √ R.F. Signal Generator for F.M.
- √ Audio Frequency Generator
- √ Bar Generator
- √ Cross Hatch Generator
- √ Color Dot Pattern Generator
- √ Marker Generator

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

Model TV-50A GENOMETER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary!

Specifications

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. 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).

The Model TV-50A comes complete with shielded leads and operating instructions. Only

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For the first time ever: ONE TESTER PROVIDES ALL THE SERVICES LISTED BELOW!

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ALL PURPOSE BRIDGE

Model 76 . . . Total Price $26.95—Terms: $6.95 after 10 day trial, then $5.00 monthly for 4 months if satisfactory. Otherwise return, no explanation necessary!

IT'S A CONDENSER BRIDGE

with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

IT'S A RESISTANCE BRIDGE

with a range of 100 ohms to 5 megohms

IT'S A SIGNAL TRACER

which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

CAPACITY BRIDGE SECTION

4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts and leakages up to 20 megohms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

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. Provision has been made for use of phones and meter if desired.

IT'S A TV ANTENNA TESTER

The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

RESISTANCE BRIDGE SECTION

2 Ranges: 100 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

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? 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

Model 76 comes complete with all accessories including R.F. and A.F. Probes; Test Leads and operating instructions. Nothing else to buy. Only

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Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligation.

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Address .....

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

All prices net, F.O.B., N. Y. C.

- ☐ **Model TW-11** ..... **Total Price $47.50**
  $11.50 within 10 days. Balance $6.00 monthly for 6 months.
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  $6.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model 83** ..... **Total Price $38.50**
  $8.50 within 10 days. Balance $6.00 monthly for 5 months.
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  $22.50 within 10 days. Balance $10.00 monthly for 5 months.
- ☐ **Model 77** ..... **Total Price $42.50**
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- ☐ **Model 79** ..... **Total Price $38.50**
  $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model TV-50A** ..... **Total Price $47.50**
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- ☐ **Model 76** ..... **Total Price $26.95**
  $6.95 within 10 days. Balance $5.00 monthly for 4 months.

TELEVISION

(*Continued from page* 103)

good sweep and marker generator, and put the rf and if sections in good alignment. Also check the ratio-detector alignment. If you need to go farther, check C52—this is the ratio-detector charging capacitor. Low capacitance or high power factor here can cause buzz. Since the sound signal is passed through the video amplifier, nonlinearity of amplifier operation can cause buzz. Your report does not give voltages, but these should be checked in the video amplifier circuit.

Flyback replacement

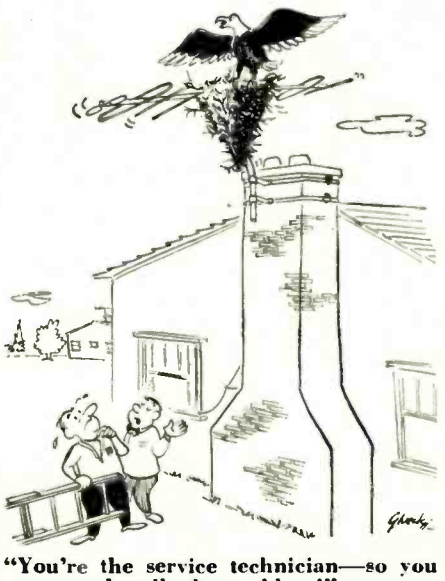
I have a Mirrortone chassis 9049 with a burnt-out horizontal output transformer. Could you tell me what transformer I can use and how to rewire the chassis?—E. B., Buffalo, N. Y.

You can use a Stancor A-8144, Merit A-3038, Triad A-99X, Halldorson Z1802 or Thordarson 26553. You willl have to drill one new mounting hole and connect the primary and secondary in series as an autotransformer. To connect the transformer, compare the schematic in the carton with the schematic diagram of the receiver, and wire accordingly.

Vertical weaving

A Stromberg-Carlson 119C shows a weaving vertically on network programs. There is no weaving on local programs. How can this trouble be localized?—A. M. D., Glen Burnie, Md.

The weaving is caused by power hum which is not synchronized with the local utility frequency. The filtering is probably inadequate in the receiver, which causes a fairly high ripple in the plate supply voltages. Improving the power supply filtering will probably correct the trouble. There is also a possibility that 60-cycle hum is getting into the signal from a tube heater–cathode leak, or a circuit fault equivalent to it. However, first check the B-supply line with a scope. END



"You're the service technician—so you handle the problem!"

new SOUND DETECTOR SYSTEM for TV

This simplified FM demodulator circuit converts the signal to AM before detection

By ROBERT F. SCOTT
TECHNICAL EDITOR

THE 1958 Hotpoint 14S208 and 14S209, 14-inch portable TV sets using the Q3 chassis, feature a radically different type of FM audio detection, called the *Delta Sound System*, that keeps cost down without degrading audio quality. In this system, the commonly used ratio detector, gated-beam and Foster-Seeley discriminators have been replaced by a circuit that converts the FM signal to AM before detection. A special circuit has been added to cancel out any AM interference or noise that may ride in on the FM carrier. The frequency discriminator used here is a time-rate demodulator—commonly called a slope detector. It produces an rf output voltage whose amplitude is directly proportional to the frequency swing of the FM signal. See Fig. 1.

Fig. 2-a shows the resonance curve of a parallel-tuned circuit. The voltage is maximum at resonance and falls off as frequency is shifted to either side of resonance. In slope detection of an FM signal, the circuit is adjusted so that the carrier frequency falls on the linear portion of one of the slopes—point A or B, for example. Now, as the frequency of the FM carrier varies with modulation, the voltage across the tank circuit swings in amplitude. A linear swing of the FM carrier produces a linear change in the amplitude of the rf signal developed across the circuit. This is shown in Fig. 2-b.

Assume that the carrier at rest (4.5 mc) develops 10 volts. If it swings 10 kc to 4.49 mc and develops 15 volts, a 10-kc swing in the opposite direction to 4.51 mc will develop 5 volts across the circuit. *Thus the voltage across the tank is converted from a constant-amplitude FM signal to an amplitude-modulated signal with the same carrier frequency.* The resulting signal is then fed to any convenient type of AM detector for demodulation.

There are two good reasons why this simple discriminator is suitable for modern TV sets but not for tunable FM sets. First of all, the resonant tank responds to signals falling on either slope of the curve. The overall selectivity of the average receiver is not great enough to prevent interference from other incoming signals that may produce an intermediate frequency falling on the discriminator's curve.

This problem seldom exists in an intercarrier TV receiver because the 4.5-mc intercarrier sound signal is generated in the set's video detector as the result of the beat between the video and sound carriers and not the result of heterodyning a single incoming signal in the set's mixer. Also, the sound if response is sharper in a TV set than in an FM broadcast receiver because of the lower intermediate frequency and the narrower carrier TV sound swing.

Secondly, the desired FM carrier must be centered on a linear portion of the discriminator's curve to provide good linearity and distortion-free reception. In an FM receiver, slight mistuning or oscillator drift may cause the if signal to swing over a nonlinear portion of the discriminator curve and produce distortion. This doesn't happen in a TV receiver because the 4.5-mc carrier frequency is constant regardless of receiver tuning or oscillator drift.

How the Delta Sound System works

In this circuit (Fig. 1), the 4.5-mc intercarrier sound carrier signal is tapped off the plate of the video amplifier and fed to the grid of the 4.5-mc sound if amplifier V108. The output of this amplifier is developed across the primary of T301, a bifilar-wound 4.5-mc

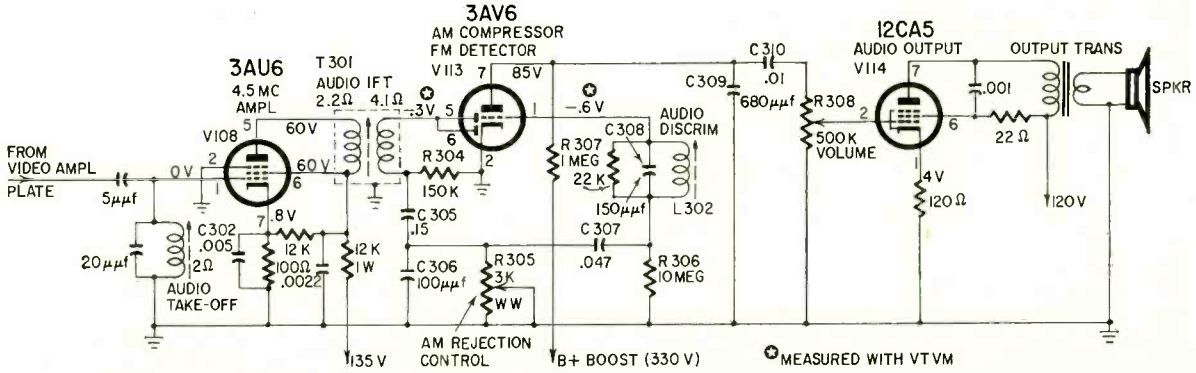


Fig. 1—Circuit of Delta Sound System used in two Hotpoint portable TV receivers.

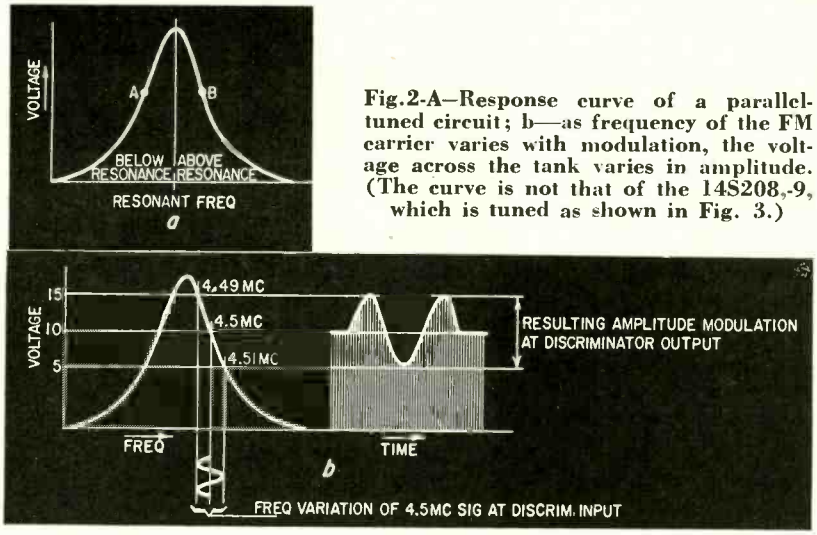


Fig. 2-A—Response curve of a parallel-tuned circuit; b—as frequency of the FM carrier varies with modulation, the voltage across the tank varies in amplitude. (The curve is not that of the 14S208,-9, which is tuned as shown in Fig. 3.)

if transformer. The signal voltage on the secondary side of T301 appears across the winding, C305 and the parallel combination of C306 and R305. The signal thus developed is applied to the diode (AM compressor) plates of V113.

When the diode is conducting, it loads the plate circuit of V108 and compresses the signal envelope, thus limiting the signal and reducing the percentage of modulation of any stray noise, sync pulses and automotive ignition interference that may appear as amplitude modulation on the 4.5-mc FM carrier.

The dc component of the rectified signal returns to the cathode of V113 and ground through R304. A small predetermined portion of the compressed FM carrier and any residual AM interference appear across C306. This signal is fed to the grid of V113 through coupling capacitor C307 and the 4.563-mc tank circuit (L302–C308).

The tank circuit and the input capacitance of the triode section of V113 form a discriminator whose resonant frequency is such that the 4.5-mc carrier falls on the linear portion of one of its slopes. See Fig. 3. As explained earlier, a linear deviation in carrier frequency produces a linear change in its amplitude. This 4.5-mc AM signal is applied to V113's grid.

During the first few cycles of the 4.5-mc AM signal, V113's triode acts as a grid detector, rectifying the signal in the grid–cathode circuit. Grid current flows through R306 and develops a voltage drop that charges C307 and biases the grid almost to cutoff. This is the correct condition for plate detection.

With the grid biased to cutoff, V113 now acts very much like a class-B amplifier. Positive swings of the 4.5-mc AM grid signal are amplified, producing pulses in the plate circuit. The average value of these 4.5-mc pulses corresponds to the modulation envelope. The 4.5-mc rf signal is bypassed to ground through C309 and the audio component is developed across plate load resistor R307. (The plate detector is also called a bias or power detector.)

The audio voltage developed in V113's plate circuit is applied to the volume control through C310. Filter capacitor C309, volume control R308, plate resistor R307 and V113's internal plate resistance together form a deemphasis network. The signal across the volume control is applied to the grid of the audio output tube V114 which develops 0.7 watt undistorted and 1 watt maximum output.

Cancelling residual AM

The unwanted AM signal that remains on the 4.5-mc sound carrier after compression in V108's plate circuit is cancelled out so it does not appear in the output. Positive-going AM noise pulses on the FM sound carrier envelope are rectified by the compressor diode and appear as negative-going spikes across R305. These negative spikes are applied to V113's grid and produce positive-going pulses in the plate circuit.

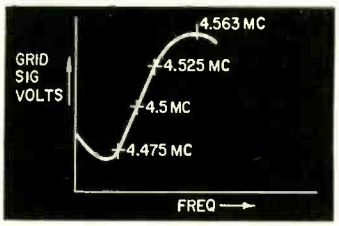


Fig. 3—A discriminator peaked at 4.563 mc lets the 4.5-mc carrier fall on the linear portion of the slope.

Simultaneously, the original positive-going pulses on the carrier envelope produce negative-going pulses in the plate circuit of V113 when applied to the grid. Thus, interference on the FM carrier envelope produces simultaneous negative- and positive-going pulses in the detector output. The AM REJECTION CONTROL (R305) may be adjusted so the noise pulses at V113's plate are of equal amplitude so they cancel out and do not appear in the audio output. The control must never be set in the full clockwise position (resistance shorted out) because this will shunt the 4.5-mc signal to ground and prevent it from reaching the discriminator circuit. END

STANDING WAVES and NO COLOR

By ROBERT G. MIDDLETON
RADIO-ELECTRONICS TELEVISION CONSULTANT

Fuzz runs into an unusual problem—color on some channels and none on another

"WHAT have you been doing for excitement lately?" asked Fuzzball, as he dropped into a chair near the door.

"It was a nice day," Bess replied. "What'll you have, boy?"

"Scramble two, on toast," Fuzz ordered.

Bess raised her voice 15 db. "Adam and Eve on a raft—wreck 'em!" she called to the cook.

Red set down his cup and leaned back grinning. "Bess learned her trade in the old school," he observed.

"Say, Red."

"Shoot."

"You'll figure I'm off my rocker when I tell you about this one."

"Now where would I ever get that idea?" Red asked innocently.

"I been beating the devil around the stump so long on that saloon job that I've just about had it."

"What's the general complaint?"

"Well, on the rainbow generator, the set works OK. Get a good pattern. On channel 5 the color broadcast comes in OK. But on 2 I get black-and-white with no color."

An amused smile spread over Red's face.

"What are you using for an antenna —a wet finger?" he asked.

"Try again," Fuzz replied. "We got a conical on the roof of the saloon."

"Conical's a good one for color in this area," Red agreed. "Well, maybe you might have noticed something, and again maybe you didn't."

"Such as?"

"Can you get color on 2 if you slide a hunk of tinfoil along the lead-in, or trim it to a critical length?"

"I never thought to try," Fuzzball replied.

"Do you see what I'm driving at?" asked Red.

"I'd make a wild guess you're hinting that there's standing waves on the lead-in."

"Eggszactly," Red replied, "and you can eat your eggs now, if you want to—Bess brought 'em, you know."

"No. I didn't know," Fuzz admitted, "you got me so confused."

"You're confused over a case of standing waves?" Red groaned.

"I'm buffaloed," Fuzzball admitted.

"Maybe I should draw you a diagram," Red suggested. "But here's the pitch. If the front end doesn't match the lead-in, there's going to be reflections back from the set. Then, if the antenna don't match the lead-in, there's re-reflections from the antenna. Take a bad case, with certain lengths of lead-in, and the color signal gets cancelled out. Now do you see the picture?"

Fuzzball's fork stopped halfway to his mouth. "I got you, Red," he replied. "The color signal can get knocked down without knocking the black-and-white signal."

"Absolutely! You'll even see cases where the contrast is built up on the black-and-white, and the color signal is weakened so much that the color killer won't kick out."

"I suppose I could put in a new tuner strip on 2," Fuzz suggested.

"Probably would help some," Red agreed. "But quite a bit depends on the signal strength, too, with some of these tuners."

"What's signal strength got to do with it?" Fuzzball demanded.

"Simply this," explained Red. "A weak signal puts little or no agc bias on the rf amplifier, but a strong signal puts a high bias on the grid."

"So tell me something I don't know," Fuzz replied scornfully.

"Now hear this," grinned Red, "the input impedance of the rf amplifier tube depends on the grid bias unless the stage is neutralized."

"What are you trying to tell me, then?"

"Well, if the input impedance of the tube goes up or down, that impedance is reflected back through the coupling coils to the input terminals of the set."

"That makes sense," Fuzzball admitted.

"Glad I'm getting through to you," Red replied.

"If the input impedance don't stay put, then it's impossible to cure the trouble," Fuzzball suggested.

Use a pad

"Not at all," Red replied. "In fact, it's usually very easy. On a strong signal, you can cure an impedance symptom by padding the lead-in. Hand me that napkin. I'll sketch a couple pads and their formulas."

"I never thought of that," Fuzz mused.

"Some resistor outfits make neat little 300-ohm H-pads to give 3-, 6-, 12-, and 15-db losses," Red advised him. "Printed circuit."

"Just one thing," Fuzz protested.

"What's that?"

"There's a couple channels where the set wouldn't take much of any loss."

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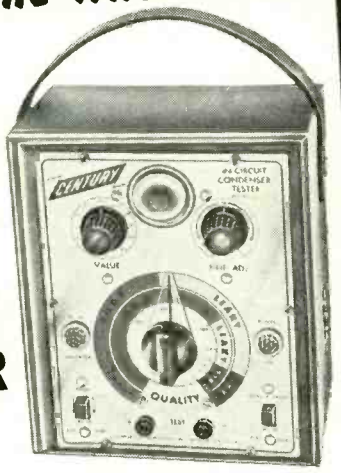

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- ✓ Checks for inter-element shorts and leakage.
- ✓ Checks for gas content.
- ✓ Checks for life-expectancy.

