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MARCH 1958

Radio-Electronics

HUGO GERNSBACK, Editor

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(See page 50)

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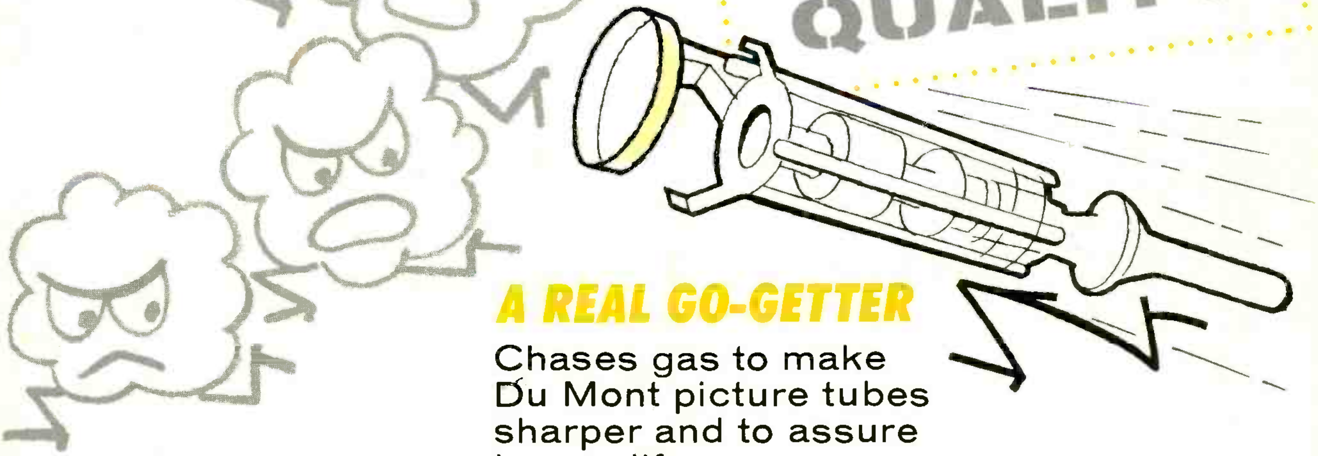

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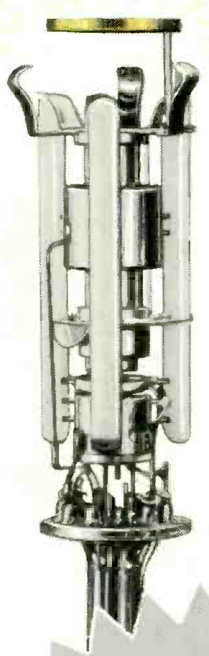

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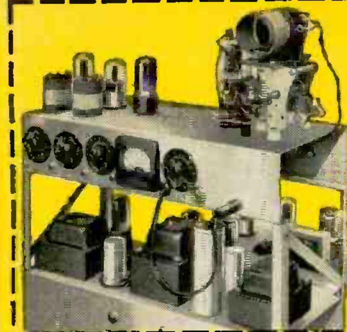

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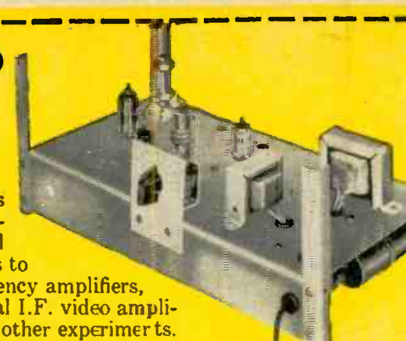

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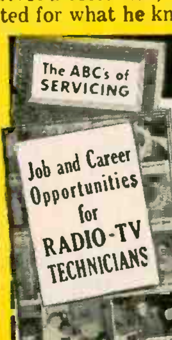

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MARCH, 1958

Radio-Electronics

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

EDITORIAL

AUDIO—HIGH FIDELITY

TEST INSTRUMENTS

WHAT'S NEW

ELECTRONICS

TELEVISION

RADIO

ON THE COVER

(Story on page 50)

Using the overhead projector is A/3C Janet F. Streib, Aircraft Control and Warning Operator at the North American Air Defense Combat Operations Center in Colorado Springs, Colo. Rack-mounted tape recorders can be seen in the background through the transparent map board.

Color original by Claude W. Treece, M/Sgt., USAF

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News Briefs

USE FM TUNERS in television receivers, is the request the FM Committee of the National Association of Broadcasters (NAB) has made of television receiver manufacturers.

The request is based on the committee's belief that the recent growth in FM stations, set sales and audiences indicates public demand for such a move. The sale of adapters which enable TV sets to receive the FM band backs up this stand. It was pointed out that building FM tuners into new TV sets could boost TV receiver sales. The committee also considered ways to promote the installation of FM receivers in cars.

SAFER PORTABLE TV SETS are being made this year. All receivers in G-E's line of portables for 1958 are equipped with a polarized power plug for use in modern polarized electric outlets. "Death Rides the Hot Chassis" (RADIO-ELECTRONICS, October, 1957) gave details on the protection offered by this type of plug. The new portables are covered with a vinyl plastic, further reducing any possible shock hazard.

ANNUAL FRENCH RADIO Exhibition, customarily held in Paris each spring, will in 1958 break away from a long-standing tradition. Instead of being reserved only for national products, the 1958 show will be international and open to foreign manufacturers. This change reflects the new European attitude toward tighter international relationships on the technical level. It has been enthusiastically welcomed in other countries, and already more than 20 nations well be present, including a sizable number of American firms.

The 1958 French Radio show will be held in Paris, from June 20 to 26.

8 NEW TV STATIONS have come in with the March winds:

WBLN, Bloomington, Ill. 15
WMBD-TV, Peoria, Ill. 31
KXLJ-TV, Helena, Mont. 12
KMOT, Minot, N. D. 10
KUED, Salt Lake City, Utah 7
WIPR-TV, San Juan, P. R. 6
KVII, Amarillo, Tex. 7
KWRB-TV, Riverton, Wyo. 10

Three stations have closed down:

WPAG-TV, Ann Arbor, Mich. 20
WNAO-TV, Raleigh, N. C. 28
KSWO-TV, Lawton, Okla. 7

Both WPAG-TV and KSWO-TV, however, anticipate early returns. WPAG-TV's shutdown, they promise, is for only 6 months, pending allocation of channel 12 to Ann Arbor. KSWO-TV had the misfortune of a serious fire, and we wish them luck and haste in their rehabilitation.

Changes in call letters were but two:

WNEP-TV, Scranton, Pa. 16
(formerly WARM-TV)
KZTV, Corpus Christi, Tex. 10
(formerly KSIX-TV)

Our total of operating US stations has zoomed to 530 (438 vhf and 92 uhf), 30 of which are noncommercial (6 uhf).

Canada is getting there, too, what with two new starters lengthening her list to 49 last month:

CHCA-TV, Red Deer, Alta. 6
CFCL-TV, Kapuskasing, Ont. 3

Two letters have come in correcting our January *TV Station List*. Earl E. Dippner, of Strasburg, Pa., writes us that WCMB-TV, Harrisburg, Pa., channel 71, has suspended operations. CHBC-TV, of Kelowna, B. C., calls our attention to its channel listing—3 when it should be 2—and its two satellite stations, CHBC-TV-1 at Penticton on channel 13 and CHBC-TV-2 at Vernon on channel 7.

DR. WILLIS R. WHITNEY, dean of industrial research in America, died Jan. 9, 1957. He was 89 years old. Dr. Whitney was best known for establishing the General Electric Research Laboratory in 1900 and for its development under his direction for the next 32 years.

During the time he headed the Research Laboratory many important dis-

coveries were made. On the list are fundamental discoveries in radio tubes, harnessing the cathode ray for radar and television use, the inductotherm which applied heat electronically to the human body, and development of high-voltage X-ray apparatus.

For many years Dr. Whitney served as trustee of the Albany Medical College and the Dudly Observatory in Albany, N.Y. He was a life member of the corporation of the Massachusetts

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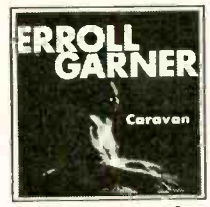


Erroll Garner plays Caravan, No Greater Love, Memories of You, etc.

Tenderly, Deep Purple, Soon, Laura, September In The Rain, 7 others

Complete score! I Could Have Danced All Night, The Rain In Spain, etc.

7 exciting new jazz improvisations by two great modern combos

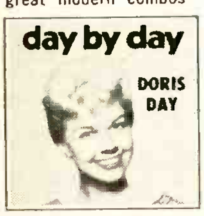
12 Sinatra favorites — Mad About You, Love Me, Nevertheless, etc.

Suave arrangements of Embraceable You, Somebody Loves Me—12 more

The Moon of Manakoora, Lotus Land, Poinciana, Jamaican Rhumba, etc.

Armstrong and his All-Stars. 10 numbers from triumphant tour abroad

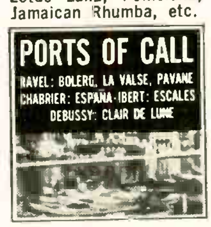
Stunning hi-fi performances of the "Firebird" and "Romeo and Juliet"



Doris Day sings The Song Is You, But Not For Me, Autumn Leaves—9 more

Emperor Waltz ,Blue Danube, Vienna Life, Gypsy Baron Overture—2 more

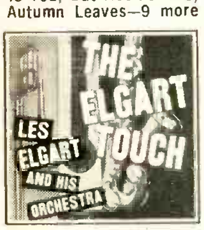
Duchin plays The Man I Love, April Showers, Am I Blue?, Brazil—11 more



A romantic musical tour —Ormandy and The Philadelphia Orchestra

Rodgers & Hammerstein's fabulous hit, with Nelson Eddy as Curly

3 Gershwin works—Concerto in F, Rhapsody in Blue, American in Paris



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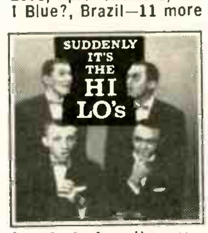

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7. Brubeck and Jay & Kai
8. Gershwin Hits—Percy Faith
9. Sinatra—Adventures of the Heart
10. Ambassador Satch
11. Firebird; Romeo and Juliet
12. Day By Day—Doris Day
13. Johann Strauss—Waltzes
14. Lure of the Tropics—Kostelanetz
15. Ports Of Call
16. Oklahoma!
17. Levant Plays Gershwin
18. The Elgart Touch
19. The Great Melodies of Tchaikovsky
20. Suddenly It's the Hi-Lo's
21. King of Swing—Benny Goodman
22. Brahms: Symphony No. 3
23. The Merry Widow
24. Wonderful, Wonderful—Mathis L-12

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NEWS BRIEFS *(Continued)*

Institute of Technology, and was also on the US Naval Consulting Board established during World War I. He was a member of the National Academy of Sciences, National Research Council, American Electrochemical Society (its president in 1912) and many other learned societies.

Over the years Dr. Whitney had received a number of American and foreign awards, too numerous to list here. He is survived by his wife, the former Evelyn Jones, and a daughter, Mrs. Van Alstyne Schermerhorn of Glenville, N.Y.

STEREO DISC IS NOT COMPATIBLE according to a report by RCA Victor covering a series of exhaustive tests performed at its Indianapolis plant.