IMPORTANT FEATURES

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NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

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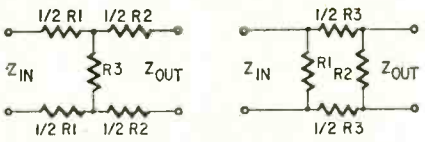

BALANCED T (H) PAD

$$R1 = R2 = Z_{IN}\left(\frac{\sqrt{K}-1}{\sqrt{K}+1}\right)$$

$$R3 = \frac{2Z_{IN}\sqrt{K}}{K-1}$$

BALANCED π (O) PAD

$$R1 = R2 = Z_{IN}\left(\frac{\sqrt{K}+1}{\sqrt{K}-1}\right)$$

WHEN $Z_{IN} = Z_{OUT}$ AND K = POWER RATIO = $\frac{\text{POWER IN}}{\text{POWER OUT}}$

The pads Red recommended. The resistors may be ¼-watt or smaller when used in TV receiving antenna circuits.

"So, you mount your H-pad inside the turret—connect it just to the channel-2 strip."

"That's pretty clever," Fuzzball said, opening his eyes.

"Think so?" asked Red. "You'll find it's got whiskers," he replied acidly.

"But how does the blamed pad work on standing waves?" Fuzzball demanded.

"Look at it this way," Red suggested. "The signal has to go through the pad to get to the set. Cuts the signal down to half, we'll say, just to take a practical example. There is a reflected signal that goes back through the pad the other way. The reflected signal is cut down by half."

"I see it all, now," Fuzzball said excitedly. "The reflection is cut down half before it gets back to the antenna. Then, the re-reflection gets cut down half again, going back to the set."

"Absolutely right," Red agreed. "The re-reflection ends up much weaker in proportion to the desired signal. And there's another advantage, too."

"What's that?"

"The signal strength is half as strong at it was. The agc bias decreases and the input impedance of the tuner changes. You get yourself a new operating point."

"So I could try out several different pads on a strong signal, to get normal color," Fuzzball suggested.

"Right again."

"What would I do if the signal is on the weak side and I run into standing-wave trouble?" Fuzz asked next.

"Then, you got to put in a better antenna and bring the signal up," Red advised.

"What about cutting the lead-in to a critical length, like you said before?" Fuzz queried.

"It's a sloppy way of getting the color in," Red replied, "and we would never do it unless the set owner is tighter than the bark on a tree and won't buy the right antenna."

"What's your reason?" Fuzzball asked with a puzzled look.

"Lead-ins that work only at a critical length are always troublemakers," Red advised him. "Get a stiff wind, and the color is likely to pop in and out of the picture. Any change in the operating conditions and you've had it."

"I see what you mean," Fuzzball agreed. "I always figured that impedance matching was a bit of a joke."

"It's a lesser evil in black-and-white reception," Red replied, "but when it raises its ugly head in color TV you can have yourself a problem."

"That brings up something else," Fuzz remarked, "sort of along the same line. On a black-and-white program, the picture can be real lousy and nobody complains much. But when color comes on, they squeal like a stuck pig if there's just a little distortion in the image."

"Not *all* our customers," Red corrected him, "but there is a definite percentage of them that react just like you say."

"Maybe those extra-fussy ones will quiet down after they get used to color," Fuzzball suggested.

"Yes and no," Red replied. "Some of it is due to the novelty of color, of course. These people will be perfectly satisfied with a Technicolor movie, and then turn around and squawk if the color TV show isn't just as good or better. Then, on the other hand, there's a built-in human demand for perfection in color pictures. Ever do any color photography?"

"A little," Fuzzball admitted.

"How do you like your shots?" Red asked.

"To tell you the strict truth," Fuzzball replied, "there's always something somewhere in the picture that doesn't look quite natural to me."

"OK, guinea pig," Red replied, "so you see how it is."

"But I still like my color photos," Fuzzball protested.

"Of course," Red replied, "and our fussy customers will still like color TV shows when they understand these things."

"They should know that nothing is perfect in this world, and probably won't be in the next one either."

"You said a mouthful," Red agreed.

"But we shouldn't use that as an excuse to cover up for ourselves," Fuzzball suggested.

"You're in the right ballpark," Red agreed quickly. "We must never be satisfied with our *own* performance. Each day on the job, we got to try to do better than we did yesterday."

"Can't I ever sit back and coast a little?" asked Fuzzball plaintively.

"Look, buddy," Red said sharply, "you don't stand still in this racket. The minute you think you're standing still, you're just kidding yourself. You are really advancing to the rear, my friend."

"You're right, of course," Fuzz agreed. "This electronics business is moving so fast you can't even lie fast enough to keep up with it." Fuzz looked very smug.

"*You* could," Bess corrected him. "There ain't no bull in Mexico could throw *you*."

Fuzzball opened his mouth to reply.

"We got to get on our horse and shovel off," Red said loudly. "Come on, Fuzz." END

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Type T . . . for most economical replacement. Encapsulated in Mallo-Seal*, this lowest-priced model can stand 500 hours in boiling water. Available in handy packs of five each for mounting by leads, and in kits using plug-in rectifiers, with mounting hardware. 400 and 365 volt ratings, 0.5 ampere. Also available from 50 to 600 P.I.V. inclusive.

Trademark of P. R. Mallory & Co. Inc.

Type P . . . for plug-in replacement. Fuse model fits sets already converted to this type of silicon unit. Available in 5-packs, and as conversion kits for half-wave, full-wave or doubler application, with fuse clip and mounting hardware. 400 and 365 volt ratings, 0.5 ampere. Also available from 50 to 600 P.I.V. inclusive.

Type E . . . for higher reliability. Military grade "top hat" rectifier, hermetically sealed for jobs where you want the absolute peak in life and dependability. Two to a pack; rating is 400 volts, 0.75 ampere. Also available from 50 to 600 P.I.V. inclusive.

Junction Silicon Rectifiers

A completely new concept in silicon rectifier design gives these new Mallory models reliability never before possible. At the heart of each is a unique diffused junction silicon element, product of extensive Mallory research in semiconductors, which has these characteristics:

Low reverse leakage.....less than 250 microamperes

Low forward drop.....less than 0.5 volt

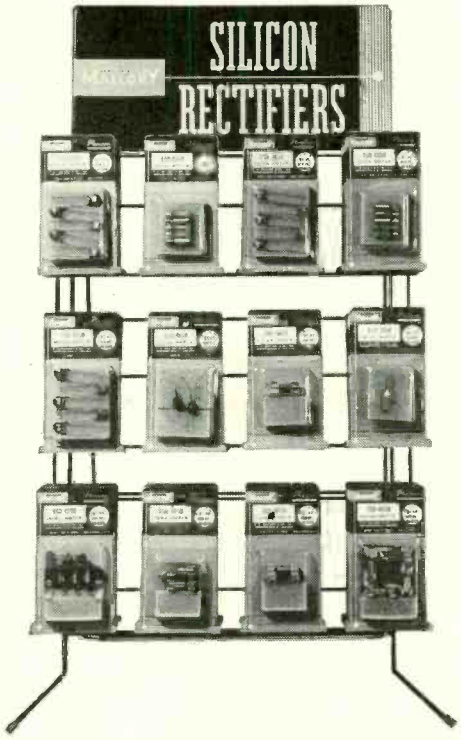
Exceptional life.....takes over 2000 hours at 85 C, with 1.5 million switching operations without failure

Moisture-proof.....exceeds humidity requirements by four times (MIL 202A)

High reliability.....100% testing eliminates premature failures, protects you against call-backs

Three different models, each designed for specific service applications, are now available to fit all television and radio circuits as replacements for metallic rectifiers.

See this display on your Mallory distributor's counter—a complete assortment—in handy see-through packs—of the full line of Mallory silicon rectifiers.



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TECHNICIANS' NEWS

IDEA REPORTS PROGRESS

A drive to put every television set manufacturer "on the record" with regard to captive and factory service is making headway, the newly formed Independent Dealers' Electronic Activities (IDEA) committee reported after its central committee met in Kansas City.

Karl Heinzman, president of Television Service Association (TSA) of Detroit, was elected 1959 chairman of IDEA, which now claims the support of approximately 100 independent service association in 40 states and Canada.

The group is currently receiving replies to its letters to manufacturers asking about their service policies and programs. The replies to date were to be released at IDEA's Jan. 11 meeting in Chicago, held too late for coverage in this issue.

Tillman Babb of Texas Electronics Association (TEA) heads the industry relations committee whose task involves contact with set manufacturers; Jack Barton of TSA–Michigan heads the intra-industry relations committee; Bob Steers, Television Service Association (TELSA) of Connecticut, heads the finance committee, and John Hemak, Minnesota Television Service Engineers (MINTSE), is chairman of the legislative committee.

TV SERVICE A LA CARTE

The credit-card fever is spreading to the field of repairs and services for the homeowner. At least three such groups are now in the process of organization or operation in various localities, to provide customers with services from fuel oil to TV repairs.

Probably the most ambitious of these is Mr. Service Club, Inc., recently formed in Chicago, with a goal of 100,000 members within the next 6 months. Mr. Service Club is frankly a business organization which plans to provide 24-hour-a-day service for householders in virtually every imaginable field, billing its members at the end of the month with one single statement.

RADIO-ELECTRONICS asked the club's president, Eddie Richmond, to describe how his organization works—with particular emphasis on TV–radio service. Membership costs householders $7.24 a year, he explained, which he said can be made up through discounts on fuel oil and other items.

Discounts on TV service? Not at all, insists Richmond. TV and other repair services will be sold to the customer at prevailing prices, with premiums for Sundays, holidays and evenings.

How does Mr. Service Club make its money, then? By charging its "repair contractors" a fixed commission on each job. In the case of TV–radio servicing, this fee is 10% of the bill. However, Richmond quickly points out, his contractors will be saved the task of billing and collecting (the club does that), and they should be kept so busy with Service Club calls that their volume will go up.

When a consumer calls the club for TV repairs, an operator consults a map showing the geographic location of the member and the nearest TV service contractor, who is phoned and dispatched on the call.

Screening potential contractors is a big job. TV technicians are being selected on the basis of reliability, brands of equipment used, fees for service calls and price per hour, and number of employees, Richmond said.

FREE TUBE TESTS URGED

Technicians were urged to win back their customers by testing tubes professionally, willingly—and free. The Television Service Association of Delaware Valley's *TSA News* gave members this advice:

"Fight back for what is yours by virtue of years of time and money spent and the know-how acquired. Exert that extra effort for a slice of the 25,000,000-tube pie. Make it easy for the customer to come into your shop. Make him feel wanted. Impart a little advice regarding his radio and TV problems. Test his tubes professionally. . . . You may spend a little time, but the likelihood is you will sell him more tubes."

TSA News reports that one Philadelphia parts distributor, Albert Steinberg & Co., is offering 4 x 3-foot signs free to technicians, for use as window streamers, announcing that all TV and radio tubes are tested free on finest testing equipment by qualified technicians, and that all tubes and parts are fully warranted.

TSA reports increasing success in its "P.T.R." ("promote the repair") campaign—which has as its objective the repair of TV sets which otherwise would be discarded for new ones. Some TSA members reportedly have adopted a flat "overhaul charge" with a new set guarantee; others are offering a special discount for overhaul jobs and counting on high volume to offset the lower profit.

BARTON HEADS TELECTRO

Telectro Service Associates, Inc., independent service contract company organized by members of Television

NOW! A SOLDERING GUN WITH

DUAL HEAT

...switches instantly from 90 to 125 watts

ONLY $7.95 list

MODEL 8200K

NEW Weller®

"EXPERT" SOLDERING KIT

only Weller features DUAL HEAT

Saves time, adds convenience and greatly increases tip life. Trigger-matic control switches instantly to low (90 watt) or high (125 watt) heat as the job requires.

only Weller has a HIGH EFFICIENCY TIP

Utilizes the advantages of copper for superior heat transfer, plus iron-plating for durability and long life. Flat cross-section design adds strength and rigidity.

only Weller has such COMPACT DESIGN

The compact "feel" and comfortable balance aid precision soldering. And the housing in new, modern design is extremely rugged.

- New Dual Heat gun also features instant heat and prefocused spotlight. Guaranteed for 1 year.
- Kit also includes all-purpose Solder, Cleaning Brush and Soldering Aid.

DUAL HEAT INSTANTLY ADAPTS GUN TO VARYING NEEDS... Two position switch feature has never before been available at such a low price. Use first trigger position for soldering components and precise heat control for delicate jobs. Second trigger position gives higher heat for soldering to chassis and similar work.

Available Now From Your Electronic Parts Distributor

WELLER ELECTRIC CORP., 601 Stone's Crossing Road, Easton, Pa.

Service Association (TSA) of Michigan, elected 1959 officers at its annual stockholders meeting in Detroit.

The new president is E. J. (Jack) Barton, of Barton Radio & TV, succeeding Karl Heinzman, who declined to run for re-election. Harold Chase, Chase TV Service, is vice president. Phil Fabian was re-elected secretary and Ed Brown, treasurer.

Telectro was formed to promote and contract service for the independent service industry and is currently handling warranty service on Sylvania, Philco and Hotpoint TV as well as receiver service for several large dealers.

"FAIR PRACTICES" PROBE

An investigation of methods to eliminate "fraudulent practices" in the TV service and tube supply industries was mapped by an industry committee at a meeting in the office of New York State Attorney General Louis J. Lefkowitz in New York City.

One of the two technicians' associations represented on the committee—the Empire State Federation of Electronic Technicians Associations (ESFETA) — ignored the meeting. A spokesman explained later that ESFETA objected to the presence on the committee of the National Tube Testers Association, which was described as an organization of do-it-yourself tube-tester owners. ESFETA also charged that an earlier organizational meeting had shown little promise (RADIO-ELECTRONICS, January, 1959, page 114).

The committee decided to investigate: (1) how the industry can "inspire greater confidence" in TV technicians, (2) how to meet the problem of deceptive advertising by "some TV servicemen," and (3) how to cope with the problem of defective tubes on the market.

Organizations represented at the meeting were Associated Radio & Television Servicemen of New York (ARTSNY), Electronic Industries Association (EIA), National Electronic Distributors Association (NEDA), Better Business Bureau of New York, Metropolitan Electrical Appliance Dealers Association, RCA, Fordham Radio Supply Co. and the tube-tester group.

TV LECTURE SERIES

A free program of three lectures on new TV circuits and techniques is being offered to technicians' associations by Westinghouse. The lectures, which can be presented separately or at a single three-hour session, discuss printed circuits, transformerless power supplies, receiver descriptions, special circuitry and automatic fine tuning. One lecture deals with customer relations and is illustrated by a motion picture "Adding Sell to Service." Arrangements are being handled through the TV–Radio Div. at Metuchen, N. J., and its regional service managers and the Electronic Tube Div., Elmira, N. Y. END

STUFF THAT PLUG

Broken plugs and loose dangling wires at the ends of appliance cords are old-hat to the electrical-appliance repairman. Although it is true that breakable bakelite plugs are no longer part of newly purchased electric appliances, they are still used for replacements and are still found on older appliances.

When an appliance bearing the older type plug comes in to the shop for repair, I stuff it with plastic wood before the appliance is allowed to leave the shop. Once the wood stuffing has set, it's next to impossible to pull the cord from the plug. What's more, the stuffing supports the plug's outer shell, reducing the chance of its breaking should the plug be stepped on.—*J. A. Comstock*

SCREW EYES FOR TV SAFETY

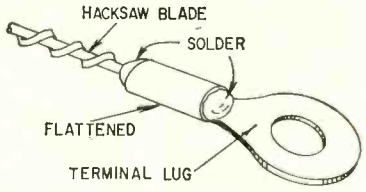
Many TV service technicians leave the backs off their own sets to facilitate repair work. A less dangerous method, but one that lets you remove the back without running for a nutdriver, is to use screw eyes to hold the back on. This permits rapid and easy removal, yet it keeps the children away from dangerous voltages.—*John Urbanowicz*

HACKSAW BLADE REPAIR

Many service technicians have discovered that the spiral-(drill-) blade hacksaws work more efficiently than standard types for cutting control shafts and other odd sawing jobs. They have only one drawback—the blades are rather thin and tend to break off easily near either end.

When a blade breaks near the end, it can be easily restored to a usable length with a ring type terminal lug, as shown in the drawing. Put the end of the blade into the lug as you would

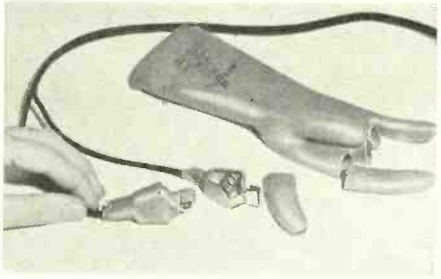
TRY THIS ONE *(Continued)*



a wire, flatten the lug and solder to strengthen the joint. You can make several repeated repairs in this way until about only half the blade remains. —*J. C. Alexander*

GLOVE FINGERS INSULATE CLIPS

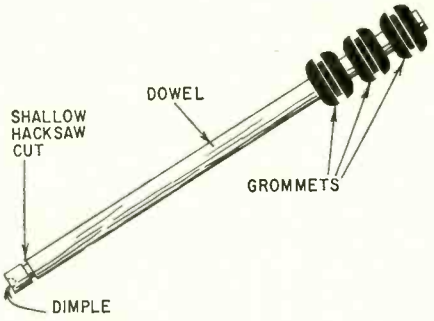
When you have to insulate test clips that will be connected to live circuits and there aren't any insulating jackets handy, cut insulating covers from the



fingers of old rubber gloves and slip them over the clips. Make a small hole in the tip of the glove's finger to slip it over the test lead. You may have to stretch the covers some to get them to fit over large size clips like the ones shown.—*John A. Comstock*

TUBE TAPPER AND WIRE PUSHER

Two, three or four rubber grommets placed on a 7- or 8-inch dowel section make a handy tube tapper. Form a dimple in the other end of the dowel with a small twist drill. The dimple

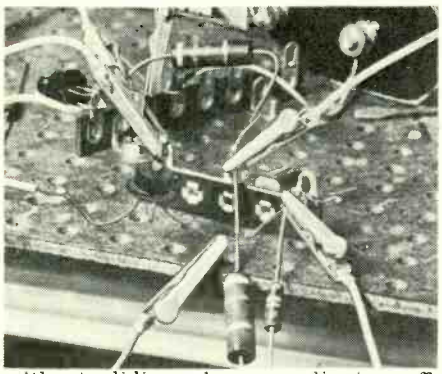


stops the dowel from slipping off lug and wire ends when it is used as a pusher to dress lugs, etc.

Ring the dimpled end with a shallow hacksaw cut to be used for pushing leads into better dress.—*Frank W. Dresser*

MINI-GATOR CLIPS

The new Mini-Gator clips, not much larger than a transistor, are ideal for fast setups of experimental transistor circuits. Unlike other clips, these easily hang onto the smallest transistor leads



without sliding along or slipping off.

Small sections of flexible stranded wire with Mini-Gators on each end can be used for hurry-up wiring of breadboard circuits. Lead lengths of 3 to 6 inches seem to be the most useful.