The report states: "A stereo disc, playing monaurally, will disseminate a sound of music. But the net result is comparable to that of a worn pre-high-fidelity record. Even with the best high-fidelity pickups now available some stereo records played monaurally also exhibit considerable distortion on the first play. Another problem is that music from the two channels of a stereo recording does not always combine properly to give a satisfactory output."

The report concluded, "We are definitely convinced the stereo disc is not a replacement for the present-day fine-groove record as far as high-fidelity monaural sound is concerned. However, played on proper stereo equipment which is not yet on the market, the stereo disc will give full-dimensional sound presently found only on tape." The question of *cartridge* compatibility was apparently not taken up by the committee. Some mention of it appears in the item "Low-Cost Stereo Pickup" in this department.

HENRY W. McCANDLESS, the man who made the first vacuum tube, died Dec. 24, 1957, at the age of 91.

When de Forest first started enclosing his early (two-element) audions in a glass envelope, he approached McCandless, owner of a specialty electric company in New York City, to make the models of the new devices. Many of McCandless' suggestions—based on his lamp experience—were embodied in the bulbs, and he continued to make the experimental models up to and including the three-element audion. Afterward he manufactured audions for de Forest commercially. (See "How Audions Were Built" in the January, 1947, issue of RADIO-CRAFT, a story about McCandless.)

McCandless sold his firm to Westinghouse in 1914, continuing with that company as head of its special lamp department until 1919, then as consultant till his retirement in 1935.

A LOW-COST STEREO PICKUP has been announced by Electro-Voice. Twin ceramic elements and an 0.7-mil diamond stylus form the working heart of the cartridge which is expected to cost only

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microphonics...
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ECC82 A PLUG-IN
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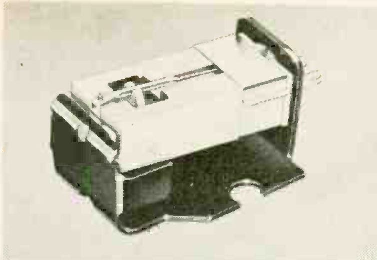

$19.50. This new unit is completely compatible—it can be used to play the Westrex system 45/45 stereo disc or any standard hi-fi disc. First production of the new unit is being routed to phonograph manufacturers. Later, when stereo discs reach the market, owners of hi-fi equipment can adapt to stereo by adding a second amplifier and speaker system to their existing setup and replacing their present cartridge with this new stereo pickup cartridge.

Calendar of Events

Institute of High Fidelity Manufacturers Show, Feb. 26–Mar. 2, Hotel Biltmore, Los Angeles, Calif. RADIO-ELECTRONICS and the Gernsback Library will exhibit in Room 2325.

Hi-Fi Music Show, Mar. 7–9, Penn-Sheraton Hotel, Pittsburgh, Pa.

High-Fidelity Music Show, Mar. 14–16, Shoreham Hotel, Washington, D. C.

Hi-Fi Music Show, Mar. 21–23, Hotel Robert Treat, Newark, N. J.

IRE Show, Mar. 24–27, New York Coliseum, New York, N. Y.

Hi-Fi Music Show, Mar. 28–30, Lord Baltimore Hotel, Baltimore, Md.

Electronic Waveguide Symposium, Apr. 8–10, Engineering Societies Building, New York, N. Y.

Conference on Automatic Techniques, Apr. 14–16, Statler Hotel, Detroit, Mich.

Radio Component Show, Apr. 14–17, Grosvenor House and Park Lane House, London, England.

Instruments Electronics and Automation Exhibition, Apr. 16–25, Olympia, London, England.

London Audio Fair, Apr. 18–22, Waldorf Hotel, London, England.

83rd Convention of Society of Motion Picture & Television Engineers, Apr. 20–26, Ambassador Hotel, Los Angeles, Calif.

Electronic Components Conference, Apr. 22–24, Hotel Ambassador, Los Angeles, Calif.

Spring Meeting of International Scientific Radio Union, (URSI) Apr. 24–26, Willard Hotel, Washington, D. C.

FM AIDS AM as part of a plan to add 250 stations to the Mutual Broadcasting System's 460 existing AM outlets. Spread throughout the country, the new AM stations will receive their program material via a network of 80 FM relay stations. Each AM station will pick up the FM signals and rebroadcast them for local listeners. Most stations now use telephone lines to carry the program to the transmitter. The FM network will in many cases make possible a higher quality of sound reproduction than could be obtained with the low-grade wires available at some of the sites. END

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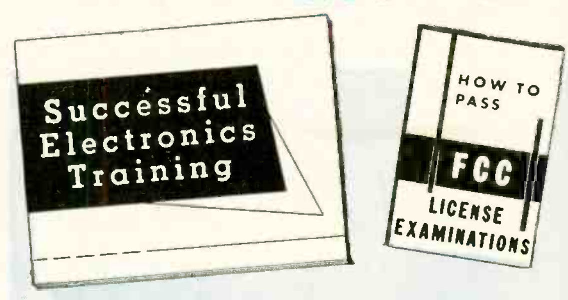

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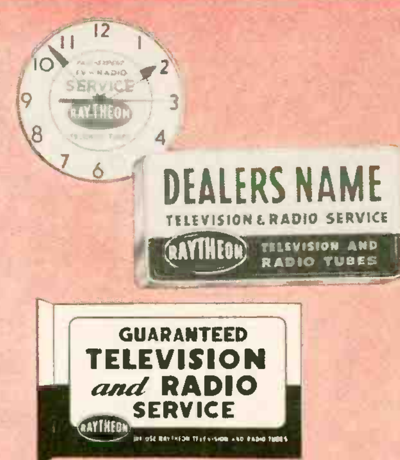

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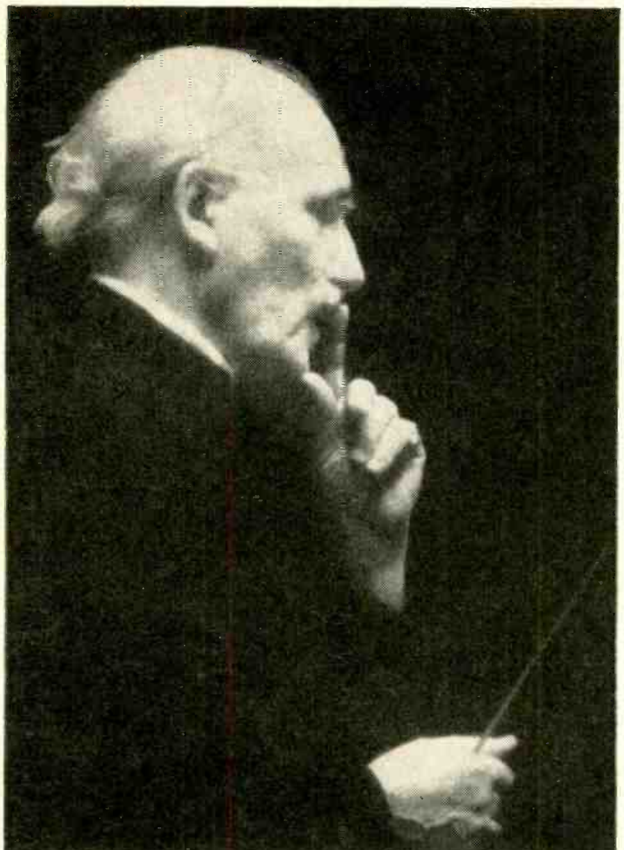

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SAMUEL CHOTZINOFF, General Music Director, NBC
JACQUES BARZUN, author and music critic
JOHN M. CONLY, editor of *High Fidelity*
AARON COPLAND, composer
ALFRED FRANKENSTEIN, music critic of *San Francisco Chronicle*
DOUGLAS MOORE, composer and Professor of Music, Columbia University
WILLIAM SCHUMAN, composer and president of Juilliard School of Music
CARLETON SPRAGUE SMITH, chief of Music Division, N. Y. Public Library
G. WALLACE WOODWORTH, Professor of Music, Harvard University

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EACH month, three or more RCA VICTOR Red Seal Records will be announced to members. One will always be singled out as the *record-of-the-month*, and unless the Society is otherwise instructed (on a simple form always provided), this record will be sent to the member. If the member does not want the work he may specify an alternate, or instruct the Society to send him nothing. For every record purchased, members will pay only $4.98, the nationally advertised price of RCA VICTOR Red Seal Records (plus a small charge for postage and handling).

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Correspondence

CORRECTION PLEASE

Dear Editor:

I would like to make a correction in the article "Hi-Fi Pickups Arms" by Julian D. Hirsch, which appeared in the December issue.

Mr. Hirsch says that the Pickering 190D pickup arm is available only in a 16-inch model. The actual *length* of this arm is 12 inches. The original model 190, produced some dozen years ago, *was* 16 inches long. The 4-inch overhang on this arm was eliminated to bring it to its present size.

Kudos to Mr. Hirsch for his lucid presentation of the complex subject of pickup arms, a topic that can give the prospective buyer gray hair.

ARTHUR Z. ADELMAN
(Pickering & Co. Representative, New York, N. Y.)

CHECK THE CHECKER

Dear Editor:

I have built the rotator checker described in "Fix That Rotator" in the January issue. I have not yet had the opportunity to try it on an actual repair job, but it works fine with new motors I have in the shop.

I have found an incorrect value given for the pilot-lamp dropping resistance (R1 and R2). The proper resistance for a 24-volt drop at .06 amp is 400 ohms. As the power dissipated by the resistor is only 1.5 watts, a 5-watt unit is sufficient. The 275 ohms shown in the article applies too much voltage to the lamp and will cause frequent lamp replacement.

W. J. STILES
Keytesville, Mo.

(Mr. Stiles is right. In the author's original version an 18-volt transformer was used and 275 ohms was the correct value. To make it more universal we changed this to a 24-volt unit but inadvertently forgot to change the dropping resistance. Thanks for spotting the error, Mr. Stiles.—*Editor*)

CAN WE HEAR DOPPLER?

Dear Editor:

Paul W. Klipsch's article "Loudspeaker and Acoustic Fundamentals" in the October, 1957, issue of RADIO-ELECTRONICS should not, I feel, go unanswered.