Insulating sleeves available for these clips guard against accidental shorts.—*Edwin Bohr*

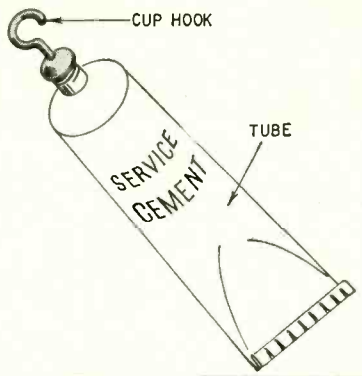
INSULATE ELECTROLYTICS

Many subminiature electrolytic capacitors do not have insulated cases. However, such insulation is often needed when the capacitor is used for interstage coupling, for example, and when the positive terminal is grounded and the case is hot. Also some have a metal case that is not connected to *either* terminal but must be insulated from the chassis to prevent noise.

A satisfactory solution to this problem *without covering capacitance and voltage markings* is to coat the capacitor with polystyrene coil dope. The coil dope should be thin enough to drip slowly. If it is too thin the coating will be too thin and if too thick it will be impossible to make a neat job. Use polystyrene coil dope thinner to get the right consistency. To apply, simply dip the capacitor in the coil dope and hold it under a 60-watt lamp for about a minute while rotating it with the fingers to obtain an even coat. Then hang it from a convenient support until dry.—*J. E. Pugh, Jr.*

HANGER TOPS FOR TUBES

Those tubes of radio–TV servicing chemicals that lay around on the bench and eventually become punctured won't if you hang them up out of the way.



Remove the tube's original cap and screw a cup hook into the opening. This way you can hang the tubes on brads driven into the edge of a shelf or the service bench.—*John A. Comstock*

PLASTIC TAPE KINK

Before I go outdoors to splice TV lead-in in cold weather, I put a roll of electrician's plastic tape in an inside pocket to keep it warm. I find the warm tape sticks better than cold, and that a warm roll goes farther because it has more stretch inch per inch.—*J. C. Alexander*

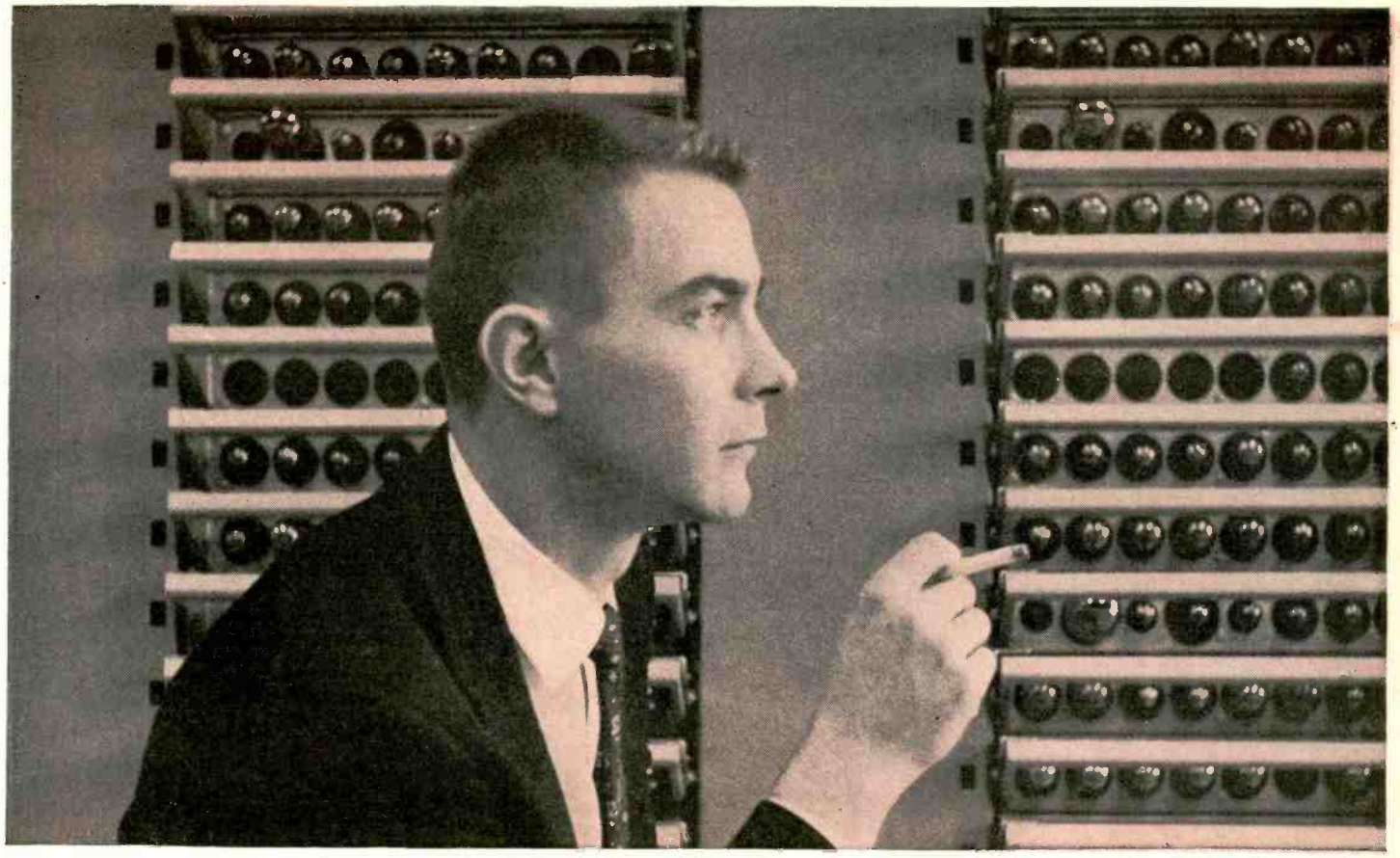
HANDY MAGAZINE KINK

When I have to dump radio–TV parts from a container to find the one that I need, I open up a copy of RADIO-ELECTRONICS and pour the parts out on it. Once I've found the part needed, I grab the magazine by its outer edges and "funnel" the parts back into their container.—*Scott Mack* END

CORRECTION

The cathode bias on the EL84/6BQ5 output stage in Fig. 2 of "The Hi-Fi Amplifier Abroad" (page 33, September, 1958) is erroneously shown as 79 volts. The correct bias is 7.9 volts.

We thank Mr. Angelo Lathes, of New York, N.Y., for bringing this to our attention.



How far can you go in electronics .

"Just being called a Field Engineer—an impressive title for a man without a degree—that really gives me a lift."

This is Jim Pieratt talking. With a high school education and Navy Technical training behind him, Jim holds a key job in one of America's most important electronic projects. He's an IBM Computer Units Field Engineer on Project SAGE.

Jim is 25, lean, crew-cut and soft-spoken. He smiles modestly when you ask him about his accomplishments. We were curious to know whether he had been technically inclined when he was a youngster.

"The truth is that I didn't become interested in electronics until I joined the Navy," says Jim. "Before that, the only technical thing I might have done was to take a couple of alarm clocks apart. I chose electronics in the Navy because I thought there was a future in it."

Change of attitude

"A lot of fellows may think, as I did, that a computer is too complicated for anybody but an Einstein to understand. It's not so. Even the largest computers like SAGE, which occupies space equivalent to a city block, can be comprehended by the ordinary man. But I didn't know this when I went for my employment interview—and I wondered if the algebra and trig I'd taken at Kalamazoo Central High would qualify me. Then my interviewer told me a little about computers . . . how they work and what my job would be after I finished IBM school. I made up my mind right then; I wanted this job."

Training school

Soon, Jim and 21 other fellows like himself started training in Kingston, New York, getting on real intimate terms with IBM's electronic giant. Marvel of complexity though it is, when it sits on the floor and you study it part by part, the computer loses its mystery. Little by little, you begin to understand the whole from the sum of the components.

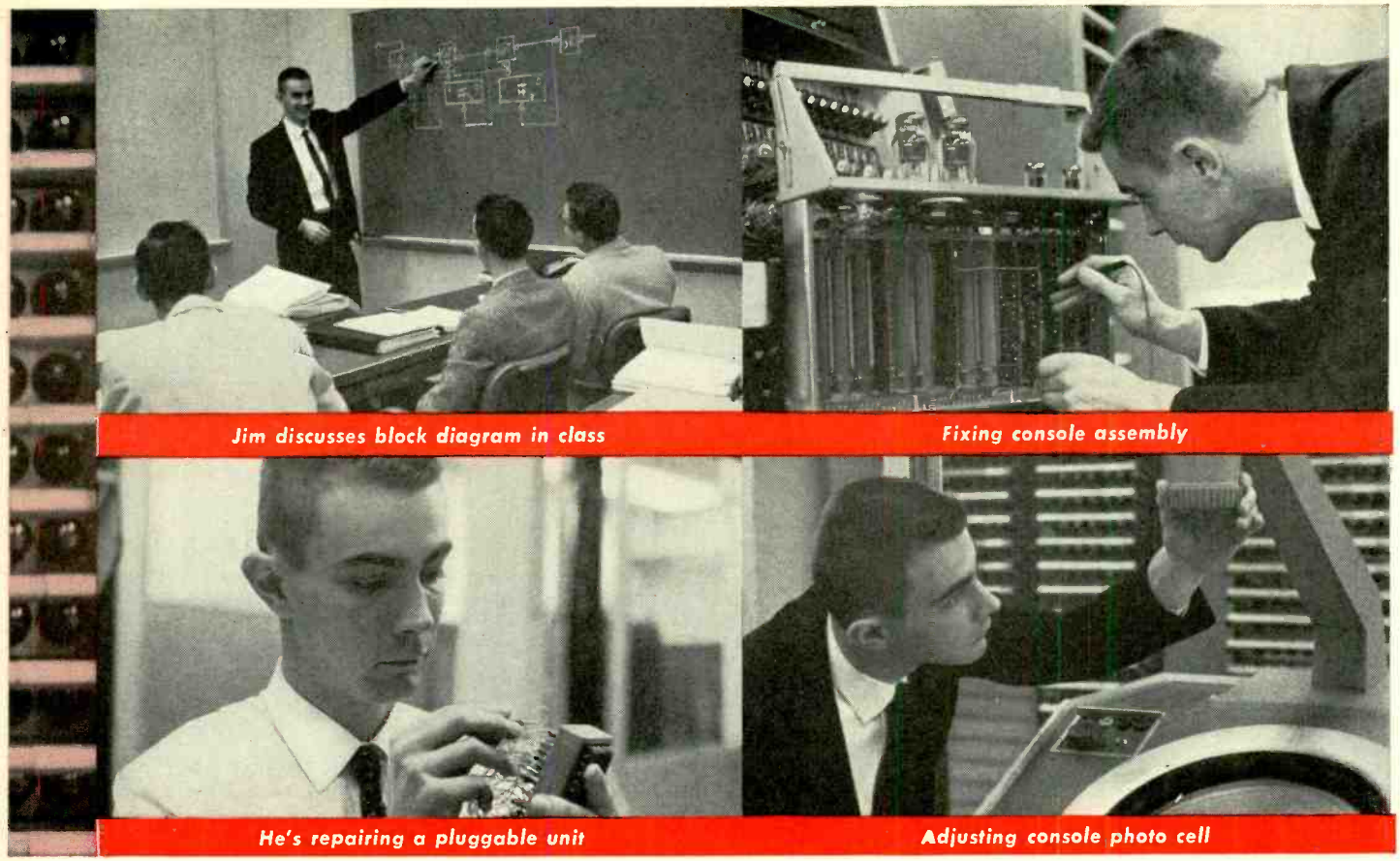
"The 25 weeks I spent in training were very happy," says Jim. "It's interesting all the way. They encourage you to think for yourself and you're rewarded for your effort. Field Engineers can merit salary increases based on school performance."

Strategic job on Project SAGE

Jim is stationed in Virginia, near Richmond. His duties include installing, checking and testing out computer units. The giant electronic computers are the very heart and mind of Project SAGE (Semi-Automatic Ground Environment). To the in-put section of the computer comes data from radar sites, ships, reconnaissance planes and ground observer posts throughout the country. The display consoles give a visual representation of the complete air defense situation. Jim's prime responsibility is to keep the display consoles running.

8 pleasant hours a day

"I'm essentially my own boss and I'm encouraged to think for myself. For me, this is an ideal environment.



Jim discusses block diagram in class

Fixing console assembly

He's repairing a pluggable unit

Adjusting console photo cell

. . . without a degree?

What do I like best about my job? Trouble-shooting, I think. I enjoy being able to repair anything that isn't working properly. As a Field Engineer, I have opportunities to assume other engineering functions. For instance, while I have nothing to do with design engineering, I do suggest changes for review by the Design Engineers. I also rewrite engineering procedures."

Where do you go from here, Jim?

"There's plenty of room for me to grow at IBM. My next step up should be to Systems Engineer. This calls for more headwork. After that, if I display enough initiative, I may become a Group Supervisor."

Family, friends, recreation

Jim, his wife and three-year-old daughter live in a pleasant ranch home, just a few miles from the site. Social life? "We've made quite a few friends here," says Jim. "Mostly among the IBM fellows and their wives. We play golf together."

Where do you go from here?

Can you look ahead, as Jim Pieratt does, and see yourself as a man on the way up? Maybe you should give some thought to IBM Military Products and the Project SAGE program. Opportunities are greater than ever. IBM's long-range program will continue to grow in importance and vast sums will be invested in hiring the right men to accomplish its vital objectives.

If you have a minimum of 3 years' technical schooling—or equivalent experience—you may be eligible for advanced training for 5 months as a Computer Units Field Engineer. While training, you receive full pay plus living allowance before assignment to a permanent location. You are paid a salary, not hourly wages, plus overtime.

From then on, you can go as far as your abilities and ambition will take you. IBM is the leader in a field that offers you unlimited horizons. And, as you may already know, at IBM you receive company-paid benefits that set standards for industry today.

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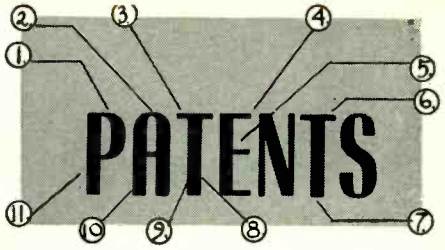
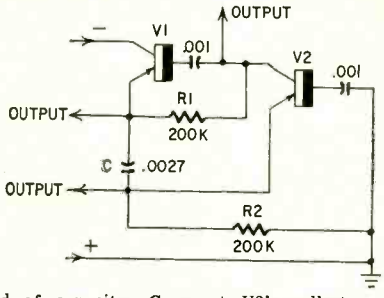


FREE-RUNNING MULTIVIBRATOR

Patent No. 2,827,568

Ernst R. Altschul, New York, N. Y. (Assigned to United States of America as represented by Secy. of the Navy)

This is one of the simplest multivibrators. With the values shown its frequencey is 1,000 cycles. The output terminal may be at either



end of capacitor C or at V2's collector, the other terminal being ground.

To show the action, assume that V1 conducts. Current flows through R2 and V1 to charge C. Note that the drop across R2 blocks V2. When C is charged, the voltage drop disappears and V2 starts to pass current. Now, C can discharge through R1 and V2, and the drop across R1 blocks V1.

When C is completely discharged, V1 conducts again, and the cycle repeats.

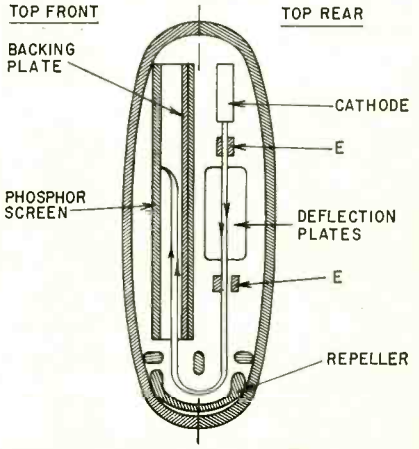
FLAT KINESCOPE TUBE

Patent No. 2,795,729

Dennis Gabor, London, England (Assigned to National Research Development Corp., London, England)

Undoubtedly, the flat tube will in time revolutionize the TV industry. Here is one type that shows considerable promise. The description given here is limited, but more details appeared on page 43 of the March, 1957, issue.

See the side view of the tube. An electron gun,



including cathode and deflection plates, sends the beam on its way down the rear of the tube. At the bottom, an electronic "mirror" (repeller) repels the beam to return it upward between the phosphor screen and the backing plate, at the front of the tube. The backing plate holds an array of insulated horizontal conductors which can charge (positively) or discharge through distributed capacitance, by means not shown here.

When the wires are charged, the beam can move freely to the very top of the screen. Wires that are discharged repel the beam toward the screen. The charge-discharge cycle is a sawtooth-voltage wave, thus providing the required vertical scan. The deflection plates control horizontal scanning.

If the device has a three-gun cathode and a mask behind the screen, it becomes a color

tube. In that case, electrodes E are provided (as shown) to displace the beams so they pass through appropriate openings in the mask.

RELAXATION OSCILLATOR

Patent No. 2,831,113

David C. Weller, Lake Mohawk, N. J. (Assigned to Bell Telephone Labs, Inc.)

This is a high-powered self-excited oscillator. Fig. 1 shows some of the waveforms it delivers. They are: (a) voltage across C2, (b) voltage across C1, and (c) voltage at V2's collector.

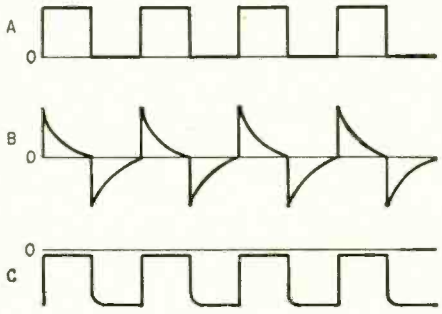


Fig. 1

V1 is a low-power control transistor in the oscillator's circuit (see Fig. 2). V2 may be a high-power transistor capable of handling a few watts output. When V1 conducts, it biases V2 in the forward direction, so both transistors conduct (or block) at the same time.

R1, R2 bias V1 for normal conduction. When the battery is switched on, V1 begins to pass current so V2 also conducts. Voltage at V2's

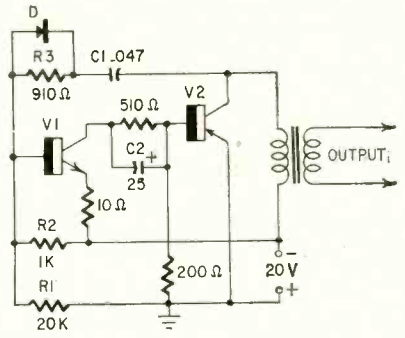
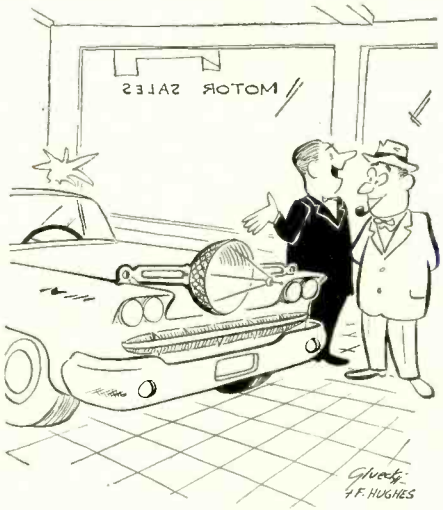


Fig. 2

collector goes more *positive* and feeds back power to V1's base. This increases conduction in *both* transistors, and they soon both reach saturation.

Saturation is maintained until C1 begins to discharge through D and R2. This reverses bias on V1. A chain of events (like that described above) soon results in both transistors being blocked. The cycle continues indefinitely.

The circuit shown is adjusted to oscillate at about 3 kc. Output power is limited only by the transistor used for V2. END



"And this gadget fouls up the radar traps."

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- MINIATURE ATOM SMASHER
- PRODUCES 75,000 VOLTS
- ABSOLUTELY SAFE

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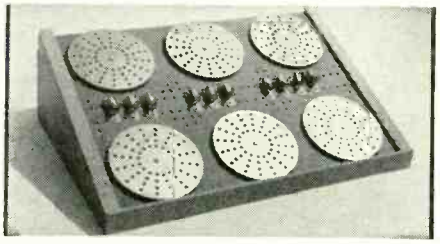

Control Panel of GENIAC® set up to do a problem

You can construct over 125 different circuits and different machines that compute, reason, solve puzzles and demonstrate a wide variety of basic computer circuits with the GENIAC® electric brain construction kit. 30,000 schools, colleges, industrial firms and private individuals have bought GENIACS since we first brought them on the market.

We have recently added a circuit for composing music, which gives us special pleasure because it was designed by a 16 year old boy who learned about computers from his GENIAC. Dozens of other youngsters have created their own designs for computing circuits, used GENIACS in their school projects and established a solid foundation of information on computers with GENIACS.

Each kit comes complete with Beginners Manual, Study Guide, instructions for building all the machines and circuits (exclusive with our GENIAC), parts tray, and our complete question answering service. When you buy a GENIAC you are buying a first course in computer operation.

Each kit comes with a one week money back guarantee if you are not satisfied.

Price of Kit complete with parts tray, rack, all components, manuals and texts **$19.95** (postpaid in U.S., add 80c west of Mississippi). ($2.00 outside United States.)

MAIL THIS COUPON

(Please be sure to include your name & address)
OLIVER GARFIELD CO., Inc., Dept. RE-29
108 E. 16th St., New York 3, N.Y.
Please send me:

1 GENIAC® Electric Brain Construction Kit and Manual. .....
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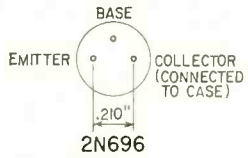
$19.95 (Complete assembled) .....
$14.95 (In kit form) .....
Add 80¢ for postage and handling in U.S.; $1.00 abroad.

NEW TUBES and SEMI-CONDUCTORS

A WIDE range of interesting types appears this month. There are a high-voltage rectifier for TV receivers, a germanium power transistor, a dual beam-power tetrode, a high-frequency tetrode transistor and other semiconductor devices among them.

2N696

An n-p-n diffused-silicon transistor designed for high-frequency switching, amplifier and oscillator applications. In switching, it has a 150-ma rating



2N696

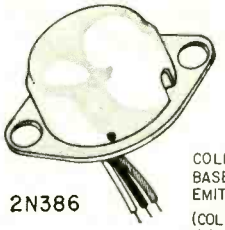
with an 80-millimicrosecond rise time. As an amplifier, it features 15-db neutralized gain at 30 mc. As an oscillator it produces 0.6 watt at 70 mc.

Maximum ratings of this Fairchild Semiconductors unit are:

V_{CEO}	40
V_{CBO}	40
V_{EBO}	5
P_{total} at 25°C (watts)	2

2N386

A hermetically sealed, p-n-p germanium power transistor for high-voltage use in high-power amplifiers,



2N386

COLLECTOR-RED
BASE-BLACK
EMITTER-YELLOW
(COLLECTOR CONNECTED TO CASE)

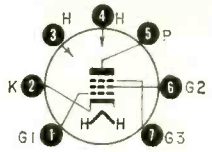
servo amplifiers, power converters and switches. It will deliver 5 watts of undistorted power output (class A) with a typical power gain of 33 db. Typical cutoff frequency is 10 kc.

Maximum tentative ratings of this Philco transistor are:

V_{CE} (V_{BE}=1.5, I_C=5 ma)	60
V_{CB} (I_C=5 ma, I_E=0 ma)	60
I_C (amps)	3
P_{total} (watts)	12.5

3DK6, 4DK6, 6DK6

A series of pentode amplifiers designed for if service in TV receivers. The heaters in these tubes have a con-



3DK6, 4DK6, 6DK6

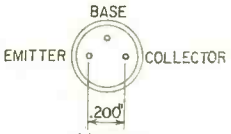
trolled warmup for series-string circuits. All are identical except for heater ratings. These are: 3DK6—3.15 volts, 600 ma; 4DK6—4.2 volts, 450 ma; 6DK6—6.3 volts, 300 ma.

Characteristics of these CBS tubes in class-A amplifier service are:

V_P	125
G_3	connect to cathode at socket
V_{G2}	125
$R_{cathode\ bias}$ (ohms)	56
R_P (approx) (k ohms)	350
gm (μmhos)	9800
I_P (ma)	12
I_{G2} (ma)	3.8
V_{G1} (approx)	—6.5

2N658

This is a medium-frequency p-n-p fusion-alloy junction transistor in-



2N658

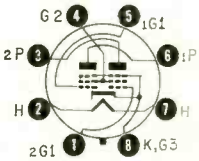
tended for computer and switching applications requiring good current gain at current levels up to 1 amp.

Made by Raytheon, maximum ratings of the unit are:

V_{CBO}	25
V_{EBO}	12
V_{CEO}	16
V_{CE} (V_{BE}=0.1)	24
I_C (amp)	1

6DY7

A dual beam-power pentode designed for use in stereophonic sound systems. The tube has a single cathode, and G2's are connected internally. The 6DY7 heater is rated at 6.3 volts, 1.2 amperes.



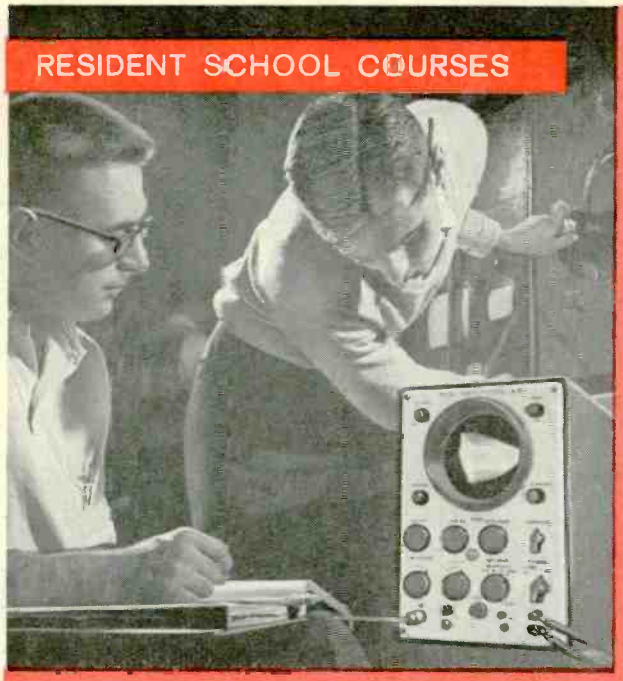
6DY7

Typical operating characteristics of this Sylvania tube as a class-AB1 amplifier (two sections in push-pull) are:

V_P	250	400
V_{G2}	250	250
V_{G1}	—16	—20
$V_{peak\ af,\ grid\ to\ grid}$	32	40
I_P (zero sig) (ma)	77	58
I_P (max sig) (ma)	74	74
I_{G2} (zero sig) (ma)	3.5	1.7
I_{G2} (max sig) (ma)	15.5	14.0
R_L (plate to plate) (ohms)	9,000	14,000

(*Continued on page* 132)

RESIDENT SCHOOL COURSES



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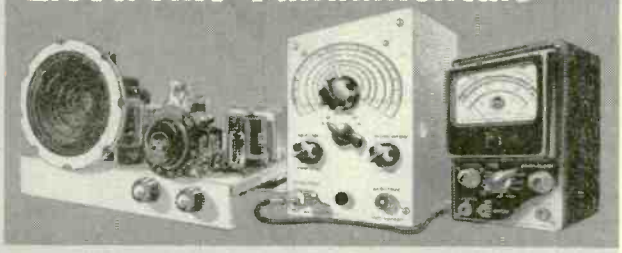
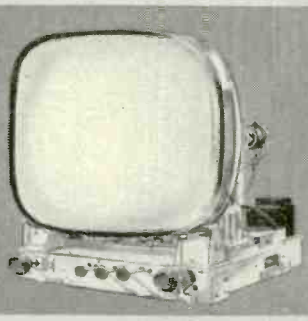


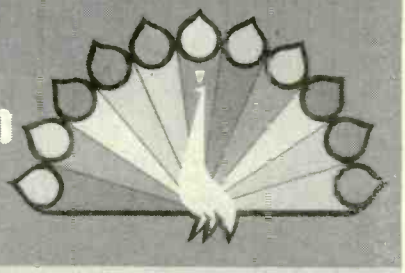
course II

Television Servicing



course III

Color Television



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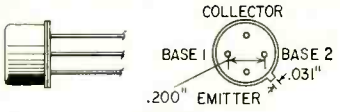
NEW TUBES & SEMICONDUCTORS *(Cont'd)*

P_{output} (max sig) (watts)	11	20
Harmonic distortion (total) (%)	2.5	2.0

3N35

A grown-diffused silicon tetrode transistor which has a typical 20-db power gain at 70 mc. It is designed for use in high-frequency if, rf and



3N35

video amplifiers, and high-frequency oscillators. It is made by Texas Instruments.

Maximum ratings of the 3N35 tetrode transistor are:

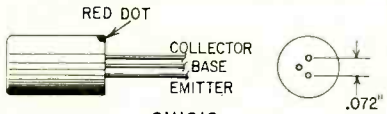
I_E (ma)	20
I_C (ma)	20
I_{B1} (ma)	5
I_{B2} (ma)	5
P_c (mw)	125

Minimum breakdown voltages are:

BV_{CBO}	(I_C=50 μa, I_{B2}=0, I_E=0)	30
BV_{EBO}	(I_C=50 μa, I_{B2}=0, I_E=0)	1
BV_{CEO}	(I_C=1 ma, I_{B2}=0, I_{B1}=0)	30

2N1010

This is an n-p-n germanium-alloy junction transistor intended for use in the input stages of audio amplifiers



2N1010

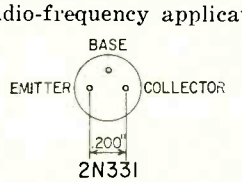
such as high-fidelity preamps, tape recorders, microphone preamps and hearing aids, where low noise is important. Maximum noise factor is 5 db.

Maximum ratings of the RCA 2N1010 in class-A audio amplifier service are:

V_{CB} (peak)	10
V_{CE} (peak)	10
V_{EB} (peak)	10
I_C (peak) (ma)	2
I_E (peak) (ma)	2
P_{total} (mw) (at 55°C)	20

2N331

A p-n-p germanium alloy-junction transistor intended for use in low-power audio-frequency applications.



2N331

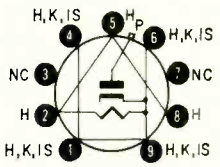
Maximum ratings of this RCA transistor in class-A af amplifier service are:

V_{CB}	30
V_{EB}	12
I_C (ma)	200
I_E (ma)	200
P_c (mw)	
(25°C)	200
(55°C)	60
(71°C)	25

1H2

This is a miniature heater–cathode type diode designed for use in TV

receivers as the high-voltage rectifier. It is primarily intended for use in flyback type power supplies.



IH2

Maximum ratings of this General-Electric tube are:

PIV_P (dc component)	24,000
(total dc and peak)	30,000
I_P (steady state peak) (ma)	50
Dc output current (ma)	0.5

Miscellaneous

The 6EM5 and 8EM5, beam power tubes for vertical-deflection amplifier service in 110° system, were announced by RCA.

The 1N2069, 1N2070, 1N2071 diffused silicon rectifiers made by Texas Instruments handle 750-ma average rectified current.

1N1763 and 1N1764 silicon rectifiers for use in power supplies of color TV receivers have been introduced by RCA.

A duo-triode pulse tube, the 6955, is being made by CBS-Hytron. END

US Wants Electronic Inventions

(Continued from page 35)

miles. Continuous wave phase-comparison systems can now measure distances up to 250 miles over sea water at 1-to-45,000 accuracy and up to 100 miles over land to 1-to-35,000 accuracy. (Condensed)

915. ULTRA-LONG-RANGE RADAR SET. A set having an over-the-horizon capability extending to perhaps 2,000 miles. This capability would be based on the intentional utilization of superrefractive ducts in the atmosphere and would provide penetration of very remote areas for target location and tracking.

917. OPTIMUM STABILIZATION DEVICE FOR AIRBORNE RADAR ANTENNAS. A size–weight device for mechanically or electronically stabilizing very long radar antennas for aircraft motions in tip, tilt, or yaw.

918. COMPOUNDED AIRBORNE SENSOR. A device to accept inputs from airborne optical, infra-red and radar sensors and display them compatibly on a single medium with redundant images eliminated.

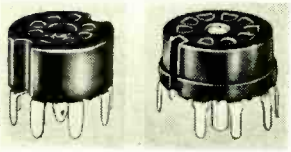
924. IMAGE-INTENSIFICATION DEVICE. A hand-held device capable of amplifying starlight to twilight level or higher to provide "daylight seeing" at night.

926. DISPLACEMENT TIME GAUGE. Develop a simple inexpensive electronic radar type displacement gauge. This gauge should be able to measure relative displacement between itself and some object on the order of 10 to 20 feet away with an accuracy of .01 inch, and a time resolution of .001 second. (Condensed)

942. DETECTION AND TRACKING OF SUBMARINES FROM AIRCRAFT. The detection and tracking of submarines still exists as a difficult problem, particularly under adverse weather conditions. Dependable, accurate and simple devices are needed. *—H.G.*

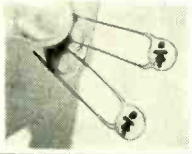
On the Market

PRINTED-CIRCUIT SOCKETS. Precision molded. 8 types,



various sizes, from 7 to 9 pins with center shields.—**Waldom Electronics Inc.**, 4625 W. 53 St., Chicago 32, Ill.

SILICON RECTIFIERS, *type TSR* (encapsulated), *type PSR* (plug-in), *type ESR* (top-hat), *type SSR* (stud). New design

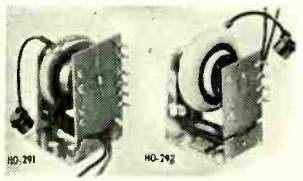


cuts reverse leakage current and forward voltage drop. Freedom from premature failure guaranteed. All units automatically tested at factory. Encapsulated in new *Mallo-Seal* coating.—**P. R. Mallory & Co. Inc.**, 3029 E. Washington St., Indianapolis 6, Ind.

RELIABLE ELECTROLYTICS, *type QE*. Computer-grade,

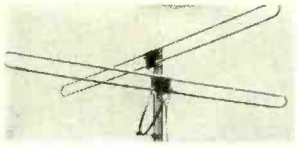
for precision and industrial equipment. Useful life expectancy more than 10 years. Rated for operation from −20° to 85° C. Drawn aluminum cases in 4 diameters, 4½ inches high.—**Aerovox Corp.**, New Bedford, Mass.

FLYBACKS, exact replacement. *Stancor HO-291* (shown) replaces Hoffman part 5118A; *HO-292*, Hoffman 5154A and 5154-3; *HO-294*, Emerson



738103 and 738109; *HO-295*, Emerson 738106, 738107 and 738111; *HO-296* replaces Emerson 738119, 738122, 738128, 738129 and 738140.—**Chicago Standard Transformer Corp.**, 3501 Addison St., Chicago 18, Ill.

FM ANTENNA, *Taco G 666*. Turnstile type. Gold anodized.



Folded-dipole terminals connected by tuned transmission line. Terminal impedance 300 ohms. For strong-to-medium signal-strength areas.—**Technical Appliance Corp.**, Sherburne, N. Y.

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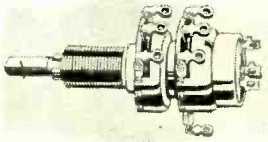
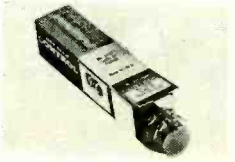


covers all popular makes and models in use today, including private brands. — **Centralab Div., Globe-Union Inc.**, 900 E. Keefe Ave., Milwaukee 1, Wis.

AUTO RADIO CONTROLS, exact replacement. 98 controls



to fit 199 auto makes and models.—**G-C Electronics Mfg. Co.**, 400 S. Wyman St., Rockford, Ill.

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You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 16 Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for Television.

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You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

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The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer, and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

A COMPLETE RADIO COURSE—NOTHING ELSE TO BUY

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, wire, solder, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive all parts, tools, instructions, etc. There is nothing else to buy. Everything is yours to keep.

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of troubles in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

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Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

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The Progressive Radio "Edu-Kit" has been sold to many thousands of individuals, schools and organizations, public and private, throughout the world. It is recognized internationally as the ideal radio course.

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The high recognition which Progressive "Edu-Kits" Inc. has earned through its many years of service to the public is due to its unconditional insistence upon the maintenance of perfect engineering, the highest instructional standards, and 100% adherance to its Unconditional Money-Back Guarantee. As a result, we do not have a single dissatisfied customer throughout the entire world.

☐ Send "Edu-Kit" Postpaid. I enclose full payment of $22.95.
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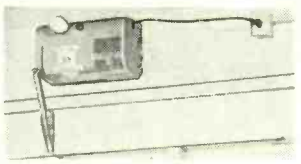
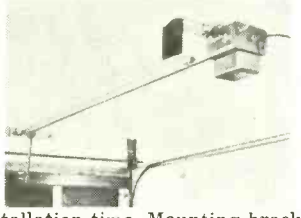
PROGRESSIVE "EDU-KITS" INC.
1186 Broadway, Dept. 149G, Hewlett, N.Y.