Mr. Klipsch attempts to show that a direct-radiator loudspeaker (a speaker using no horn or similar coupling device) inherently exceeds the limits for tolerable distortion. This distortion, he claims, is due to Doppler effect asso-

(Continued on page 18)

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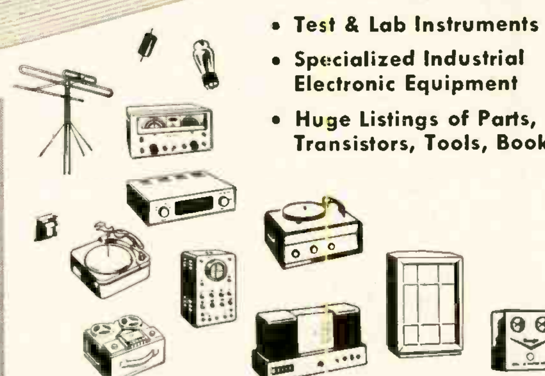

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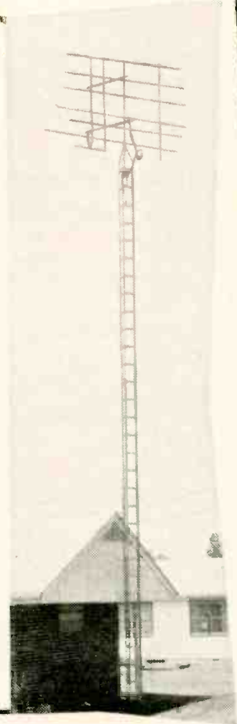
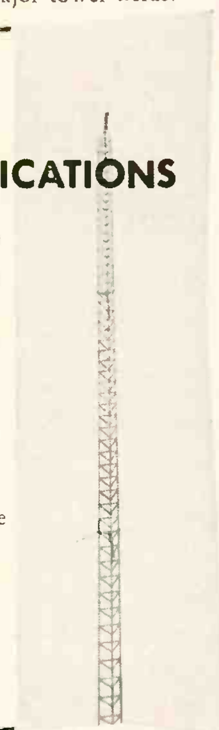
By far the biggest usage of Rohn products has been and still is for home TV installations. In addition to finest of self-supporting towers, the Rohn line includes telescoping masts, tubing, roof towers and all other types of accessories for installations of all kinds. Wise dealers and servicemen rely *entirely* on the Rohn line for *all* installation requirements. This means BIGGER PROFITS.



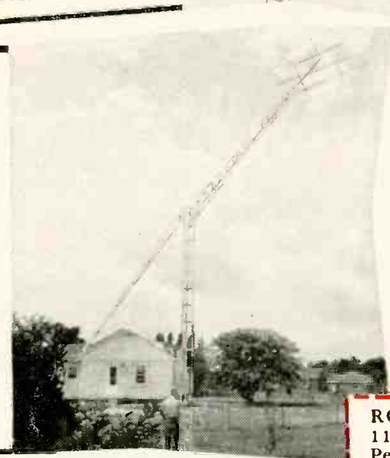
2 COMMUNICATIONS

Many distributors, dealers and servicemen are making EXTRA PROFITS by stocking or handling the heavier type Rohn Towers that are suitable for communications purposes. There is a demand in *every area* for radio communications towers, micro-wave towers, radio telephone towers and industrial towers. You can supply this need in your area. Special new literature is available for your use.



3 AMATEUR USE

Another major field of usage for Rohn Towers is in the field of amateurs and experimenters. The especially designed "fold-over" tower is the *best in the field* for the amateur because it allows working on the antenna *on the ground.* Thousands of amateurs use Rohn Towers with a tremendous demand still to be sold. You can supply this demand in your area and capture BIG PROFITS for yourself.



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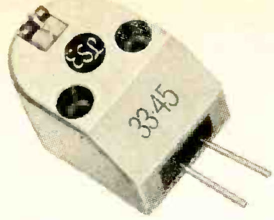

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Years Ahead

If you always insist upon the very best, here is the one phono pickup for you: the superlative new ESL C-60 Series electrodynamic cartridge.

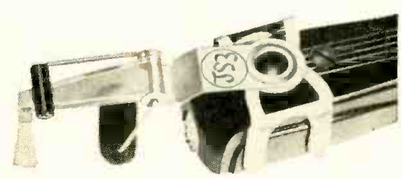
Your ears will soon tell you of the C-60 Series perfection in record reproduction: unmatched clarity, smoothness, and naturalness. No other pickup is so truly musical.

The reasons why are many, including a response which is inherently linear, unlike the inherently non-linear response of most pickups. The C-60 Series is distinguished, too, by complete absence of system damping. Only an undamped cartridge can actually have the extraordinarily small dynamic mass of the C-60 Series (only one one-thousandth of one gram), its superb transient response, and its ability greatly to increase the life of records and styli.

Frequency response of the C-60 Series is flat within one db from 18 cps to 20,000 cps (Elektra 35 test record), and response extends well beyond 30,000 cps. No need to change the input resistor of your preamplifier for the C-60 Series, because its magnificent performance is completely unaffected by load resistance. And no transformer is required with modern preamplifiers.

Complete details of C-60 Series superiority may be obtained without cost from ESL. Meanwhile, visit your record dealer's, and hear this cartridge that's years ahead!

THE *Automatic* RECORD CLEANER



If you always insist upon the very best, here is the one record cleaner for you: the unique new ESL Dust Bug.

Experts the world over acclaim the Dust Bug as the surest, safest way to clean records and eliminate surface static. They acclaim its convenience, too, because the Dust Bug cleans records automatically while they are being played.

The Dust Bug for record changers (above) is easily slipped onto the arm of your changer. Special Dust Bug fluid is provided in a dispenser. After a wipe with the dispenser across the Dust Bug bristles and plush pad, the changer is operated as usual. The Dust Bug sweeps each groove scrupulously clean just before it is played by the stylus, and eliminates the record static which would attract more dust.

Extend the life of your valuable records and styli with the ESL Dust Bug. The changer model, with fluid in dispenser, costs only $4.75. If yours is a manual player, the regular model Dust Bug is only $5.75 complete. Try it at your dealer's today.

FOR LISTENING AT ITS BEST

ESL **Electro-Sonic Laboratories, Inc.**

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CORRESPONDENCE *(Con'd from page 14)*

ciated with the necessarily large cone excursions, and would exist even if the speaker mechanism itself were ideal.

Three kinds of proof are used in the article: references to technical literature, a mathematical derivation and analogy to flutter in tape machines. I would like to comment briefly on all three.

With regard to the technical literature cited:

1. An unfortunate placement of the footnote mark in Mr. Klipsch's first letter might lead readers to think that Frank L. Massa's "Acoustic Design Charts" included data on excursion limits for tolerable distortion. Massa's book contains no reference to diaphragm excursion limits, Doppler effect or frequency modulation.

2. E. W. Kellogg, as reported, purposely limited the excursions of his 8-inch speakers (vintage 1931) to 0.2 cm, but this fact cannot be used to support the significance of Doppler effect or to indicate Kellogg's awareness of it. The sole reason for the 0.2-cm limitation was clearly stated in the paper—"Without special construction, hitting *(of the voice coils)* would occur"—and Kellogg specifically discussed the desirability of constructing a special speaker that would permit large voice-coil excursions.

3. Beers and Belar, also as reported, gave an equation for Doppler distortion in speakers. They took pains, however, to point out that they were discussing laboratory test tones only and that studies had yet to be made to determine what constituted significant frequency modulation in speakers from the point of view of musical reproduction. With reference to the practical effects of FM distortion in actual speaker performance they wrote: ". . . it is probable that this form of distortion is usually masked by distortion from other sources . . .," although they felt that even such a minor factor should be considered in the quest for fidelity. In considering it, they indicated that several entirely effective antidotes were available.

Their mathematical analysis showed that FM speaker distortion—whose seriousness from a listening point of view was questionable to begin with—could be reduced by a factor of as high as 33 through the simple expedient of using separate bass and treble speakers.

Mr. Klipsch's own mathematical derivations are based upon the assumption that there is a direct correspondence between flutter in tape machines and FM in speakers. Profound differences that actually exist between the two are:

1. In a tape machine the entire frequency spectrum is subject to frequency modulation at the low-frequency flutter rate. In any speaker system employing a separate bass unit the treble range is not subject to FM by the woofer.

2. It is now known that the perceptibility of frequency modulation of an audio signal (flutter) is a function of flutter rate; that is, the rate at which

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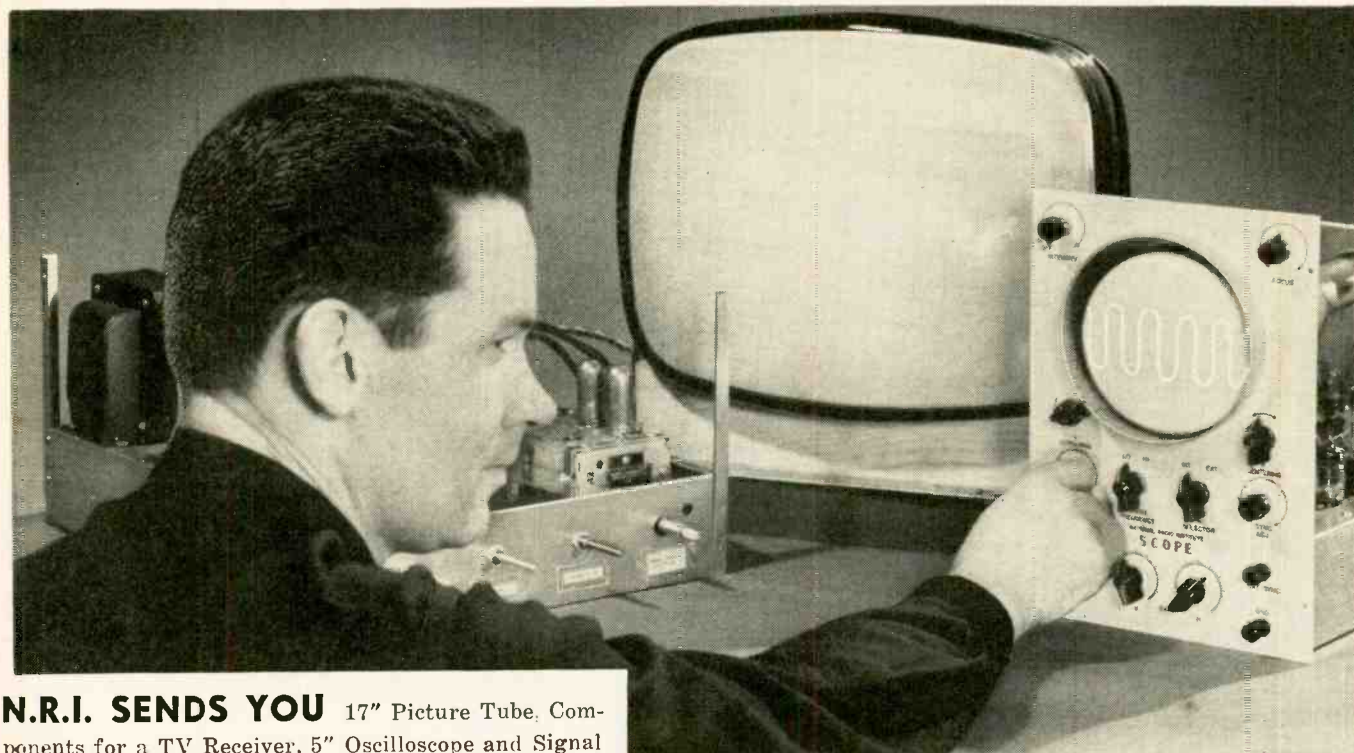

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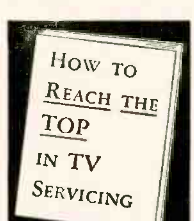