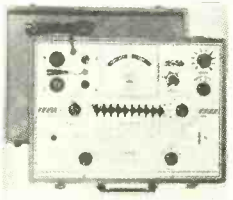
Simple installation. Radio controlled (200–400-kc band). Transmitter sends out 2 radio frequencies interlocked with an audio frequency; door opens only when both rf signals are equal in strength. — **Paxton Products**, 929 Olympic Blvd., Santa Monica, Calif.

GARAGE-DOOR OPERATOR, *Genie 400.* Requires 50% less in-



stallation time. Mounting brackets preattached and assembled. ⅓-hp motor. — **Alliance Mfg. Co.**, Alliance, Ohio.

TUBE TESTER, *model 3414.* All switch settings can be made before warmup for speed.

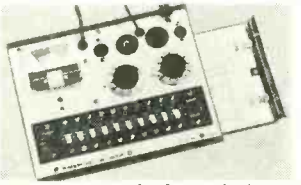


Burned-out tubes rejected instantly. New rapid neon-indicator short test. Continuity test circuit also tests appliances for shorts or opens. Nonobsolescence design.—**Triplett Electrical Instrument Co.**, Bluffton, Ohio.

ELECTROLYTIC SUBSTITUTOR, *Sencore Electro-Sub model ES 102.* Substitutes in any circuit operating at 2–450

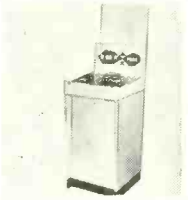
volts. Capacitance range includes 10 separate electrolytics from 4 to 350 μf. Surge-protector circuit prevents arcing and healing of intermittent capacitor being paralleled. — **Service Instruments Corp.**, Addison, Ill.

TUBE CHECKER KIT, *Knight-Kit 400.* Checks for filament continuity, shorted ele-



ments and cathode emission of 400 tube types. Compact and portable; weight 5¼ pounds. Selector slide switches. Flip cards. 7- and 9-pin miniature, octal and loctal sockets.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

TUBE TESTER, self-service *model A-1000F.* Fully tests prac-



tically all tubes now in use. Also tests auto radio vibrators, 0Z4 tubes, fuses and lamps. Single "test" button.—**American Scientific Development Co.**, Box 109, Redlands, Calif.

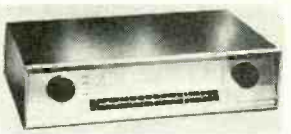
R-C BRIDGE, *model RC-1.* Portable tester checks capaci-

tances of 10 μμf to 2,000 μf in 4 ranges, 0.5 ohm to 200 megs in 4 ranges; tests capacitor leakage, reactance ratio between any 2 capacitors, inductors or resistors. Capacitor test voltage continuously variable 0–500 volts dc.—**Pyramid Electric Co.**, 1445 Hudson Blvd., North Bergen, N. J.

VOLTOHMYST KIT, *model WV-77E.* Measures ac rms from 0.1 to 1,500 volts; dc from .02 to 1,500 volts; peak to peak ac from 0.2 to 4,000 volts; resist-

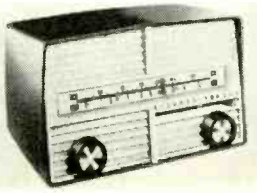
ance values from 0.2 ohm to 1,000 megohms. Fuse-protected divider network resistors.—**RCA, Electron Tube Div.**, Harrison, N. J.

AM–FM TUNER, *model EM-085-ER.* Etched wiring board and PAC units used. 2 if stages,



limiter, Foster-Seeley discriminator; afc. — **Erie Resistor Corp.**, 644 W. 12 St., Erie, Pa.

NEW AUDIO LINE. *Model R-98* FM–AM radio (shown) features rf amplification on both FM and AM, agc, 2 if stages,



rear-mounted speaker, built-in antennas. Also available: tuners, amplifiers, speakers in matching cabinets. — **Blonder-Tongue Laboratories Inc.,** 9 Alling St., Newark 2, N. J.

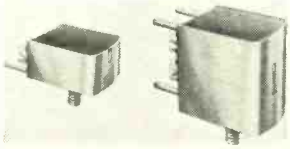
COAXIAL SPEAKER, *CA-12A, 12-inch.* Range 35–20,000

cycles. Inductor–capacitor crossover network at 2,000 cycles. Elliptical tweeter. Rated at 40 watts, average program material. — **Sonotone Corp.,** Elmsford, N. Y.

EXTENSION SPEAKER. Compact cabinet, 50-foot cable,

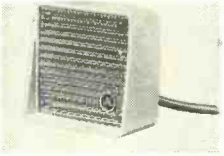
clips. No special tools required. —**Hank & Bert,** Box 8338, Denver 10, Colo.

ERASE HEADS, double-gap, laminated, high-efficiency type



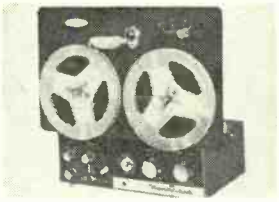
for magnetic tape equipment. *Model ME-100* is 2-track head; *SE-50,* 4-track stereo; *SE-100,* 2-track stereo. All produce 56-db erasure. — **Nortronics Co.,** 1015 S. 6 St., Minneapolis 4, Minn.

RECORDER MIKE, *model M-150.* Replacement unit for tape recorders. Output —44 db. Range 30–10,000 cycles. Crystal type.



5-foot shielded cable.—**Astatic Corp.,** Conneaut, Ohio.

TAPE RECORDER KIT, *model TR-1A.* Tape deck; 2-speed,



belt drive unit. Response 50–5,000 cycles within 2 db at 7½ ips. Single-control lever operation. Electron-ray tube recording-level indicator. Separate erase and combination record/playback heads. — **Heath Co.,** Benton Harbor, Mich.

RECORD CLEANER KIT, *Stereo/Hi-Fi Discleaner.* Con-

tains cleaning solution, applicator pad, dusting pad. Solution removes static charges. Velvet pads have pile sheared to match .045-inch groove depth of stereo discs.—**Walco Products Inc.,** 60-RE Franklin St., East Orange, N. J.

HI-FI CABLE KIT, *HK 510.* 36-inch shielded cable with

phono plug and pigtails, 18-inch shielded cable with 2 phono plugs, double phono jack adapter, phono plug adapter, in plastic box.—**Anchor Products Co.,** 2712 W. Montrose Ave., Chicago 18, Ill.

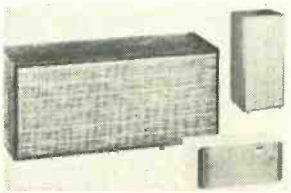
STEREO TUNER KIT, *Heathkit PT-1.* 16-tube AM–FM com-

bination. 3 circuit boards. Prewired, prealigned FM front end. Built-in AM rod antenna. Tuning meter; afc. Flywheel tuning. AM and FM circuits can be used simultaneously. Cathode-follower outputs with individual level controls. Variable AM bandwidth. 10-kc whistle filter. Tuned-cascode FM front end. FM age and amplified avc for AM. Silicon diode power supply. —**Heath Co.,** Benton Harbor, Mich.

STEREO ENCLOSURE, *217-Duo.* 2-speaker stereo in single

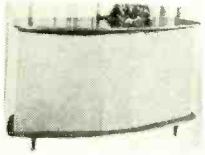
cabinet 3 feet wide. Speakers arranged for 160° deflection of sound. 30 inches high, including 6-inch legs. Walnut, mahogany, blond or unfinished birch.—**Hartley Products Co.,** 521 E. 162 St., New York 51, N. Y.

STEREO ENCLOSURE, *Catalina TSE-1,* for bookshelf or floor use in limited space. Takes 8-inch coaxial speaker or 8-inch



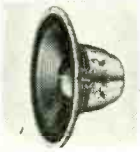
woofer and tweeter. Legs included.—**Argos Products Co.**, 310 Main St., Genoa, Ill.

STEREO SPEAKER SYSTEMS, *Stereorama* series. 30° angular separation in single



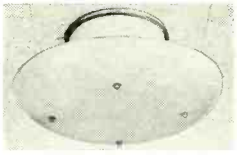
contemporary enclosure. May be used with 12-watt amplifier. Choice of woods. *Stereorama II* combines 2 *Frazier Mark II* speaker systems. *Stereorama I* uses *F-8-3X Black Box* systems. —**Frazier, International Electronics Corp.**, 2649 Brenner Dr., Dallas 20, Tex.

STEREO WOOFER, *model C-12SW*, 12-inch. Dual voice coil



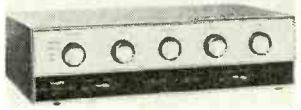
eliminates need for isolation network or control filter when used as single bass speaker for stereo system. 1½-lb. Alnico 5 magnet. Response 40–6,000 cycles overall. Built-in adjustable response limiter can be set for 700-, 2,500-, or 5,000-cycle cutoff to suit requirements of most tweeters. Power rating 25 watts integrated program. Impedance 8 ohms.—**University Loudspeakers Inc.**, 80 S. Kensico Ave., White Plains, N. Y.

SPEAKER BAFFLE, *model DFI 8*. Nonresonant Fiberglas in folded infinite ceiling baffle. May be mounted on ceiling or



atop post for outdoor installations. Choice of 2-tone color combinations.—**Fourjay Industries**, 2360 W. Dorothy Lane, Dayton 39, Ohio.

STEREO PREAMP control center, *Knight KN-700A*. Sepa-

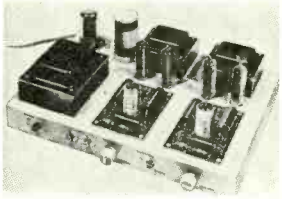


rate bass and treble controls for each channel. 10 inputs (5 pairs), all controlled from front panel. Dc on all tube heaters. Provision for remote control. Response 20–20,000 cycles ±1 db. Hum level 55 db. below full output on tape channels, 60 db below on magnetic, 80 db on auxiliary.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

STEREO CONVERTER. Contains phono oscillator to use any broadcast-band radio for second channel of stereo system without wiring. Volume controls for

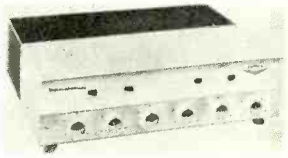
both channels and balance control. Ceramic stereo phono cartridge included.—**Bard Record Co. Inc.**, 66 Mechanic St., New Rochelle, N. Y.

BASIC STEREO AMPLIFIER KIT, *KT-310*. May be used as dual 18-watt stereo amplifier,



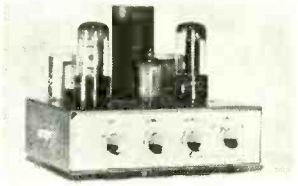
36-watt mono amp or as 2 separate 18-watt mono amplifiers. Dual inputs, each with separate volume control. Speaker output impedances of 4, 8, 16 and 32 ohms. Input sensitivity 0.45 volt per channel for full output. Response 35–30,000 cycles ± ½ db at 18 watts. Harmonic and IM distortion below 1%. 7 tubes including rectifier.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

STEREO AMPLIFIER KIT, *Qual-Kit model STA-24*. Stereo preamp and dual 12-watt stereo amplifiers or single 24-watt mono amplifier. Williamson type with special output transformers tapped for 4-, 8- and 16-ohm speakers. Dual ganged bass, treble and loudness controls, balance control, mode and se-



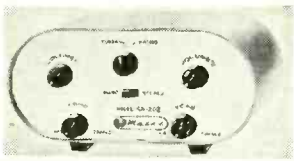
lector switches.—**Quality Electronics Inc.**, 319 Church St., New York 13, N. Y.

STEREO AMPLIFIER, *SA-3*. 2-channel, inverse feedback, 3-watt (1.5 watts per channel). Input 0.3 to 1 volt for ceramic cartridge, tuner or tape. 3-meg input impedance, 8–10 ohms output impedance. Individual tone



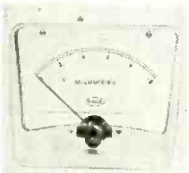
and volume controls for each channel. 3 tubes plus silicon rectifier. Also avilable: *SA-7* 7-watt stereo amplifier. — **Continental Manufacturing Inc.**, 1612 California St., Omaha, Neb.

STEREO AMPLIFIER, *Masco "Torulf" SA-202*. 4 watts output. Includes preamp. Output impedance 4 ohms each channel. Tuner and phono input impedance 470,000 ohms. Input sensi-



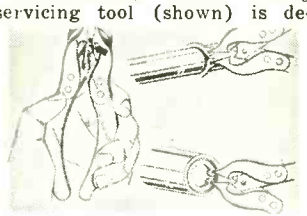
tivity 0.2 volt for rated output. Response 50–15,000 cycles ±1 db. Treble cut type tone controls. Hum and noise 70 db below 2-watt level.—**Mark Simpson Mfg. Co.**, 32-28 49 St., Long Island City 3, N. Y.

ACRYLIC-CASE METERS. Clear plastic-case meters which can be painted to match any



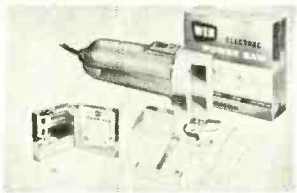
color equipment by spraying with acrylic lacquer. *Model 25-LP* is 2½-inch rectangular; *35-LP*, 3-inch rectangular; *45-LP*, 4½-inch rectangular.—**PACE Electrical Instruments Co.**, 70-31 84 St., Glendale, N. Y.

SERVICING AIDS. *C-ring* servicing tool (shown) is de-



signed for insertion and removal of C washers and retaining rings on tuners, detents, control and switch shafts, etc. *Silver Print* and *Copper Print* are new compounds for repairing and touching up printed circuits around eyelets, parts, etc.—**Walsco Electronic Mfg. Co.**, 100 W. Green St., Rockford, Ill.

POWER-SAW KIT, *model 505K.* Contains *model 505 Uni-*

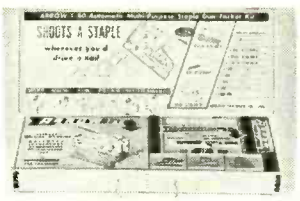


versal power saw in heavy gauge metal kit with 5 assorted blades. Can be used as rip, jig, cross-cut, coping, scroll, keyhole and hacksaw. — **Wen Products Inc.**, 5806 Northwest Hwy., Chicago 31, Ill.

PHONO PIN-PLUG, *Grip-A-Lip model PPP-1.* Finger-grip

lip permits removal of plug without pulling on cable.—**DeRo Electronics**, 134 Nassau Rd., Roosevelt, N. Y.

STAPLE GUN-KIT, *T-50* Contains heavy-duty gun-tacker, screen, wire and window shade attachments, 5,000 staples and

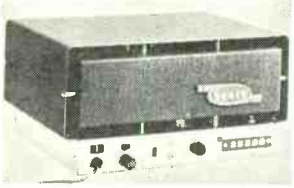


staple lifter.—**Arrow Fastener Co.**, 1 Junius St., Brooklyn, N.Y.

STEREO ADAPTER, *Knight KN-750.* To control stereo systems using two separate amplifiers rated up to 12-watts each. Installed between speakers and amplifiers the unit controls: balance, volume, phasing, channel

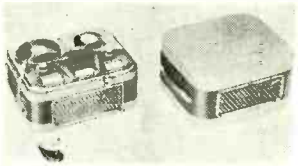
reversal and selection of stereo or mono.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago, Ill.

POWER AMPLIFIER, *model 250.* Rated at 40 watts, 80 watts instantaneous peak. Flat frequency response from 12–40,000



cycles. Less than 0.5% harmonic distortion at rated power output.—**H. H. Scott,** 111 Powder Mill Rd., Maynard, Mass.

STEREO TAPE RECORDER, *Stereo Continental.* Twin-track, 3-speed unit. Push-button controls. Response 40–16,000 cycles



at 7½ ips; 50–12,000 cycles at 3¾ ips; 60–6,000 cycles at 1⅞ ips. Inputs for recording from tuner, phono, microphone and mixing (recording two signals simultaneously or in sequence). With dual preamps, one power amplifier and built-in speaker. Second power amplifier and second channel speaker available in matching case.—**North American Phillips Co.**, High Fidelity Products Div., 230 Duffy Ave., Hicksville, N.Y.

MODULE TYPE CABINETS for hi-fi components. Equipment and speaker cabinets measure either 18 or 36 inches wide, 29 inches high and 16 inches deep. Mobile shelving to accommodate amplifier, tuner, turntable or changer, tape deck and associated equipment. Mahogany or walnut finish.—**Sherwood Electronic Labs.**, 4300 N. California Ave., Chicago 18, Ill. END

All specifications on these pages are from manufacturers' data.

NOTEWORTHY CIRCUITS

TWO REFLEX RECEIVERS

Two reflex trf circuits that have become popular in England are shown in Figs. 1 and 2. The first was described in *Practical Wireless* and uses one tube, an ECL80, which is a triode and output pentode in one envelope. The pentode section is used as an rf amplifier and the triode as a detector. The output from the detector is fed back to the rf section and used as the output tube. The circuit's performance is equivalent to that of the usual three-tube trf midget receiver.

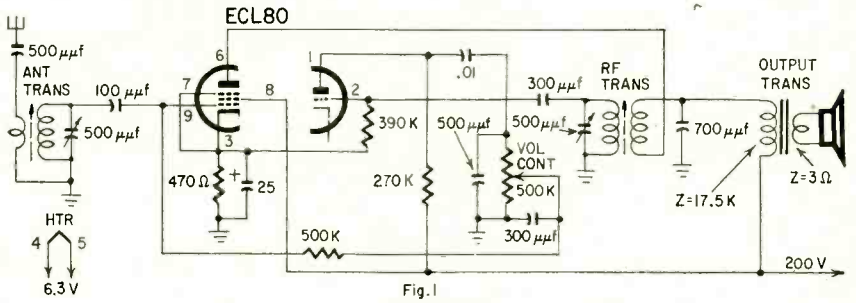


Fig. 1

The second receiver was shown in *Wireless World* and is slightly more novel as it has a push-pull output. Two rf pentodes are again used both as rf and push-pull output stages. SP61's are high-gain rf pentodes, somewhat similar to 6AC7's but with a gm of 8.5 ma/v (8,500 μmhos). If a 6H6 is used in place of the crystal diode, the 100,000-ohm detector load should be increased to 470,000 ohms.—*A. W. J. March*

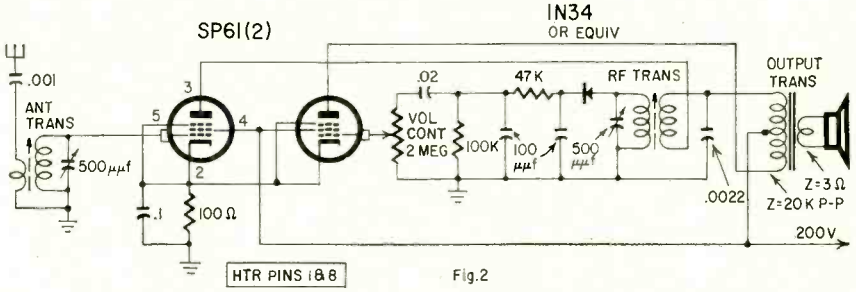


Fig. 2

(The European type tubes used in these circuits may be obtained from Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y., International Electronics Corp., 81 Spring St., New York, N. Y. and from distributors of European radios.—*Editor*)

AUTOMATIC BRIGHTNESS AND CONTRAST CONTROL

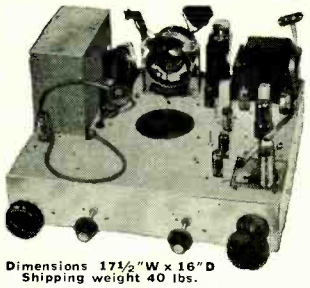
An interesting automatic brightness and contrast-control circuit is used on the latest models of German Metz television receivers. A somewhat simplified version is shown in the diagram. It shows the video amplifier and the horizontal output tube—the first providing the video signal and the second a negative bias—and a double triode which is used in the automatic circuit.

V1-b is the contrast control tube, a variant of the familiar keyed-tube circuit, with its cathode tied to the cathode of the video amplifier. Its plate is fed by pulses coming from the flyback transformer. Its cathode receives the video signal. The agc voltage developed on its plate can be adjusted with contrast pot R1. However, it is also controlled by the grid bias, which is obtained from the negative voltage on the grid of the horizontal output tube through the resistance of a selenium photocell. This cell measures the ambient light in the room and increases the grid bias as the ambient light decreases. As a result, the contrast setting for the receiver is automatically adjusted to suit room lighting conditions.

V1-a receives a fraction of the video signal at its grid, and works as a grid detector. The dc plate voltage is applied

DX-16 Super Deluxe TV KIT

70° or 90° — operating all 17", 21", 24" and 27" PICTURE TUBES



Dimensions 17½"W x 16"D
Shipping weight 40 lbs.

NEW IN DESIGN—Mounts Horizontally, Vertically

- ★ Produces a 16-Tube Chassis with 30-Tube performance.
- ★ Latest Intercarrier Circuitry and Multi-section Tubes.
- ★ Standard Neutrode Tuner for Selectivity & Fine Definition.
- ★ 5 Microvolts Sensitivity (20V peak to peak at CRT grid).
- ★ Fast Action AGC for Drift Free, Steady and Clear Pictures.
- ★ 3 Hi-gain Video I.F. Stages for fine Contrast and Details.
- ★ AGC Level Control, for adjusting reception to signal area.
- ★ All Video and I.F. Coils factory pre-aligned and tuned.
- ★ Large 250ma Power Transformer for dependable service.
- ★ 12" Speaker or Twin-cone 6" x 9" Speaker.

Includes **LIFE-SIZE** step-by-step Building Instructions
Most Up-To-Date and Practical Course in Television

COMPLETE KIT with SET of WESTINGHOUSE TUBES **$79.97**
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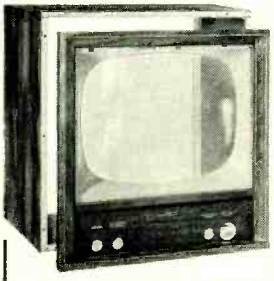


BUILD YOUR OWN CABINET FOR ANY TV CHASSIS

Comparable to the type that Top Mfrs. use on high priced TV sets.
CABINET KIT with 90% of the job done, includes—

FRONT SECTION in Solid Mahogany, Walnut or Blond Korina. **TOP, SIDES, BACK, MASK, SAFETY GLASS, ETC.**

And EASY-TO-FOLLOW ASSEMBLY INSTRUCTIONS

Front, Top and Sides supplied in a beautiful Piano Finish ● Knob panel undrilled ● For matching Mask specify type or number of CRT used. Same price—Mahogany, Walnut or Blond. (Shipping weight 36 lbs.)

21" CABINET KIT 26"H, 25"W, 22"D **$24.95**

FRONT SECTION Only for WALL INSTALLATIONS Includes Mask, Safety Glass, Decals and Illustrated Instructions. **21" $17.45** | **24" or 27" $22.97**
Complete as pictured, ready to install—in Mahogany, Walnut, Blond or unfinished.

PULSE KEYED AGC KIT

Finest, most accurate and the easiest Kit to install—in any make TV RECEIVER Complete—including 6AU6 Tube & Instructions **$4.59**

TV PLASTIC OPEN MASKS

21"—Rectangular 18" x 22½" $2.38
24"—Rectangular 21" x 26" 4.93
27"—Rectangular 21" x 26" 4.93
On 21" specify type number of CRT used

TV SAFETY GLASS in HANDY SIZES

16" x 20" ..... $2.94 | 20¼" x 25" $5.47
18" x 22½" ..... 5.16 | 21" x 26" 5.87

90° TV CONVERSION KIT

Convert any Size, any make **TV RECEIVER** to operate the 24" or **ANY 90° PICTURE TUBE.**

COMPLETE SET OF ESSENTIAL PARTS includes matched set of 90° **YOKE & 18kv FLYBACK, 30kv FILTER, 6AX4 TUBE, BRACKETS, WIDTH CONTROL, CONDENSERS, RESISTORS, ETC.**

Your Price **$15.98** List Price $39.75
Incl. CONVERSION MANUAL with Step-by-Step Instructions & Diagrams

Similar Kit for any 70° CRT... **$13.97**

STEREO — Selected as BEST for Quality, Performance & Price

$98 DeWald #M-1000 "AMBASSADOR AM-FM TUNER" both Stereo & Monaural $68
$98 DeWald #M-1200 "CONCERTO 30-WATT AMPLIFIER" both Stereo & Monaural $68
$59 BASS REFLEX CABINET for 12" or 15" Speaker, in Mahogany, Walnut or Blond $34
$28 12" HI-FI UNIVERSAL TYPE SPEAKER woofer & tweeter range 50 to 15000 cps $14
$49 DELUXE VM 4-SPEED RECORD CHANGER incl. Cartridge plays all Stereo & Monaural $26
$332 "COMPLETE PACKAGE DEAL" includes ALL FIVE ITEMS as shown above.....for only $199

TUBULAR CONDENSERS — 85°C TOP QUALITY—Equally as good for Radio or TV work.

.0047-400v, .01-400v, .02-400v, .047-400v, .001-600v, .0047-600v, .01-600v, .02-600v..... 5¢ ea.
.1-400v, .25-400v, .47-400v, .047-600v, .1-600v, .25-600v, .001-1000v, .01-1000v..... 8¢ ea.
.035-1000v, .047-1000v, .1-1000v, .015-1600v, .03-1600v, .001-6000v, .005-6000v ..... 14¢ ea.

ELECTROLYTIC CONDENSERS — 85°C 1-50v, 1-150v, 2-450v, 5-150v, 8-150v ..19¢ ea.

20/20-150v, 50/30-150v, 40-150v, 10-450v, 20-450v, 30-450v, 40-450v, 60-450v, 80-450v.....34¢ ea.

CARBON RESISTORS — Regular factory stock in Stackpole, I.R.C., Speer, etc.

½ WATT 10% 10, 39, 47, 100, 120, 150, 270, 330, 390, 470, 560, 680, 820, 1k, 1800Ω..... 2¢ ea.
½ WATT 10% 2700, 3300, 3900, 4700, 5600, 6800, 8200, 10k, 15k, 18k, 22k, 27k, 33kΩ.... 2¢ ea.
½ WATT 10% 39k, 47k, 50k, 56k, 68k, 82k, 100k, 120k, 150k, 180k, 220k, 270k, 330kΩ.... 2¢ ea.
½ WATT 10% 390k, 470k, 560k, 680k, 820k,Ω 1, 1.2, 1.5, 2.2, 6.8, 10, 15 MEGΩ.... 2¢ ea.
1 WATT 10% 3.3, 10, 39, 100, 120, 150, 330, 470, 560, 680, 820, 1k, 1800, 2700, 4700Ω.. 3¢ ea.
1 WATT 10% 6800, 10k, 15k, 22k, 27k, 33k, 39k, 47k, 68k, 82k, 150k, 470k, 680kΩ..... 3¢ ea.
2 WATT 10% 3.9, 18, 22, 82, 100, 180, 2200, 4700, 6800, 8200, 18k, 22k, 100k, 470kΩ.... 4¢ ea.

CERAMIC CONDENSERS 1, 2, 3, 5, 6, 10, 22, 25, 47, 50, 51, 56, 82, 100, 120, 200 mmf .... 3¢ ea.
CERAMIC CONDENSERS 220, 250, 270, 330, 470, 1k, 1200, 1500, 2k, 5k, 6800, 15k mmf .... 3¢ ea.
MICA CONDENSERS 5, 25, 50, 60, 68, 75, 100, 120, 150, 220, 270, 390, 470, 510, 10k mmf.. 3¢ ea.
MICA CONDENSERS 560, 680, 820, 1k, 1500, 2k, 2500, 3300, 4700, 6k, 6800, 8k, 10k mmf . 3¢ ea.

"ONE DOLLAR" buys

As much as $15 worth — Everything Brand New and sold to you with a money back guarantee.

DEDUCT 10% ON ANY ORDER OF $10 OR OVER

(ON THESE DOLLAR BUYS)
Plus a FREE SURPRISE PACKAGE

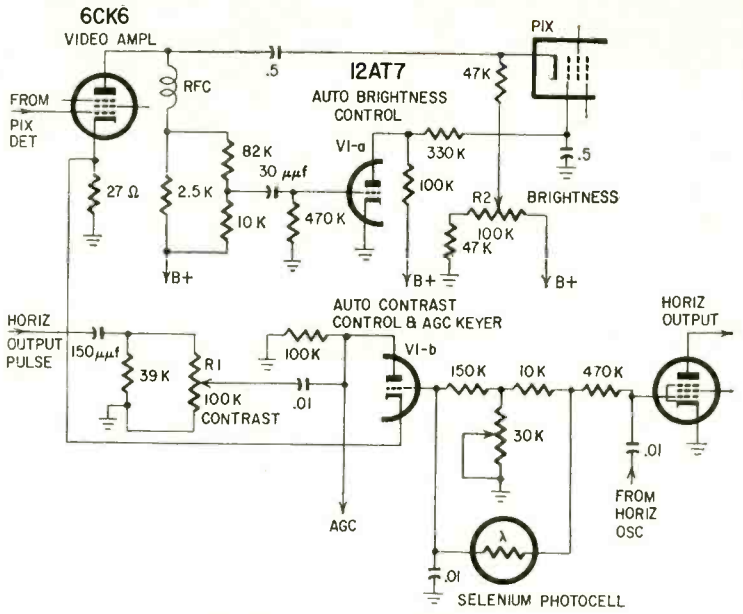
- ☐ $15 — "JACKPOT" TELEVISION PARTS..... $1
- ☐ 1 — RCA 70° FLYBACK TRANS. #75240 .... $1
- ☐ 1 — $11 TODD 60° DEFLECTION YOKE..... $1
- ☐ 4 — RCA TUBES #1U4 also serves as a 1T4 ..... $1
- ☐ 10 — TV CARTWHEEL CONDENSERS 10kv $1
- ☐ 40 — ASST. PRECISION RESISTORS best sizes $1
- ☐ 35 — ASST. DISC CERAMICS best numbers $1
- ☐ 2 — ELECTRIC MOTORS 1½ volt, 1001 uses ... $1
- ☐ 1 — 5" PM SPEAKER alnico #5 magnet..... $1
- ☐ 20 — TUBULAR CONDENSERS .05-600v $1
- ☐ 20 — TUBULAR CONDENSERS .001-1000v $1
- ☐ 100 — ASSORTED FUSES popular sizes $1
- ☐ 100 — ASST. ½ WATT RESISTORS some 5% .. $1
- ☐ 70 — ASSORTED 1 WATT RESISTORS some 5% $1
- ☐ 35 — ASSORTED 2 WATT RESISTORS some 5% $1
- ☐ 50 — ASST. TUBULAR CONDENSERS..... $1
- ☐ 10 — 6' ELECTRIC LINE CORDS with plugs .. $1
- ☐ 5 — TV CHEATER CORDS with both plugs $1
- ☐ 4 — 50' SPOOLS HOOK-UP WIRE 4 colors $1
- ☐ 50 — STRIPS ASST. SPAGHETTI best sizes ... $1
- ☐ 100 — ASST. RUBBER GROMMETS best sizes .. $1
- ☐ 100' — TWIN LEAD-IN WIRE 300Ω heavy duty .. $1
- ☐ 50' — FLAT 4-CONDUCT. WIRE many purposes . $1
- ☐ 25' — INSULATED SHIELDED WIRE..... $1
- ☐ 1 — $7 INDOOR TV ANTENNA hi-gain 3 section . $1
- ☐ 50' — ANTENNA ROTOR 4-CONDUCT. WIRE. $1
- ☐ 20 — ASST. TV KNOBS, ESCUTCHEONS, Etc. $1
- ☐ 3 — ASST. TOGGLE SWITCHES spst, dpdt, etc. $1
- ☐ 15 — ASST. ROTARY SWITCHES $15 worth.... $1
- ☐ 100' — FINEST NYLON DIAL CORD best size... $1
- ☐ 200 — SELF TAPPING SCREWS #8 x ½" $1
- ☐ 35 — ASST. RADIO KNOBS screw and push-on... $1
- ☐ 100 — KNOB SPRINGS standard size ⅜" x ½"..$1
- ☐ 100 — ASSORTED KNOB SET-SCREWS..... $1
- ☐ 25 — ASSORTED CLOCK RADIO KNOBS..... $1
- ☐ 600 — ASST. H'DWARE screws, nuts, rivets, etc..$1
- ☐ 50 — ASST. SOCKETS octal, noval and miniature..$1
- ☐ 20 — ASSORTED TUBE SHIELDS best sizes..... $1
- ☐ 50 — ASST. MICA CONDENSERS some in 5%..$1
- ☐ 50 — ASST. CERAMIC CONDENSERS " $1
- ☐ 10 — ASST. VOLUME CONTROLS less switch...$1
- ☐ 5 — ASST. VOLUME CONTROLS with switch ... $1
- ☐ 100 — VOLUME CONTROL HEX NUTS..... $1
- ☐ 20 — ASST. PILOT LIGHTS popular types..... $1
- ☐ 10 — PILOT LIGHT SKTS. bayonet type, wired...$1
- ☐ 50 — ASST. TERMINAL STRIPS 1, 2, 3, 4 lug... $1
- ☐ 10 — ASST. RADIO ELECTRO. CONDENSERS. $1
- ☐ 5 — ASST. TV ELECTROLYTIC CONDENSERS. $1
- ☐ 25 — ASST. MICA TRIMMER CONDENSERS.. $1
- ☐ 2 — ELECTROLYTIC COND. 40/40 — 450V....$1
- ☐ 30 — FP CONDENSER MOUNTING WAFERS.. $1
- ☐ 3 — ELECTROLYTIC CONDENSERS 80-450v .. $1
- ☐ 3 — ELECTROLYTIC COND. 50/30-150v. $1
- ☐ 10 — HV TUBULAR CONDENSERS .001—6000v..$1
- ☐ 10 — HV TUBULAR CONDENSERS .005—6000V..$1
- ☐ 35 — MICA COND. 20 - 100 mmf & 15-270 mmf.....$1
- ☐ 35 — MICA COND. 20 - 470 mmf & 15-680 mmf.....$1
- ☐ 35 — MICA COND. 20 - 820 mmf & 15-1000 mmf $1
- ☐ 35 — CERAMIC COND. 20 - 5 mmf & 15-10 mmf....$1
- ☐ 35 — CERAMIC COND. 20 - 25 mmf & 15-47 mmf...$1
- ☐ 35 — CERAMIC COND. 20 - 56 mmf & 15-82 mmf ...$1
- ☐ 35 — CERAMIC COND. 20 - 100 mmf & 15-150 mmf ..$1
- ☐ 35 — CERAMIC COND. 20 - 270 mmf & 15-470 mmf ..$1
- ☐ 35 — CERAMIC COND. 20 - 1000 mmf & 15-1500 mmf ..$1
- ☐ 35 — CERAMIC COND. 20 - 2000 mmf & 15-5000 mmf ..$1
- ☐ 50 — 100Ω ½ WATT RESISTORS 5%.....$1
- ☐ 75 — 470KΩ ½ WATT RESISTORS 10%.....$1
- ☐ 3 — VARIABLE CONDENSERS 420/162 mmfd ..$1
- ☐ 10 — ASST. WIREW'ND RES. 5, 10, 20 watt...$1
- ☐ 3 — AUDIO OUTPUT TRANS. 50L6 type $1
- ☐ 3 — AUDIO OUTPUT TRANS. 6K6 or 6V6 type..$1
- ☐ 3 — I.F. COIL TRANSFORMERS 456 kc.....$1
- ☐ 3 — I.F. COIL TRANSFORMERS 10.7 mc FM ..$1
- ☐ 4 — OVAL LOOP ANTENNAS ass't hi-gain types.$1
- ☐ 3 — LOOPSTICK ANT. new ferrite adjustable $1
- ☐ 12 — RADIO OSCILLATOR COILS 456 kc $1
- ☐ 3 — ½ MEG VOLUME CONTROLS with switch .$1
- ☐ 5 — 50K VOLUME CONTROLS less switch $1
- ☐ 10 — SURE GRIP ALLIGATOR CLIPS.....$1
- ☐ 1 — GOLD GRILLE CLOTH 14"x14" or 12"x18" .$1
- ☐ 5 — SETS SPEAKER PLUGS wired $1
- ☐ 10 — SETS PHONO PLUGS and PIN JACKS..$1
- ☐ 2 — $2.50 SAPPHIRE NEEDLES 4000 playings ..$1
- ☐ 5 — DIODE CRYSTALS 2—1N21 2—1N22 1—1N64 $1
- ☐ 3 — DIODE CRYSTALS 1—1N60. 1—1N64. 1—1N69 $1
- ☐ 2 — SELENIUM RECTIFIERS 1—65 ma & 1—150 ma $1
- ☐ 15 — ASST. TV COILS sync. peaking, width, etc. .$1
- ☐ 5 — TV CRT. SOCKETS with 18" leads $1
- ☐ 5 — HI-VOLT. ANODE LEADS with 18" leads ...$1
- ☐ 1 — LB. SPOOL ROSIN CORE SOLDER 40/60 ..$1
- ☐ 6 — SPIN TIGHT SOCKET SET 3/16" to 7/16" ..$1
- ☐ 3 — TV ALIGNMENT TOOLS 5", 7", 12" $1

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

TELEPHONE COrtland 7-2359



to the picture-tube grid through a filter circuit. The positive plate voltage decreases when the video signal decreases, so this circuit acts as an amplified black-level clamping stage and provides a sensitive adjustment of brightness as a function of the video signal level.