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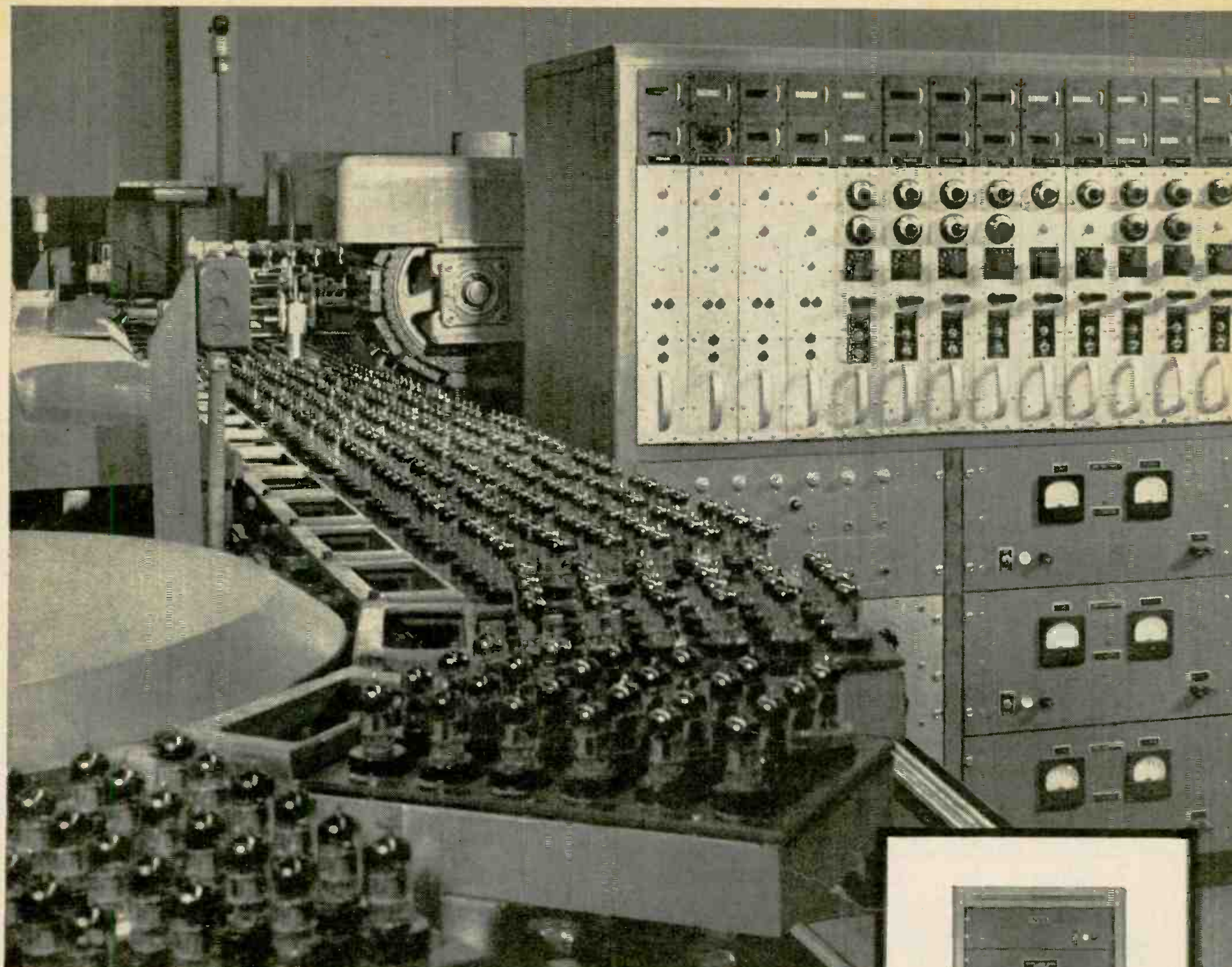

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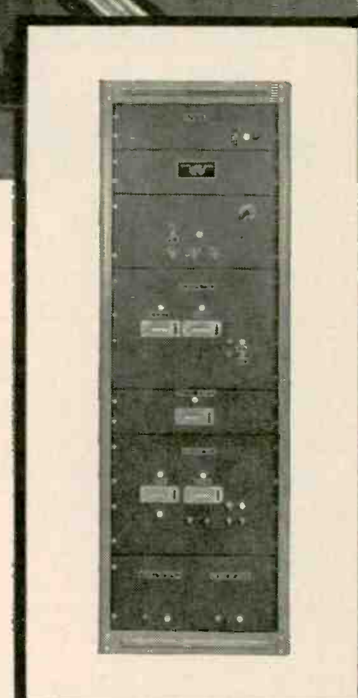

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the frequency variation takes place. This is spelled out in American Standard Z57.1–1954,[1] and further elaborated in subsequent studies at the US Naval Material Laboratory[2] and at MIT[3].

Maximum flutter perceptibility is at a flutter rate of 2–3 cycles, a common one for tape transports or turntables. At 30 cycles the lowest FM rate under question for speakers, flutter perceptibility is reduced by a factor of about 4.

For an extreme case of ½-inch excursions at 30 cycles, in a 2-way 1,000-cycle crossover speaker system, perceptible FM distortion is far less than that allowed in a tape transport or turntable mechanism meeting current NARTB standards for professional *recording* turntables (0.1% peak instantaneous flutter, no statement of flutter rate or of modulated frequency). Although the speaker's peak "flutter" is about 0.35%—0.25% rms—the high fluter rate keeps us out of danger, and we are further protected by the fact that the woofer does not handle the treble spectrum.

When the Audio League staged a demonstration of live organ vs stereotape playback at St. Mark's Church in Mt. Kisco, N.Y., only direct-radiator speakers were used (including four AR-1's, the speaker I strongly suspect Mr. Klipsch had in mind when he spoke disparagingly of "little speakers") and the burden placed on each was at least as great as the burden it would bear if operating alone in a living room. Reports in *Audio, Audiocraft, Hi-Fi Music at Home, The New York Post* and the *Saturday Review*, each by a different ear-witness, were unanimous in stating that the difference between the live and recorded sound was usually undetectable. Yet organ music, with its large component of fundamental bass energy—this particular organ has a solid pedal down to 32 cycles—constitutes the most severe test of a speaker from the point of view of large diaphragm excursions. The subjective results here bear out the objective data.

EDGAR VILLCHUR
Acoustic Research, Inc.
Cambridge, Mass.

[1] "American Standard Method for Determining Flutter Content of Sound Recorders and Reproducers," sponsored by IRE and published by the ASA. 1954.
[2] F. A. Comerci, "Perceptibility of Flutter in Speech and Music," *Jour. SMPTE 64*, page 117, March, 1955.
[3] Ibid.

LICENSING OPPOSED

Dear Editor:

I am opposed to licensing the television technician. A move like this will encourage unethical practices among technicians, using their licenses as a shield—or should we say a badge. Let's be honest with each other!

I am also opposed to pay TV. I was always under the impression that the airways were as free as the air we breathe, unless someone gets the idea of taxes for that too. Let's all get together and kill any such move.

NICHOLAS LELLA
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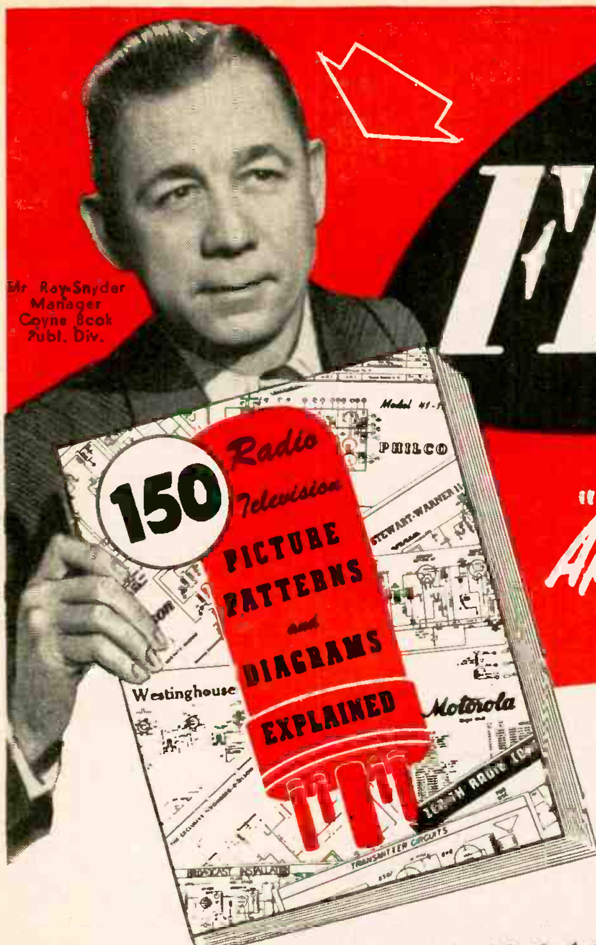

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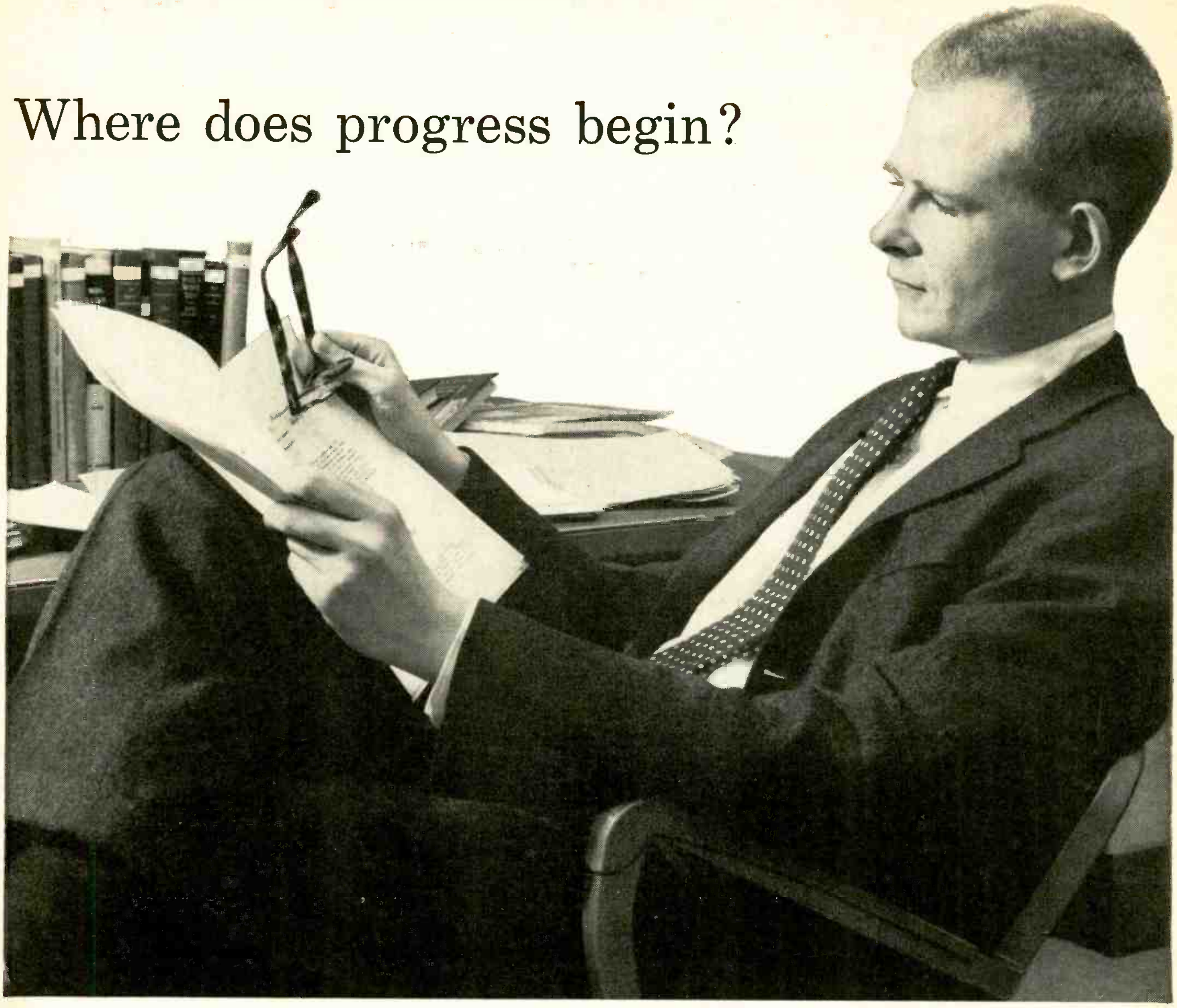