Since this level is controlled by the automatic contrast circuit—the video amplifier and V1-b have a common cathode return—the photocell indirectly provides for automatic brilliance control. Potentiometer R2 is the conventional manual brightness control.—*A. V. J. Martin*

(This circuit performs the same basic function as the automatic contrast-ratio control used in the Westinghouse model 846K21 receiver and described on page 29 of the August, 1953, issue. —*Editor*) END

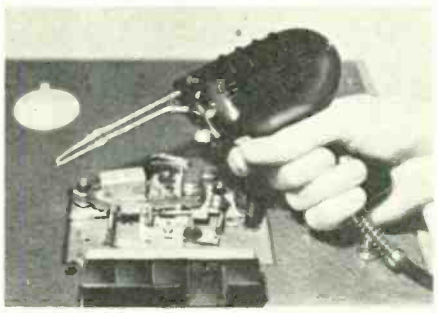
Technotes

WIND COILS EVENLY

Winding small coils with enameled or similar wire is hampered by the fact that it becomes increasingly difficult to distinguish between layers. Apply a thin coating of white fast-drying paint evenly over the layer preceding the layer being wound, and let the paint dry for a moment before wrapping the next layer of wire. Performance of the coil won't be affected by the paint, and the coil will have a factorylike evenness.—*Harry J. Miller*

SERVICING TAPE RECORDERS

When a tape recorder comes in for repair with the complaint that it fails to operate properly on playback (or playback and record if it has a single head with a dual-purpose winding), the trouble invariably can be traced to an open winding in the head. But don't use an ohmmeter to check continuity! If the winding isn't open, you



may magnetize the head with direct current from the meter. Instead, turn the recorder on, set the controls for playback and inject a hum signal into the head by holding a soldering gun near the head. The field set up by the gun's transformer will induce a signal into the playback winding and appear as hum from the recorder's speaker if the winding is not open. This is a fast accurate check for head continuity. Absence of hum from the speaker indicates an open winding (assuming the playback switching and amplifiers have been tested and already found operative).—*John A. Comstock*

PHILCO MODEL 52-2224

Complaint: Intermittent sound. The volume would drop after a period of time. It might or might not come back to normal. While it was low, a crackling could be heard from the speaker. A complete check of tubes, parts and voltages revealed nothing that might be at fault.

The trouble was in the sound discriminator transformer. A simple replacement cured a troublesome problem.—*Wilbur J. Hantz*

OLDSMOBILE AUTO RADIO

After about a week, the owner of an Oldsmobile auto radio model 982543 returned with the same complaint—a weak signal and the usual "You just fixed it . . . Why? . . . etc.!"

Again the set was pulled and the last if transformer retuned, just like the previous case history from the file card. No looseness was observed in either slug, but tapping the transformer eventually produced another detune with its associated signal loss.

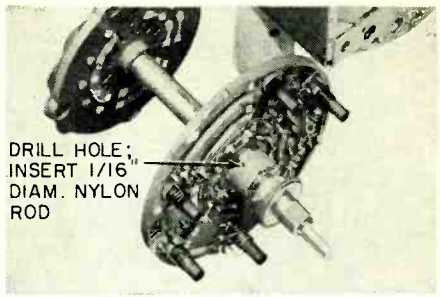
Before replacing the transformer, the technician looked it over under a magnifying glass. All joints were good, but he noticed a PC unit containing two capacitors was cracked. The PC was replaced and the trouble ended. —*James A. McRoberts*

ADMIRAL T104N TUNER

Several Admiral T104N tuners have revealed trouble with the channel selector. Typical complaints have been, "Something is loose in the channel selector . . . a short." "It won't hold stations."

This model has a disk type switch for channel selection and in some receivers the oscillator (top) disk comes loose on the shaft and doesn't ride correctly above the switch contacts when stations are changed.

The solution to this problem is simple. Remove the tuner cover and, using a



1/16-inch or smaller bit, drill a hole through the disk retaining ring and shaft, making sure that the disk is in the proper position. Before drilling, place a piece of cloth in and around the tuner shaft just below where the drilling operation will take place, to catch as many metal scraps as possible.

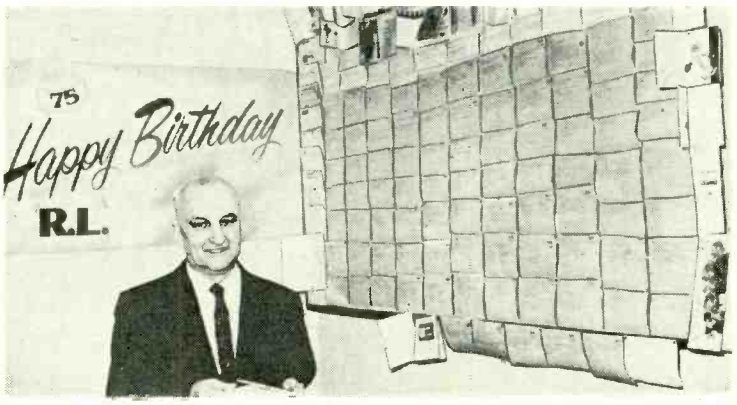
After the hole has been made, use a *nylon or fiber* rod to pin the disk to the channel-selector shaft. If a metal pin is used the shaft will be hot.—*Admiral Service Data Supplement*

PHILCO MODEL C-5709

When this auto radio is first turned on, it may motorboat for a short period. Any technician having this problem with this set should connect his ammeter in series with the output transistor's collector. For perfect operation, current should be about 60 ma. A 10-ma variation in either direction is normal. Greater variation usually means a bad transistor.—*A. Von Zook* END

BUSINESS and PEOPLE

R. L. Triplett, chairman of the board and founder of the Triplett Electrical Instrument Co., Bluffton, Ohio, displays some of the many congratulatory messages from industry leaders as he observes his 75th birthday. Widely known as an electronics industry pioneer, he founded in 1904 the test equipment company which bears his name.



Howard W. Sams chairman of the board of Howard W. Sams & Co., Indianapolis technical publisher, also became chairman of the 120-year-old book publishing firm Bobbs-Merrill Co. of Indianapolis, with the purchase of Bobbs-Merrill by the Sams company.

J. Gerald Mayer is the new president of Radio Receptor Co., Brooklyn, N. Y., subsidiary of General Instrument Corp. He has been with Radio Receptor since 1957 and previously was executive vice president of Micamold Electronics Manufacturing Corp., another General Instrument subsidiary. **Monte Cohen**, president of General Instrument, had been acting president of Radio Receptor.

Mogens E. Christiansen, former assistant sales manager, has been appointed general sales manager of the Mallory Battery Co., Cleveland, Ohio, a division of P. R. Mallory & Co., Indianapolis. He's been in the battery industry 19 years.

John J. Graham has been appointed general manager, Communications and Industrial Electronics Products Div., and **Charles H. Colledge** general manager, Broadcast and Television Equipment Div., RCA Industrial Electronic Products. Graham was formerly manager, operations administration, RCA Industrial Electronic Products, and Colledge was vice president, facilities operations, National Broadcasting Co.

Fred A. Martin was named general sales manager for the Parts Div. of Sylvania Electric Products Inc., with headquarters at Warren, Pa. He had been field sales manager for the division since 1951. He will be responsible for all Sylvania field offices.

Two pioneers in the electronic tube industry died late in 1958. **Harvey W. Harper**, founder and chairman of the board of Tung-Sol Electric Inc., Newark, N. J., died Nov. 23 at his home in Belleair, Fla. at the age of 80. **Roy Burlew**, founder of the Ken-Rad Lamp & Tube Co., died at 75, Dec. 5 at his home in Owensboro, Ky.

John R. Howland joined Philco Corp., Philadelphia, as sales manager–closed-circuit television and product control equipment, Government and Industrial Div. For the last three years he was general sales manager of Dage Television Div., Thompson Products Inc.

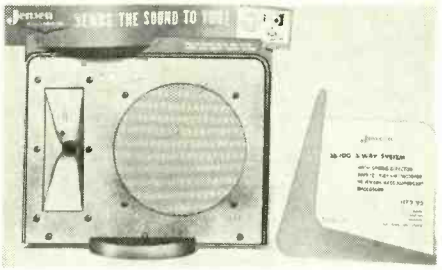
Lewis E. Gillingham, former marketing director of Remler Co., has been appointed marketing director and advertising manager of Altec Companies Inc., Anaheim, Calif.

Alfred Wish, former secretary, has been elected vice president of the Recoton Corp., Long Island City, N. Y., succeeding **Jack Karns**, resigned. Recoton

also promoted **Hank Miller** from Midwest sales manager to national sales manager.

Officers of Service Instruments Corp., Addison, Ill. (below), inspect one of the new window streamers designed to keep technicians and distributors informed of Sencore test equipment. This new point-of-sale aid is part of a merchandising and advertising schedule in RADIO-ELECTRONICS for 1959, which will include 84 separate advertisements. Reproductions of Sencore's new series of full-page editorial type advertisements, written by president Herb Bowden (right), will be available for point-of-sale use. Others in the photo are (left to right) Sencore sales vice president Ed Flaxman; S. Rodkin, president of Sander Rodkin Advertising Agency, Chicago, and Sencore engineering vice president Robert Baum.

Jensen Manufacturing Co., Chicago, is furnishing its hi-fi retailers with a



Stereo Center merchandising display for demonstration of the new Stereo Director feature of its loudspeaker line. The Center display includes background drapes and special signs.

RCA Electron Tube Div. is now marketing two separate lines of black-and-white TV picture tubes. The premium line is constructed from all-new materials, while the economy line features factory-rebuilt tubes.

Jerrold Electronics Corp., Philadelphia, is offering dealers a store display which does more than just sit there. Featuring the TV-FM Amplified Home Antenna System, the 3 x 4-foot wall-mounted display contains five plug-in outlets and can be used by the dealer as a fully operational master TV antenna system.

Unit production and sales

	First 10 months	
	1958	1957
TV Set Production	4,067,806	5,251,158
Radio Set Production	9,489,544	11,945,534
FM Radio Production (July–Oct.)	235,647	unavailable
TV Retail Sales	3,991,530	5,024,670
Radio Retail Sales*	5,647,044	6,764,221
TV Picture Tube Sales	6,801,706	8,304,181
Receiving Tube Sales	333,258,000	388,738,000
Transistor Sales	36,072,133	21,396,300

*Excluding auto receivers
Source — EIA

END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
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 Modern Electrics on file for interested readers.

In February, 1909, *Modern Electronics*

The High Tension Transformer, by M. A. Deviny.
Wireless by Compulsion.
Society of Wireless Telegraph Engineers.
Tuned Wireless Telegraphy.
Operator Binn's Wireless Log.
Navigation by Wireless.
New Method of Securing Wollaston Wire, by H. Gernsback.
Spark Gap Muffler, by L. Spangenberg.
Development in Wireless Telephony, by William Maver, Jr.
A Simple Antenna Switch, by A. C. Austin, Jr.
Wireless Registry.

OPPORTUNITY ADLETS

Rates—50c per word (including name, address and initials). Minimum ad 10 words. Cash must accompany all ads except those placed by accredited agencies. Discount, 10% for 12 consecutive issues. Misleading or objectionable ads not accepted. Copy for March issue must reach us before February 15, 1959.

RADIO-ELECTRONICS,
154 West 14 St., New York 11, N. Y.

HIGH-FIDELITY SPEAKERS REPAIRED. AMPRITE Speaker Service, 70 Vesey St., New York 7, N.Y. BA 7-2580.

CASH PAID! Sell your surplus electronic tubes. Want unused, clean transmitting, special purpose, receiving, TV types, magnetrons, klystrons, broadcast, etc. Also want military & commercial lab test and communications gear. We swap too, for tubes or choice equipment. Send specific details in first letter. For a fair deal write, wire or telephone: BARRY, 512 Broadway, New York 12, N.Y. WALker 5-7000.

RECORDERS, Hi-Fi, Tapes. Free Wholesale Catalogue. CARSTON, 215-T East 88th St., New York 28, N.Y.

STEREO TAPE RENTALS. For the very best at lowest prices. Write CALIFORNIA TAPED MUSIC ASSN., 763 El Camino Real, Redwood City, Calif.

DISCOUNTS UP TO 50% on Hi-Fi amplifiers, tuners, speakers, tape recorders, individual quotations only, no catalogs. CLASSIFIED HI-FI EXCHANGE, 2375 East 65th Street, Brooklyn 34, N.Y.

LABORATORY QUALITY equipment and Military Surplus Electronics bought, sold. ENGINEERING ASSOCIATES, 434 Patterson Road, Dayton 9, Ohio.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. HAZELTON INSTRUMENT Co., 128 Liberty Street, New York, N.Y.

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LITERATURE

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.

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STANDARD RESISTANCE values can be determined at a glance from the official *MIL-Bell* decade table for precision film resistors.—**Texas Instruments Inc.,** Box 312, Dallas, Tex.

HI-FI CATALOG *No. 510* contains 16 pages of stereo and mono amplifiers, tuners and phonographs, comprising the manufacturer's complete line.—**David Bogen Co.,** Advertising Dept., Box 500, Paramus, N. J.

STEREO CATALOG, pocket size, illustrates line of stereo and convertible-to-stereo components. Separate booklet describes the Stereo-Daptor control center and how it may be used.—**H. H. Scott Inc.,** 111 Powder Mill Rd., Maynard, Mass.

LAMP BOOKLET lists all available panel, flashlight, neon glow, automotive and multi-purpose lamps made by American manufacturers, in 24 pages.—**United Catalog Publishers Inc.,** 60 Madison Ave., Hempstead, N. Y. **10c. Free** from *Radio-Electronic Master* distributors.

EUROPEAN TUBE CHART, listing more than 250 type numbers and their American counterparts, both exact replacements and nearest substitute. Available from tube distributors.—**Sylvania Electric Products Inc.,** 1740 Broadway, New York 19, N. Y.

WIRE CATALOG *No. 859* contains 382 new items and lists wires by type and application for all electronic uses.—**Belden Manufacturing Co.,** 415 S. Kilpatrick St., Chicago 44, Ill.

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cates are listed by set manufacturer and model number in new 4-page 1959 catalog.—**JFD Electronics Corp.**, 6101 16 Ave., Brooklyn 4, N. Y.

STEREO SIMPLIFIED is a 16-page booklet, with illustrations and diagrams, describing stereo recordings and reproduction in nontechnical language.—**Sonotone Corp.**, Electronic Applications Div., Elmsford, N. Y.

TUBE SUBSTITUTION GUIDE in convenient 4-page chart form lists 150 of the most commonly used tubes and shows possible substitutions for each.—**Vis-U-All Products Co.**, 303 Fuller Ave. N.E., Grand Rapids 3, Mich.

MAGNETIC CIRCUIT Sketch Book, by Charles A. Maynard. Applications of magnets for attraction, holding or repulsion uses are given with sketches and description. Ask for *Vol. 6, No. 1* of *Applied Magnetics*.—**Indiana Steel Products Co.**, Valparaiso, Ind.

SPECIALIZED TUBES for industry and communications are listed in 6-page *Catalog 2220*. Application and performance data are given for power triodes, rectifier and clipper diodes, gas noise source tubes, TR tubes, pressurized waveguide windows and ionization gauge tubes.—**Central Electronic Manufacturers**, Denville, N. J.

SPEAKER ENCLOSURES and wall and corner baffles in kit and prebuilt form are featured, with complete measurements and descriptions, in *Catalog C-58*, which also describes the 6 models of Tube Caddy.—**Argos Products Co.**, 301 Main St., Genoa, Ill.

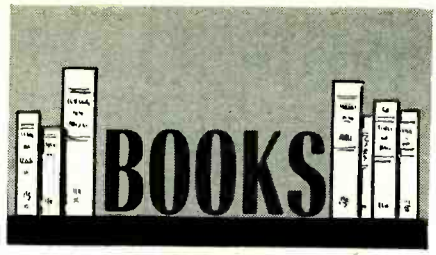
TAPE RECORDER BROCHURE and catalog for consumers describes 5 recorder models and accessories.—**Telectrosonic Corp.**, 35-16 37 St., Long Island City 1, N. Y.

SPEAKER CATALOG, 20 pages in 3 colors, shows a complete line of loudspeakers, with enclosures depicted in decorator settings. Booklet also contains discussions on how to select a speaker system and the requirements for realistic stereo.—**R. T. Bozak Sales Co.**, Darien, Conn.

ELECTRONIC CABINETS, sheet-metal products and components are illustrated and described in large-format 48-page *Catalog 159*.—**Bud Radio Corp.**, 2118 E. 55 St., Cleveland 13, Ohio.

INSTRUMENT RECTIFIER GUIDE, seventh edition, is a sturdy 45-page book listing replacement rectifiers for a wide variety of test equipment and other instruments made by nearly all manufacturers. It also lists authorized repair stations for most makes of test instruments.—**Conant Laboratories**, 6500 O St., Lincoln, Neb.

LINE CORDS, plugs and cord sets for frypans, roasters, vacuum cleaners, dryers, ranges and other types of electrical equipment are featured in complete new *Catalog 1758*.—**Belden Manufacturing Co.**, 415 S. Kilpatrick Ave., Chicago 44, Ill. END



MOST-OFTEN-NEEDED 1959 TELEVISION SERVICING INFORMATION (Vol. TV-15). Compiled by M. N. Beitman. Supreme Publications, 1760 Balsam Rd., Highland Park, Ill. 8½ x 11 in. 192 pp. $3.

A volume of original manufacturers' circuit diagrams and servicing information for over 600 models and chassis of early 1959 TV receivers of 12 brands.

HOW TO BECOME A PROFESSIONAL ENGINEER, by John Constance. McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y. 5½ x 8 in. 272 pp. $5.50.

A professional engineer is one who is registered or licensed by the state where he works. There are over 200,000 professional engineers in this country. The license marks an engineer as an expert and proves his capability to handle advanced engineering projects.

The author has helped prepare engineers for licensing for many years. Here he lists qualifications state by state, discusses the written exams and tells how to pass them. In general, these requirements include college education plus 4 years of *professional* experience. This may be design or construction supervision, major responsibility in research, college teaching, etc. Repair, installation or operation of electronic devices or machines, work as an assistant in research or design, etc. do not count.