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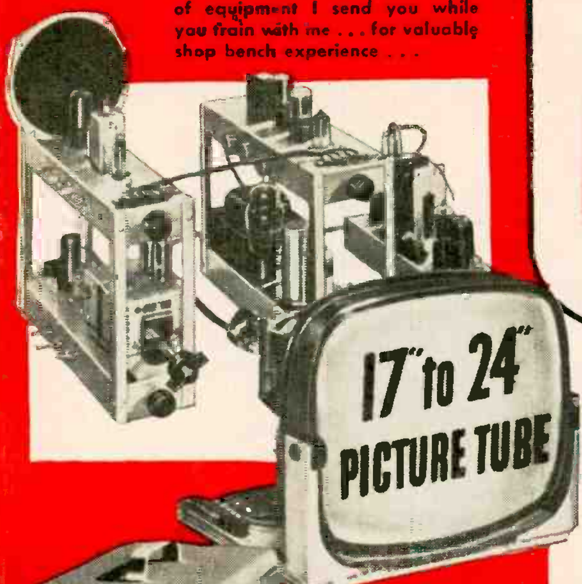

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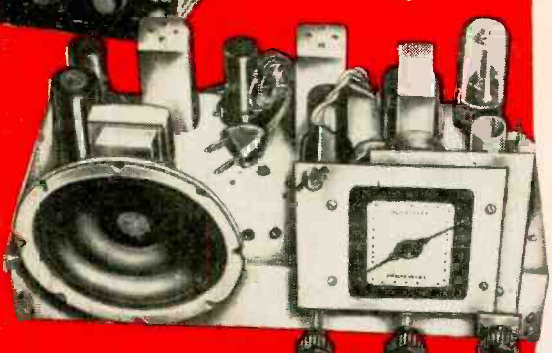

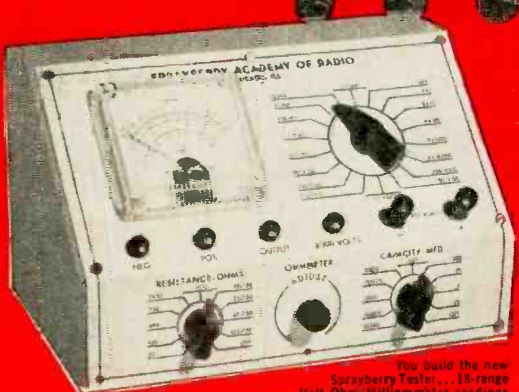

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Economy and adaptability are not all you get in the Scotchman! You get quality, too . . . the kind of quality features you are proud to point out to your customer . . . like: unbreakable TDM styrene insulators, special fatigue-resisting aluminum tubing, closed element and boom ends to eliminate windwhistle and vibration, precision die-cut elements . . . features usually found only in the highest priced antennas.

And, of course, all Winegard Scotchmen are completely factory pre-assembled. Elements lock into place automatically when you unfold them. Absolutely no antenna installs easier or quicker . . . and they're wonderfully compact and rugged.

On your next installation, do this: *Try a Scotchman antenna in the only place it really counts* . . . on one of your own customer's homes. See for yourself that the Scotchman can't be beat for performance and adaptability at such low cost!

A NOTE FROM JOHN WINEGARD

As an addition to our popular line of gold anodized Color'ceptors and Twilights, I am pleased to announce this new Scotchman series to give you a complete price range of quality all-channel Winegard antennas. You'll find valuable Scotch Stamps in each Scotchman carton which we will redeem for free antennas and other valuable premiums. This is our way of saying "thank you" for your business.

Sincerely,

John R. Winegard

John R. Winegard
President, Winegard Co.

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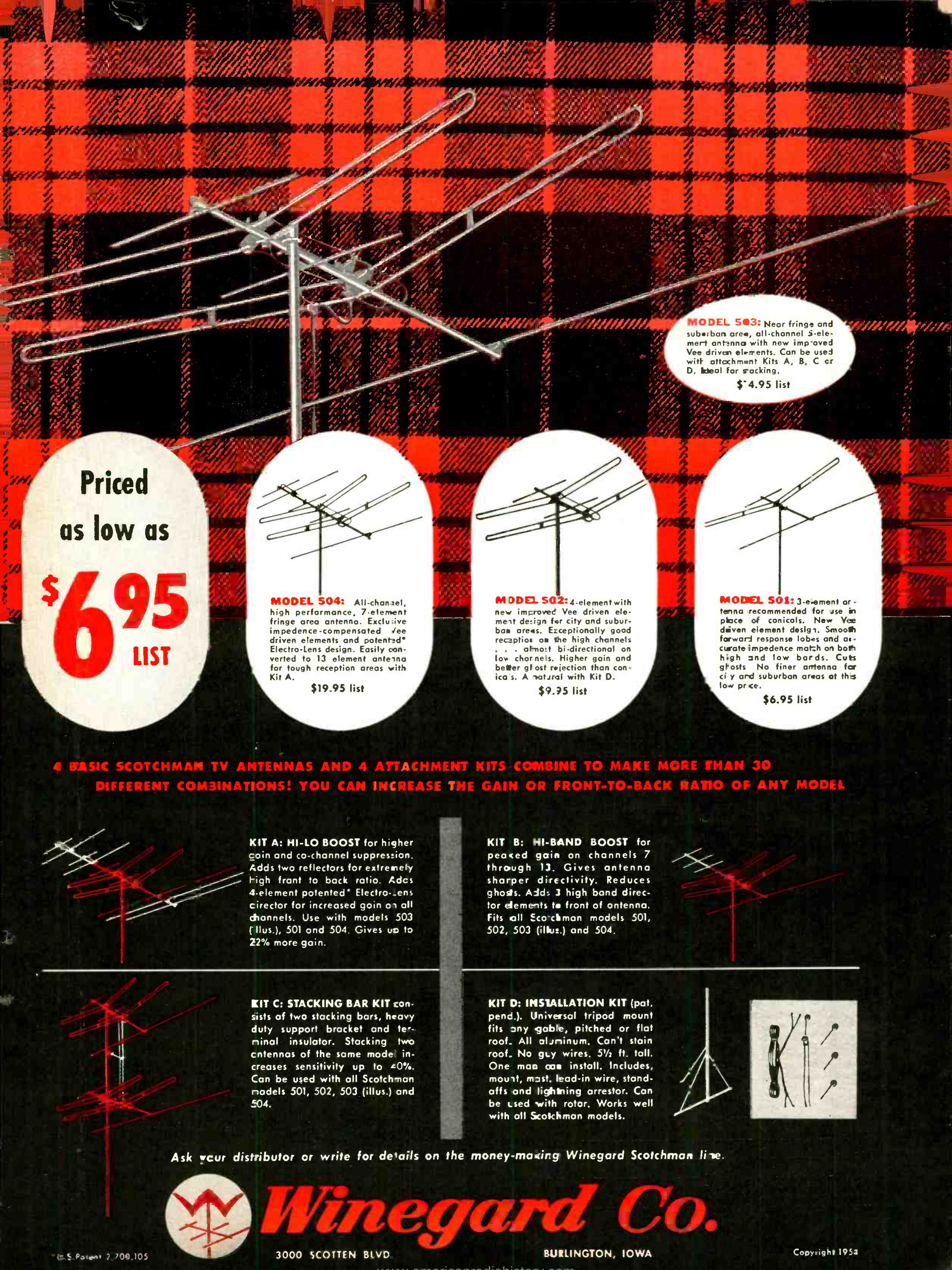

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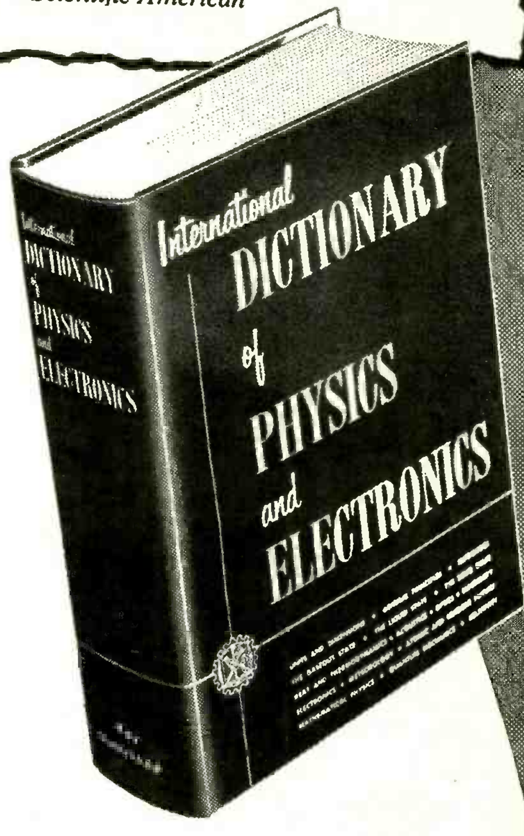

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HFT90 FM Tuner with "eye-tronic" tuning

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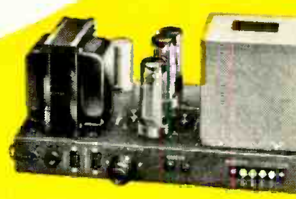

HF60, HF50 Power Amplifiers

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HFS2 Speaker System: Uniform loading & **natural** bass 30-200 cps achieved via **slot-loaded** split conical bass horn** of 12-ft path. Middles & lower highs from front side of 8½" cone, edge-damped & stiffened for smooth uncolored response. Suspensionless, distortionless spike-shaped super-tweeter** radiates **omni-directionally. Flat 45-20,000 cps,** useful to 30 cps. 16 ohms. HWD: 36", 15¼", 11½". ". . . rates as excellent . . . unusually musical . . . really non-directional" — Canby, AUDIO. "Very impressive" — Marshall (AUDIOCRAFT). **Walnut or Mahogany, $139.95. Blonde, $144.95.**

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HF60 60-Watt Ultra Linear Power Amplifier, with Acro TO-330 Output Transformer, provides wide band-width, virtually absolute stability and flawless transient response. ". . . is one of the best-performing amplifiers extant; it is obviously an excellent buy." —AUDIOCRAFT Kit Report. **Kit $72.95. Wired $99.95. Matching Cover E-2 $4.50.**

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HF30 30-Watt Power Amplifier employs 4-EL84 high power sensitivity output tubes in push-pull parallel, permits Williamson circuit with large feed-back & high stability. 2-EZ81 full-wave rectifiers for highly reliable power supply. Unmatched value in medium-power professional amplifiers. **Kit $39.95. Wired $62.95. Matching Cover E-3 $3.95.**

HF-32 30-Watt Integrated Amplifier Kit $57.95. Wired $89.95.

HF52 50-Watt Integrated Amplifier with complete "front end" facilities and Chicago Standard Output Transformer. Ultra-Linear power amplifier essentially identical to HF50. The least expensive means to the highest audio quality resulting from distortion-free high power, virtually absolute stability, flawless transient response and "front end" versatility. **Kit $69.95. Wired $109.95. Matching Cover E-1 $4.50.**

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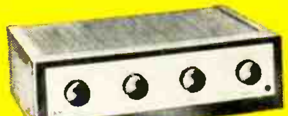
** Patents pending by Hegeman Laboratories

HF52, HF20 Integrated Amplifiers



HF12 Integrated Amplifier

HF30 Power Amplifier

HFS1 Speaker System

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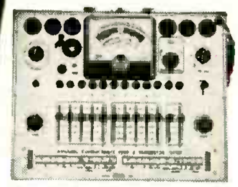

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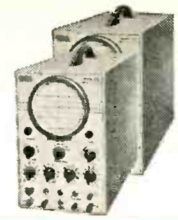
KIT $69.95 WIRED $109.95

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**



5" PUSH-PULL OSCILLOSCOPE #425
KIT $44.95
Wired $79.95

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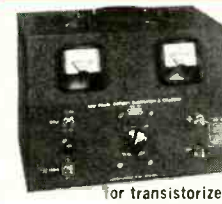
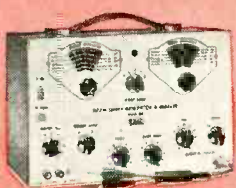
- tests 600 mil series string type tubes
- illuminated roll-chart

Pix Tube Test Adapter $4.50



6V & 12V Battery Elim & Charger #1050:
KIT $29.95
Wired $38.95
for transistorized eqpt, #1060: KIT $38.95, Wired $47.95



NEW! TV-FM SWEEP GENERATOR & MARKER #368

KIT $69.95 WIRED $119.95

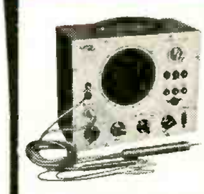
Entirely electronic sweep circuit (no mechanical devices) with accurately-biased **increductor** for excellent linearity. **Extremely flat RF output: new AGC circuit** automatically adjusts osc. for max. output on each band with min. ampl. variations. **Exceptional tuning accuracy: edge-lit hairlines** 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.

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

KIT $79.95 WIRED $129.50

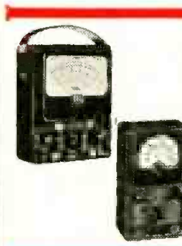
- **Features DC Amplifiers!**

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 graph 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.



Sep. hi-gain RF & lo-gain audio inputs. Special noise locator. Calibrated wattmeter.
KIT $24.95
Wired $39.95

DELUXE MULTI-SIGNAL TRACER #147



20,000 Ohms/Volt MULTIMETER #565
KIT 24.95
Wired $29.95

1000 Ohms/Volt MULTIMETER #536
KIT $12.90
Wired $14.90

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.)

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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.

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
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SATELLITE ELECTRONICS

. . . Electronics, the Essence of Satellites . . .

SINCE the advent of the Soviet man-made satellites, on Oct. 4, 1957, we have begun to realize the great importance of these small moons. It is quite certain that they are here to stay and that in the future the sky will be populated by a multitude of them, in every conceivable size and various shapes. These miniature worlds are but the stepping stones to outer space and will be the direct means of enriching our scientific knowledge in every direction.

We have already learned more about the exact shape of the earth from information given us by the satellites than from all previous study. Gravitation, cosmic and other radiation, meteorites and their density in space, meteorology—to name only a few, will all give up many of their secrets, thanks to present and future sputniks. And most of these invaluable answers will come by electronic means.

Electronic telemetering from these satellites will be the chief method of unlocking a vast array of new knowledge. To mention only one recent important scientific conclusion, let us consider weightlessness.

Since 1911, the present writer has maintained, along with other scientists, that the state of weightlessness had no adverse effect on man and was not deleterious to him. Others were vociferous in their directly opposite beliefs. As it is impossible on earth to create a state of human weightlessness—except for a few seconds—no conclusions could be reached until very recently. The answer then came via telemetering from Sputnik 2. The official Russian magazine *Soviet Aviation* stated that weightlessness in space had no effect on the dog passenger and that in fact satellite No. 2 had solved the problem of the puzzle of the effect of weightlessness in space on living entities. Said the magazine:

"The analysis of the dog's pulse, blood pressure and respiration led to the extremely important conclusion that no harm comes to a living organism in a condition of weightlessness."

As newer, larger and better-equipped satellites are launched, the answers will come at an ever-faster tempo. For one thing, most future satellites will not go dead and stop transmitting in a few weeks, as did Sputniks 1 and 2. They are certain not to be equipped again with primary batteries, which are soon exhausted. We will have lightweight storage batteries coupled to solar cells which will charge them continuously when the satellite is in the sun. Half the time, when the moonlet is in the shadow of the earth, the storage batteries take over. The arrangement will be such that the solar cells will always provide *more* energy than is used up. To keep the accumulators from overcharging, an automatic cutout is provided. Thus the satellite will always have electrical power, 24 hours a day, for the years-long life of the storage batteries. Even after the latter wear out, the satellite will still be able to transmit when in full sunlight, i.e., roughly 50% of the time. Solar cells are ideally suited for powering satellite transmitters. Indeed, as we pointed out in our January, 1958, issue, solar cells work far better out in space than on earth. With no atmosphere to contend with, 30% to 35% more solar radiation can be utilized. Furthermore, the voltage of the solar cells *increases* considerably in below-zero temperature.

World-wide television and radio broacasts via satellites seem assured for the future, in the interest of world peace and better understanding between the peoples of the world. All that is needed are four or more small 6- to 10-foot satellites circling several thousand miles above the earth. They revolve equidistantly, in such a manner that one satellite can always "see" the one ahead and the one behind. Let us assume that via a transmitter at Washington, D.C., the United States wishes to send radio and TV programs to cover the entire world *continuously*. The Washington station beams the signals to satellite A, when it is in sight. Satellite A then relays them to satellite B in space. B relays to satellite C and C to D. B, C and D in turn beam the relays to earth, thus covering the entire planet (see diagram on page 125). In the meanwhile, satellite A moves on and soon "sets" over Washington. At the same time, moon D "rises" and Washington will beam its signals to D, until D sets. Thus the four satellites will insure continuous world-wide broadcasts. The quality will be good, too, because there will always be a moonlet "in sight" on earth. We are fully aware that in an undertaking of this type a few engineering points would have to be solved, such as the Doppler effect of the speeding satellite transmitters, zero-beat heterodyning between the transmitters, and a few other problems. We believe, however, that these problems offer no great difficulties today.

Rocket experts will also question the feasibility of placing four satellites in the same orbit, equidistant from each other. In itself this would be a formidable feat—even for the Russians, considering present-day rocket science technique. But it is strictly feasible with the help of electronics. Our four satellites (and this goes for other future ones) must themselves be equipped with small "correcting" rockets. Then, if a satellite is off orbit or off course, the correcting rocket is fired from earth by electronic impulse. Thus the satellite can be maneuvered until it is where it should be. Its speed can also be increased or decreased.

Unpleasantly enough, future satellites can also be formidable weapons. Warheads, with which they could be equipped, could be fired electronically from earth. This is not a simple feat today for many reasons. Because the satellite is speeding at *more than 5 miles a second*, the aiming, the exact angle, the time of firing all must be *extremely* and fantastically accurate. Thus a tenth of a second early or late will place the bomb hundreds of miles off target. This is also true of the aiming angle. A tenth of a degree off will miss the target by hundreds of miles.

While talking of satellites, radio amateurs will welcome the news that since Jan. 14, 1958, the Army Signal Corps has been bouncing radio waves off the moon on even-numbered nights when the moon is up. The signals are on the frequency that will be used by our satellites—108 megacycles. This will be of great help to all official satellite tracking stations and those who wish to track our future moonlets and to get used to listening in on that frequency. —*H.G.*

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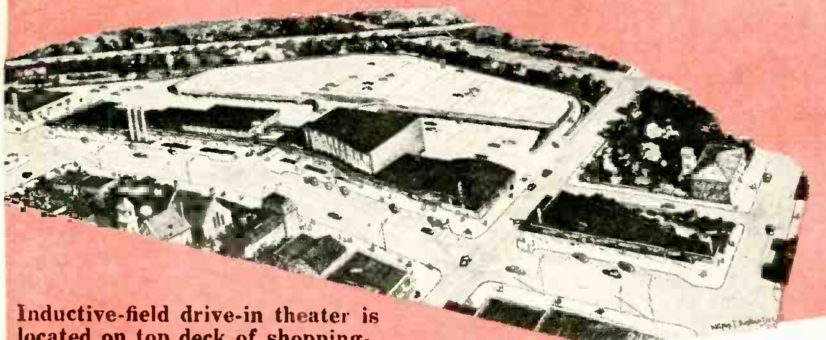
INDUCTION PICKUPS and the DRIVE-IN MOVIE

By AARON NADELL

Something new in drive-in theaters is coming. Transistor amplifiers and induction sound systems eliminate speaker posts



Inductive-field drive-in theater is located on top deck of shopping-center parking area in heart of Dover, N. J. Screen will be at left end of upper deck.

REPRESENTING a completely new technique in drive-in theaters, the Dover (N. J.) drive-in will be equipped with portable transistor-amplifier car speakers instead of the conventional type. It constitutes what its builders hope will prove the first of a great many such transistorized drive-ins.

The Dover drive-in uses conventional electronic equipment up to the output of its power amplifier. From there on, the wiring of the the area and the loudspeakers used by the patrons are altogether different.

The theater is unique. It has no loudspeaker posts—although, of course, it has speakers. It is not located far out in the countryside, but within the shopping center of a city of 11,000. It is located on the top deck of the shopping center's 2-level, 1,200-car parking lot.

As this deck is used for parking during daylight shopping hours, conventional drive-in speaker posts would be objectionable. Hence the new technique in which sound is supplied to patrons, not over the usual wires, but by way of an audio-frequency magnetic field. Underground wiring suffuses the area with this field, which corresponds to the sound to be reproduced. It can be picked up anywhere in the area by an instrument consisting of a magnetic pickup coil, a four-stage transistor audio amplifier, and a 5-inch loudspeaker.

The basic idea of using an audio-frequency field instead of wires to convey speech and music to theater patrons is not new. It was introduced roughly 10 years ago in indoor theaters, to energize earphones which theaters loaned to hard-of-hearing patrons. Originally, certain seats were wired with plugs connected to an amplifier. The hard-of-hearing patron plugged his temporary earphone into one of these receptacles. He could use the phone only in a seat that was wired for it.

When magnetic transmission was installed, these patrons were no longer inconvenienced nor embarrassed by being restricted to a particular group of seats. They could sit anywhere in the theater. In addition to the headphone, the theater loaned them a small battery-operated amplifier which they held in their laps. Loops of wire under the carpet were energized with the frequencies to be received.

The identical principle is used in the Dover drive-in, which will therefore be the first magnetic-induction drive-in theater in the United States. And the Dover's amplifier–speakers are the first transistor, encapsulated, printed-circuit amplifiers used for theater reception of magnetically induced sound.