The author has definite ideas on how a professional should behave. He refers to certain engineers who "come to work in old clothes or bring lunch pails . . . act like tradesmen, not like professional engineers."—*IQ*

PIN-POINT RECORD CHANGER TROUBLES in 5 MINUTES, by P. Sheneman. Book Publishing Div., Coyne Electrical School, 500 S. Paulina St., Chicago 12, Ill. 6 x 8¼ in., 292 pp. plus index. $3.95.

If you have ever suffered through a trial-and-error record changer repair job, you should examine this text closely. With a series of charts, photos and detailed diagrams, repairing record changers is made "almost nice." Several hundred models are listed, making the text a troubleshooting guide that saves hours of labor during a week of service work.—*LS*

ELECTRONIC CIRCUITS, by RCA Service Co. Howard W. Sams & Co., Inc., 221 E. 46 St., Indianapolis 6, Ind. 8½ x 11 in., 66 pp. $1.

There are so many radio–TV and electronic circuits that beginners may well be perplexed. Actually (and fortunately), there are very few *basic* oscillators, amplifiers, power supplies, etc. A repair expert must know, under-

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This handy book illustrates and describes the operation of the basic circuits in receivers, transmitters, radar, filters and control instruments. It analyzes common defects and tells how to deal with them. Originally written for RCA technicians, it will be found useful for reference and training.—*IQ*

TRANSISTORS, THEORY AND PRACTICE, Second Edition, by Rufus P. Turner. Gernsback Library, 154 W. 14 St., New York 11, N.Y. 5½ x 8½ in., 160 pp. $2.95.

Expanded, updated and completely revised, describes the changes made in this second edition of a most popular text on transistors. Three full chapters on transistor theory get the reader off to a sound start. Then several chapters showing and describing many types of transistor circuits reveal potentialities of the transistor. Among the types of circuits shown are amplifiers, oscillators, triggers and switches, and broadcast receivers. Closing chapters discuss tests and measurements, related devices, and care and handling of transistors. —*LS*

CONDUCTANCE CURVE DESIGN MANUAL, by Keats A. Pullen. John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N.Y. 8½ x 11 in., 128 pp. $4.25.

This manual can be a designer's best assistant. It contains "G-curves" for 71 tube types. They show *actual* mutual and plate conductance values over various regions of a tube characteristic, so it isn't necessary to rely on a single *average* value. For pentodes, the values apply for a 2-to-1 ratio of plate–screen voltage, but correction curves appear for other ratios. Each graph also shows curves of constant plate dissipation, making it more convenient to combine maximum *gain* with minimum *distortion* and *dissipation* in designing a circuit.

An important section of the manual deals with formulas for gain, output, load, distortion, etc. These formulas are derived and the author then shows how to apply them in practical examples using data from the curves.—*IQ*

THE EXPLORATION OF SPACE BY RADIO, by R. Hanbury Brown and A. C. B. Lovell. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N.Y. 6 x 9 in., 207 pp. $6.50.

This work, by two University of Manchester (England) experts on radio astronomy, presents an interesting discussion of radio astronomy and the radio telescope, a new but powerful scientific tool which can receive and pinpoint faint radio noise from distant stars and galaxies. Properly interpreted, the noise can tell much about its source and about space.

The book begins with theories and facts about the universe and how waves travel through space. It explains the specialized techniques needed to receive

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and record the very low power at high frequencies.

The authors investigate two phases of radio astronomy: The first deals with energy received directly from a distant galaxy, star, planet or the sun. Such information adds greatly to knowledge of the universe. The second concerns radio echoes from the moon, meteors or planets. This study has great practical value in measuring distance, tracking artificial satellites and extending long-distance radio communication (with the help of a space target to reflect energy from the transmitter to receiver). Dr. Lovell, the co-author, is director of the Jodrell Bank Radio Telescope (RADIO-ELECTRONICS, February, 1958, page 32).—*IQ*

AUDIO MEASUREMENTS, by Norman H. Crowhurst. Gernsback Library, 154 W. 14 St., New York 11, N.Y. 5½ x 8½ in., 224 pp. $2.90.

Many people today have high-fidelity equipment, but of this group how many know what their equipment is doing—how well is it performing? To test such a system and find out how well it works and how close it is to what it should be, a series of specialized tests are needed. Such tests are analyzed in this profusely illustrated text.

The author, after discussing measurement techniques and test equipment needed, goes on to the various types of equipment that will be tested and carefully details each of the tests that might be used for each type of audio equipment—amplifiers, preamps, pick-ups, arms, turntables, changers, tape recorders and microphones.—*LS*

ELECTRONIC ENGINEER'S REFERENCE BOOK, L. E. C. Hughes, General Editor. MacMillan Co., 60 Fifth Ave., N.Y. 11, N.Y. 4¾ x 7¼ in., 1311 pp. $18.

This book holds a vast amount of information and data on the more recent applications of electronics. Radio, TV, radar and test equipment are mentioned only briefly. Major chapters include photoelectricity, heating by rf, radiations, tube design, magnetic circuits, acoustics, computers and automation. The reader will find such topics as airport recording, magnetic ink, automatic train control, lubricants, printed circuits, nonlinear resistors and many others.

Hundreds of illustrations, charts and photos are included. There are nearly 1,000 topics.—*IQ*

IMPEDANCE MATCHING, by Alexander Schure, John F. Rider Publisher, Inc., 116 W. 14 St., N. Y. 11, N. Y. 5½ x 8½ in., 128 pp. $2.90.

Deals with problems of impedance matching at audio and radio frequencies, including a wide range of equipment used as the generator or load in electrical and electronic circuits. A previous knowledge of electronics is needed to get the most out of this text.—*LS*

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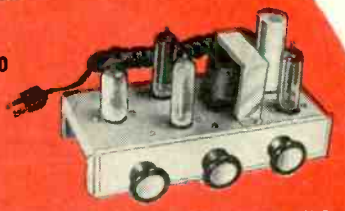

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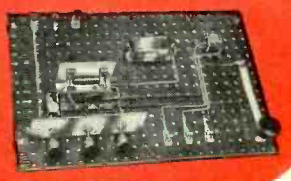

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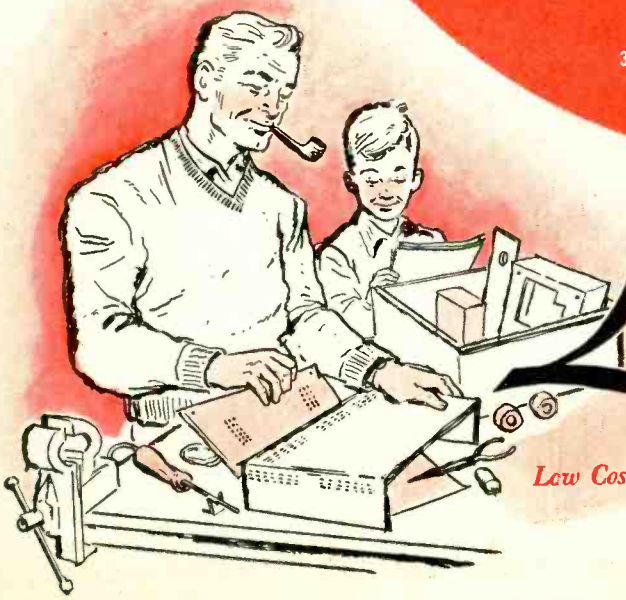

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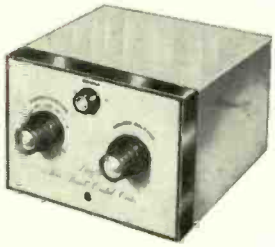

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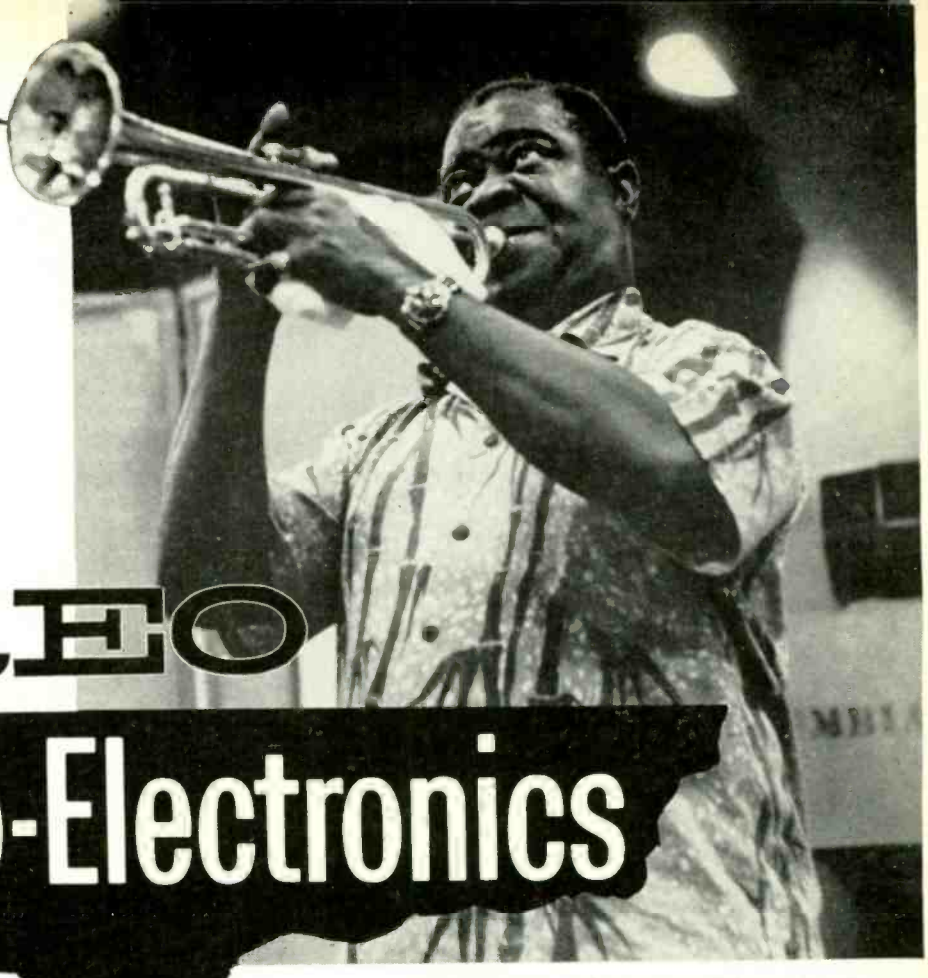

Louis Armstrong—Photo courtesy Columbia Records

Radio-Electronics

A FEW STEREO ISSUE FEATURES LINED UP FOR YOU...

STEREO ISSUE

- ☆ *A Review of Stereo Cartridges*
- ☆ *How to Get Started with Stereo*
- ☆ *Stereo Test Records*
- ☆ *Pitfalls of Phasing*
- ☆ *Will Multiplexing bring us FM Broadcasts?*
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- ☆ *Plus many other articles by top hi-fi writers. Charts, tables, diagrams, photos*
- ☆ *AND A BALANCE of good selections on TV, radio, electronics and all the popular regular departments*

In its March issue, RADIO-ELECTRONICS takes a long look at stereo—yesterday, today, tomorrow—through the eyes of some of today's best regarded hi-fi experts. The Stereo Issue catches all the excitement of this new dimension in sound. It does more. With the clinical eye of the technician it observes, tabulates, guides.

If you've walked with stereo since its first faltering steps, or if you're just getting off the ground now, RADIO-ELECTRONICS Stereo Issue is your road map to fuller understanding, better performance. It shows you how to get started, how to convert, avoid pitfalls, interpret data, choose test records. It answers the technical man's questions about stereo.

NO INCREASE IN PRICE! *This is an issue you'll read, reread, show to friends, and refer to over and over again. Don't miss it. Better reserve a copy now at your newsstand or parts distributor.* **ON SALE FEBRUARY 26**

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Designed to meet the requirements of every specific space, budget, or decor problem—and every listening preference...

University

FAMOUS MEN OF MUSIC CHOOSE UNIVERSITY

University® offers four ways to stereo

1 ***Leading Metropolitan Opera Star Leonard Warren converted to stereo quickly, easily and inexpensively... using a compact Stereoflex-2* "add-on" speaker with his University "Troubadour"***

This approach solves many problems for those already possessing a full-range monophonic system, as well as those planning to buy one now with an eye to stereo later. Thanks to the *exclusive dual voice coil* woofer used in all University stereo-adapted systems, only one such woofer is needed to reproduce the *combined* bass below 150 cycles† of both stereo channels. Thus all three models of University "add-on" speakers provide a perfect match by *direct* connection to the original speaker system. Stereoflex-1* is well suited for bookshelf installations. Stereoflex-2, with its narrow silhouette, makes a fine end table. Model SLC* can be affixed to a wall or "lite-pole," its decorative fibreglas housing blending smartly with modern furnishings. Each can also be used with any brand monophonic system *not* having a dual voice coil woofer, by using a University Stereo Adapter Network Model A-1.

2 ***Discriminating music lovers may also enjoy magnificent stereo by simply connecting two University "add-on" stereo speakers to a single dual voice coil woofer* in a suitable enclosure***

This approach offers great versatility. Since the woofer's position in the room is uncritical for stereo†, it may be installed wherever most convenient . . . in a small suitable enclosure, or in a wall, closet, etc. The two "add-on" speakers can then be placed to provide optimum stereo reproduction, without upsetting existing room decor.

3 ***Noted maestro Fred Waring chose a pair of University RRL* Ultra Linear Response speakers for his stereo system***

When planning his recent cross country concert tour, *Hi Fi Holiday*, Fred Waring turned to University engineers for a compact, quality high fidelity speaker system that could overcome the acoustical deficiencies of the theatres and auditoriums in which The Pennsylvanians would be playing. The performance of the S-11 Ultra Linear Response speakers, mainstays for the system, proved so outstanding that Mr. Waring chose two of them for his own home. Two such identical speakers are an excellent stereo solution in rooms where they can be placed in reasonably symmetrical positions. All University systems are ideally suited for this purpose, because they are stereo-matched in production to within 1 db.

4 ***Internationally famed violinist Mischa Elman prefers his stereo all-in-one . . . he selected the fabulous TMS-2*, 'Trimensional' stereo speaker that in his words . . . "approaches the authenticity of concert hall performance."***

A totally integrated single-cabinet system, the TMS-2 literally adds a third dimension to stereophonic sound... the perception of *depth*. Designed to utilize the acoustical properties of the surrounding walls of the room, the TMS-2 performs far beyond the scope of other single-cabinet stereo speakers. Its ingenious combination of electrical and acoustical principles permits placement in a corner or *anywhere* along a wall... lets you and any number of friends enjoy exciting stereophonic sound from almost any position in the room.

WHICH WAY TO STEREO IS IDEAL FOR YOU?

You'll find all the answers in University's FREE *Informative guide to high fidelity stereo and monophonic speaker systems and components.* Here, you'll find complete information on: how to select and place the four major types of stereo speaker systems... how to adapt your present monophonic system to stereo... how to choose a monophonic system *now* for most efficient conversion to stereo *later*... how to plan economical "do-it-yourself" monophonic/stereo speaker systems. See your dealer today or write Desk J8, University Loudspeakers, Inc., 80 So. Kensico Ave., White Plains, N. Y.

**Trademark and Patent Pending.*

†Bass frequencies below 150 cycles do not contribute to the stereo effect.

the case of the stereo HUMMMMMING *or* MAGNETIC *vs* CERAMIC

You may have been reading many controversial advertisements as to the merits of various stereo cartridges . . . namely, the magnetic version vs. the ceramic version. Qualified claims are made by their manufacturers . . . and most are accurate. But how a specific cartridge *sounds* in your stereo system is really the criterion. Let's consider the real facts:

IT'S A FACT! Audio Engineers agree that magnetic stereo cartridges are excellent, costly . . . but burdened with *hum*. Tests prove that the new Electro-Voice Magneramic cartridge is completely hum-free. No motor or line hum can possibly be introduced to mar soft record passages, because the Magneramic is *non-inductive*.

IT'S AN ENGINEERING AXIOM! The simpler the design of a precision product, the less chance there is of manufacturing defect. Magnetic stereo cartridges are far more complicated than the comparable Electro-Voice Magneramic stereo cartridge. With E-V, you are assured years of trouble-free, high fidelity stereo performance.

IT'S POSITIVE! When the Electro-Voice corps of 60 engineers began intensive scientific stereo studies, they had the choice of either designing a magnetic or a ceramic cartridge. Knowing that two of the most vital factors for true audio reproduction were lack-of-hum and trouble-free performance, they took the positive approach and produced a stereo cartridge incorporating simple elements permitting positive, stable control for uniform output.

And so, with the advent of stereo, Electro-Voice introduced an entirely new concept in ceramic cartridges . . . a true high-fidelity series . . .

THE E-V MAGNERAMIC

which will consistently outperform the best magnetics and do away with the "hummingbird" in your stereo system.

Choose the Magneramic . . . a new improved E-V stereo cartridge which plugs directly into magnetic inputs. See why it's the choice of so many FM stations for critical stereo broadcasts:

- NO HUM
- BEST CHANNEL SEPARATION
  Over 25 db isolation between channels
- HIGHEST COMPLIANCE
  Horizontal and vertical compliance equal to or surpasses the best magnetic cartridges
- WIDEST RANGE FREQUENCY RESPONSE
  Far in excess of any monaural (monophonic) or stereo record
- FLATTEST RESPONSE TO WESTREX 1A VELOCITY CURVE
  From 20 cps to beyond audibility
- HIGH 20 MILLIVOLTS OUTPUT
  All the voltage you need . . . and then some
- PROVEN SUPERIOR
  for conventional monophonic records as well as stereo records
- SOLD ON MONEY-BACK GUARANTEE
  We invite you to try an E-V Magneramic, with E-V's unqualified guarantee backed by over 30 years as a manufacturer.

Give the Magneramic a thorough listening test. If for any reason you aren't completely convinced of its superiority, your FRANCHISED Electro-Voice dealer is authorized to give you a full refund.

Step up to the excitement of stereo . . . step up to Electro-Voice Stereo . . . the industry's standard. Over a half-million in use, more than the total of all other stereo cartridges combined, attest to its acceptance as stereo's standard. Choose either the E-V *Magneramic* for magnetic inputs or the E-V *Standard* Stereo Cartridge for non-magnetic inputs.

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See your High Fidelity Specialist or write Dept. RE-2

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Over ½ Million In Use . . .
MORE THAN ALL OTHERS COMBINED

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he's good
because he's using the best...

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The public doesn't look *behind* a TV set very often. But when they watch you at work, it's reassuring to see the familiar red and black carton with that RCA trademark. The one thing the public *does* know about electronics and electronic products is that RCA is the outstanding name and company in the field. To benefit from the confidence that lesser known brands could never instill in your customers, latch on to RCA's "built-in" reputation —your calling card to customer good-will. Your RCA Distributor carries a full line. Next time you order tubes, specify... RCA.

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