In the conventional drive-in arrangement, the audio output of the sound amplifier is distributed over matched-impedance lines to speaker transformers located throughout the grounds. The transformers are housed in speaker boxes mounted atop speaker posts. Each post mounts one house, to which two speakers are wired. The patron parks alongside, opens his window and takes one of the speakers into his car. The speaker remains physically connected to its box, through either a straight or a coiled cord. The window must be left slightly open, even in cold weather, to accommodate the speaker cord. Before the patron drives off, he must remember to put the speaker back on its post. If he drives off without doing so, both window and speaker may be damaged.

In the magnetic-field system there are no connecting wires between the output of the amplifier and the speakers. A length of No. 12 wire is connected to the amplifier's output and laid about the grounds in a definite pattern. The pattern consists of a number of loops of wire. Each loop is about 40 feet long and 15 feet wide. These loops are laid side to side and end to end in sufficient numbers to cover the area completely. Electrically they constitute a series circuit, presenting a total af impedance of between 4 and 6 ohms, looking out from the amplifier terminals.

On entering the theater, the patron is handed a speaker unit (approximately the size, shape and weight of a conventional drive-in speaker, but containing a pickup coil and encapsulated transistor amplifier, in addition to the speaker itself). This he places anywhere in his car to suit his convenience. Windows can be kept completely closed. On leaving, he will be stopped at the exit and the speaker unit collected.

Will need more servicing

The new speakers will need more servicing than the conventional kind. There are three reasons for this.

First, the transistor amplifier needs a battery. The condition of these batteries must be checked from time to time, and replacements made as necessary. Second, the new units are composed of a greater number of components—a greater number of things that may go wrong.

Finally, the new units are more exposed to physical injury. The conventional speaker gets some protection

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as it is fastened to a cord. If dropped, it may not reach the car floor or the ground. If it is connected by a coiled cord; that acts as a tension spring and checks the force of a fall. The induction speaker–amplifier is not attached to anything. It is apt to be laid loose on the front or rear shelf of the car and may slide off or be jarred off. Children will handle it and may drop it. Further, these speakers are intended to be carried to the refreshment area. The fact that they can be carried is one of their prime advantages from a business point of view, but the practice will provide additional opportunities for accidents and consequent servicing.

Dover, N. J., is located about 35 miles west of New York City and is credited with a population of 11,174. The shopping center is in the heart of the town and has two levels of parking space.

Proprietor of the new drive-in is Walter Reade Theatres, an exceptionally progressive and enterprising organization. Some years ago this company pioneered a season-ticket-admission movie theater on Park Ave. in New York. Patrons rented their movie seats by the year, like boxes at the opera. Subsequently, Reade theaters were among the very first to install large-screen theater-size television. If enough others had done the same, possibly theaters could have obtained exclusive television rights to popular athletic events.

Vido-Sound Corp., New York City, is the inventor and proprietor of the inductive sound distribution system. Although the basic principle of inductive distribution is not new, its current application is said to incorporate some patentable features, which, of course, are secret for the present. Vido-Sound is fortunately unusual in its organization. Its chief engineer is also chairman of its board. This is Mr. S. J. Levy, who holds a number of patents in audio-frequency fields. Walter Futter is president of Vido-Sound, and John Shelton, executive vice president.

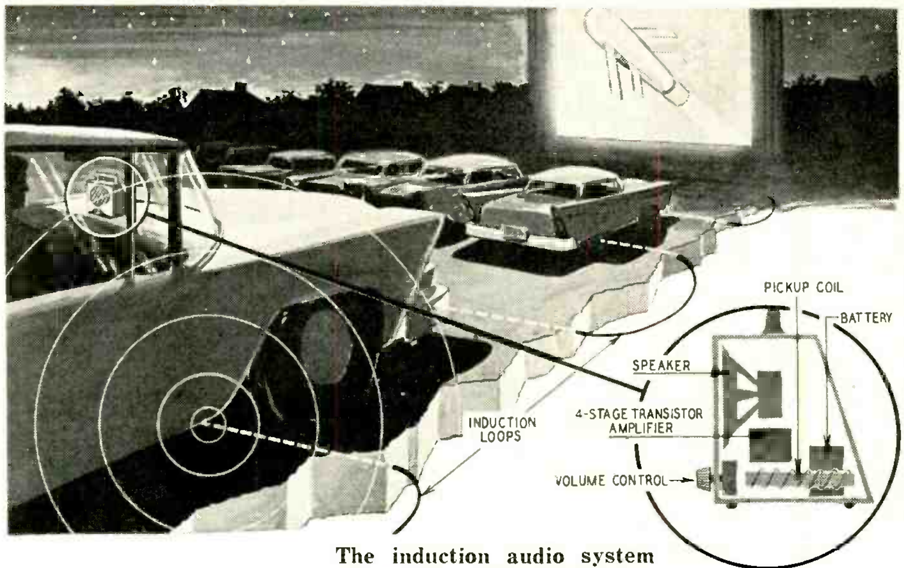
Advantages

Vido-Sound claims the following advantages for its system:

1. Lower cost. They figure the cost of equipment, including wiring, at $25 per car, which they state is less than the average cost of conventional drive-in systems. The latter cost is estimated at $30 per car. Experienced drive-in engineers are not in complete agreement.

Vido-Sound claims as a further economy that less-expensive amplifiers can be used in the projection room. Mr. Levy states that with his system a 75-watt output is adequate for 600 cars. The conventional requirement would be about 300 watts of audio.

2. Less maintenance. The Vido-Sound amplifier is a four-stage, printed-circuit, p-n-p transistor unit. Its gain is 37 db and the unit is encapsulated. This protected assembly rests in a chassis of silica gel. It uses a 9-volt battery, which has an estimated useful service life of 6 months to 1 year, and will cost the theater 49 cents. A 5-inch speaker completes the unit. As already noted, this assembly obviously needs more servicing than a conventional unit, which consists only of a speaker, volume control and case. But, in conventional installations, not only the speakers, but the speaker boxes, transformers and connections need some maintenance. And if the theater closes for the season, all those hundreds of speakers must be disconnected and taken to safety, to be returned and wired in place again before reopening. The inductive-system speakers do not have to be distributed, patrons pick them up on entering. They do not need to be collected at the end of a season. The patrons bring them back at the end of each evening and they are not left outdoors exposed to the weather.



The induction audio system as used in a drive-in theater.

3. Increased refreshment sales. The inductive speakers promote refreshment sales, since patrons can take them right along to the refreshment counter. They need not hesitate to go for refreshments out of fear of losing part of the show. These speakers solve the problem for parents of young children, who are timorous about letting the children go to the playground areas alone. The parents, carrying the speaker and refreshments, can go along, picnic with their children in the play area and still not miss any of the show.

4. Less speaker theft. In the ordinary arrangements used by conventional drive-ins no excuse exists for stopping an outgoing car and asking for the return of a speaker. The speaker is supposed to have been left back at the post. If a dishonest patron snips the speaker cord and drives off with the unit, nothing can be done about it, unless he has been seen in the act. But in the inductively operated theater every car that leaves is automatically required to hand over one speaker before leaving. The rather substantial losses that some drive-ins have suffered in the way of speaker theft are impossible under the inductive arrangement.

5. Fewer Accidents. Speaker-post accidents cannot occur—there are none. Patrons walking from their cars to the refreshment area or rest rooms cannot be caught by or trip over speaker wires.

6. Double use of area. During daylight hours, when the area is not used as a theater, it can be used for anything, since there are no speaker posts. Since the area can be put to a double use, more expensive centralized locations become practical as drive-in sites.

Objections

Since the Dover theater is the only one of its kind at present, experienced drive-in engineers who do not favor the induction process look forward to possible drawbacks of one kind or another; if not at Dover, possibly elsewhere. They expect noise from car ignition systems, from sign flashers and from refreshment-room machinery such as refrigerators. They suspect the steel underbody of the automobile may in some cases shield the transmission. Most of all they point out that experience with one theater is insufficient basis for judgment.

To such comments Vido-Sound people reply that they have not experienced any noise pickup of any kind and expect none. That at Dover the wire loops carrying the signal are fastened to the underside of the concrete upper deck, and that in nontheatrical applications signals have been picked up quite successfully from a submerged submarine.

Vido-Sound not only expects many more drive-ins to adopt its system, but foresees its successful use in many other applications—public-address systems at county fairs, carnivals and traveling shows; for two-way intercoms; possibly even for ground-to-air communications that will not interfere with any radio communication. END

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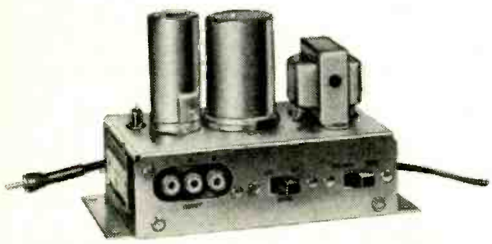
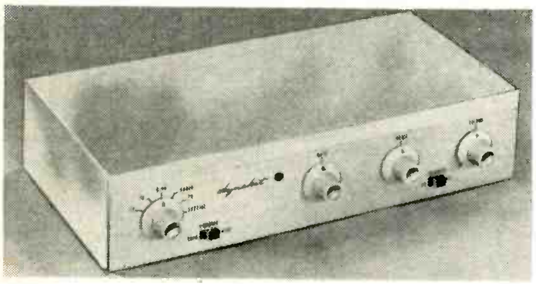
The ever-growing audio electronics industry is constantly turning out new products. Some of these are described here.

new developments in audio

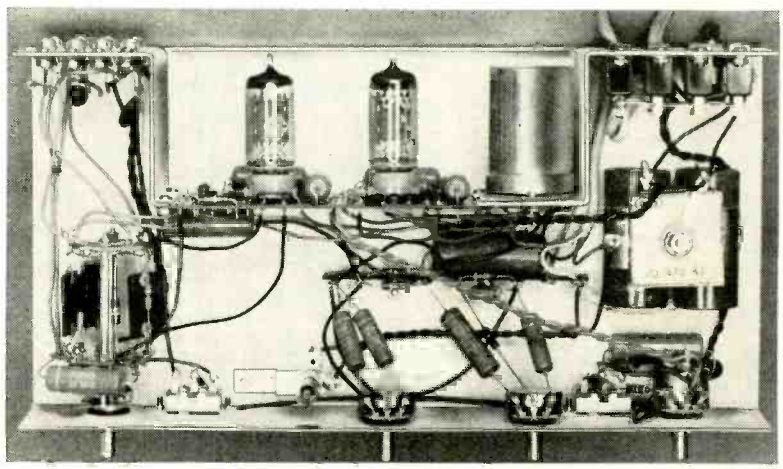


G-E's A1-Transistube phono preamp.

Dynakit's control unit in its neat simple case.



By HERMAN BURSTEIN



A look inside the Dynakit unit shows its uncramped chassis layout.

THE dynamic nature of audio electronics is evidenced by the continual appearance of new high-fidelity items. Though not all change is progress, by and large the new products are part of a development leading to increasingly faithful reproduction of music in the home. Even items which turn out to be failures serve as guides to eventual success.

This article—and others to follow from time to time—takes note of new audio products which are of particular interest because of design, performance, or features reduced cost. For this purpose, I have attempted to contact all high-fidelity manufacturers or their representatives in this country. But some may have been missed, and I hope that they will accept this invitation to submit material on their new products.*

Five new items are discussed here: a control unit, a cartridge, a speaker, a phono preamp and a turntable.

Dynakit control unit

The unpretentious appearance of the Dynakit preamplifier fails to suggest the unit's clever and skillfully integrated circuitry (Fig. 1), producing a high order of performance.

Throughout the circuit the signal is subject to negative feedback for minimum IM distortion—kept below 0.1% at operating levels sufficient to drive typical power amplifiers. Both current feedback (unbypassed cathode resistor) and voltage feedback (from plate of one stage to cathode of the previous stage) are used. Frequency-discriminating negative feedback between V1-a and V1-b produces phono equalization (and tape equalization, if desired), while frequency-discriminating feedback between V2-a and V2-b is used in connection with the bass and treble controls.

A low output impedance of about 1,000 ohms permits as much as 25 feet of connecting cable between the control unit and the power amplifier. It is obtained without a cathode-follower output, saving half a tube and reducing complexity and cost. Low output impedance is due to the negative feedback between V2-a and V2-b.

For phono (and tape) equalization, ingenious use is made of positive feedback, produced by the 100,000-ohm resistor between the cathodes of V1-a and V1-b. This increases the gain of V1-a and V1-b, permitting more accurate equalization by means of negative feedback. Unless gain before negative feedback is sufficiently high, frequency response will not vary exactly with the amount of feedback.

About 12 volts dc is placed on the tube heaters, without using a separate power supply. Instead, 6.3 volts ac from the power amplifier is used. The Dynakit control unit has a voltage-doubler arrangement, using selenium rectifiers, which produces about 12 volts dc after the drop across the rectifiers.

Although the customary thing is to use dc on the heaters or a balancing potentiometer for minimum hum, the Dynakit does both for results superior to either method alone.

High-gain voltage amplifiers are sometimes known to pick up radio stations due to grid rectification. Therefore a 10,000-ohm resistor is inserted in the lead to the V1-a grid for rf suppression. Also, a .01-μf rf bypass capacitor is used on the heaters.

A minimum number of stages—only four in two tube envelopes—is a desirable design objective, for each additional stage not only raises costs but also adds to noise and distortion. Yet with only two tubes the Dynakit provides all the basic functions and features of a top-quality control unit: six inputs, tape output, tape monitor switch, loudness switch, effective bass and treble controls, gain control, three phono-equalization characteristics, provision for tape playback equalization, and low output impedance.

Ronette TX-88

The once-lowly piezoelectric phono pickup has become a full-fledged candidate for high-fidelity use in the past

*Please address Herman Burstein c/o RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N.Y.

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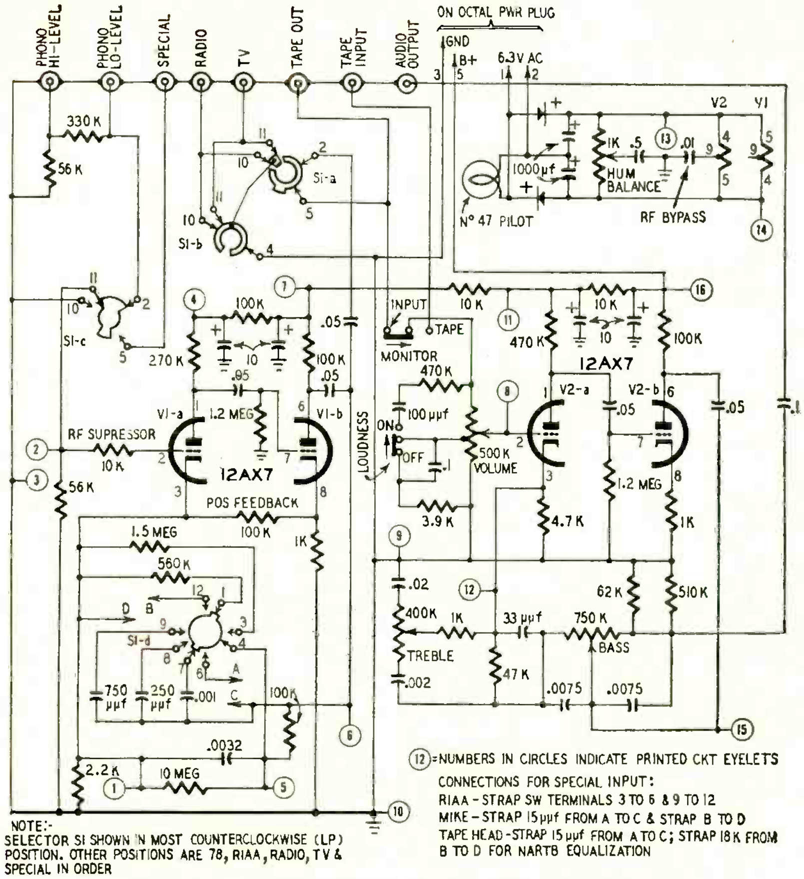

Fig. 1—Circuit of the 2-tube Dynakit control unit.

two or three years. Ronette's new TX-88 illustrates the reasons why and marks a further stage of development for this type of cartridge.

Perhaps the outstanding feature of the TX-88 is response to 24,000 cycles. The previous difficulty in obtaining such response was due to losses that increased with frequency in coupling the stylus to the piezoelectric element, a Rochelle salt crystal in the case of the Ronette. Stylus mass, coupling material between stylus and piezoelectric element, and mechanical method of coupling are the factors involved. In the TX-88, stylus mass is about 20% of the previous Ronette models. The coupling material is softer and does not "freeze" at high frequencies, and the stylus is mounted in a new way for improved coupling. Instead of having the stylus anchored at one end as in previous models, the TX-88's stylus is suspended so that, in effect, it is virtually a free-floating unit in a soft plastic cushion (Fig. 2). Lateral movement of the stylus is transmitted to the cushion along the full length of the stylus, not just at one point.

Reduced stylus mass also helps give the TX-88 a high compliance of 5×10^{-16} cm/dyne, which minimizes tracing (not tracking) distortion and needle talk. A compliance of 5 compares with the better magnetics and is exceeded only by a few of the very best pickups.

The TX-88's output should be fed to the customary 470,000- or 500,000-ohm high-level input of a control unit to achieve correct RIAA equalization. In the past, piezoelectric cartridges have required load resistances of 1 to 3 megohms to obtain adequate bass response. Since the usual high-level input resistance of a control amplifier is only about 500,000 ohms, bass response suffered unless the load resistance was increased or a capacitor of proper value shunted across the cartridge.

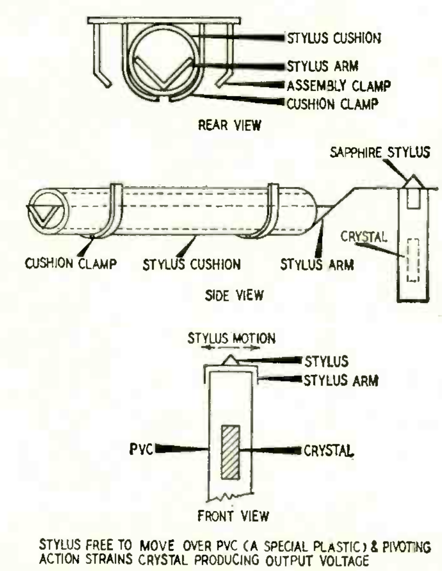

Fig. 2—In Ronette's TX-88, stylus is virtually a free-moving unit.

Hartley 217 speaker

Conflicting schools of thought exist on the advisability of dividing the audio spectrum among two or more speakers. Particularly at prices within most audiophiles' reach, there are full-range speakers which many individuals favor over multispeaker systems in the same price range or even appreciably higher.

One of the stanchest advocates of the single speaker has been H. A. Hartley, who long ago tried and abandoned the woofer–tweeter system because he feels that breaking up a sound between two or more speakers does not make for natural reproduction. His model 215 full-range unit now has a successor, the 217, which is a refined version. Its chief feature is a polymerized cone, which consists of paper put through a chemical process that changes its molecular structure, making it tougher and more rigid. At the same time the advantage of a paper cone, lightness, is retained.

Other features of the Hartley 217 are a 5-pound magnet, which is relatively very heavy for a 9-inch speaker; ½-inch voice-coil excursion for low distortion and good damping, and an extremely compliant rim suspension to help bring cone resonance below audibility.

G-E phono preamp

The G-E phono preamplifier, with us for a decade or more, has undergone a radical face-lifting. The new Transitube preamp has a transistor input stage for minimum hum and microphonics, and accommodates not only G-E pickups but also all other magnetic cartridges as well as a low-impedance microphone. No battery is required by the transistor. It obtains operating voltage from rectified and very well filtered house current.

The circuit (Fig. 3) has three inputs: for high-, medium- and low-impedance magnetic cartridges. A high-impedance cartridge, such as the G-E, normally raises the problem of high-frequency loss because its inductance in series with the low input resistance of the transistor stage would act as a low-pass filter. But the problem has been circumvented by using the loss due to load resistance to provide RIAA treble cut. The input series resistors (5,100, 2,000 and 300 ohms) form a network with the inductance and dc resistance of the particular cartridge for which each resistor is intended plus the input resistance of the transistor stage to provide RIAA treble attenuation.

However, for cartridges with extremely low inductance—such as the ESL, Fairchild and Grado—input resistance is much too high to effect sufficient treble cut. RIAA treble de-emphasis for such cartridges is provided after the transistor stage by an R-C filter made up of R8, R10 and C5. Switch S1 must be in HI position so that R10 will play its proper role. C5 has to be added to the preamplifier if a low-impedance cartridge is to be used.

RIAA bass boost is obtained by feed-

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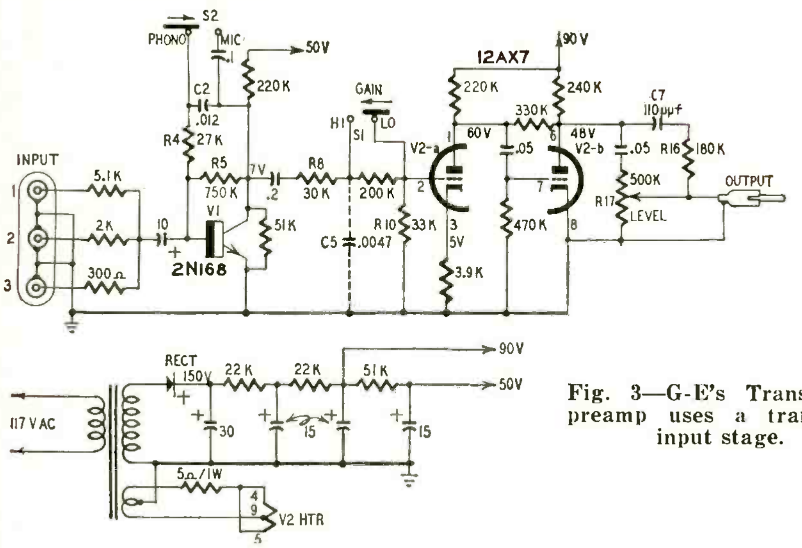


Fig. 3—G-E's Transistube preamp uses a transistor input stage.

back between the collector and base of the transistor via R4, R5 and C2. When using the unit with a low-impedance microphone (preferably 250 ohms), S2 eliminates the equalization.

To prevent the signal from a cartridge or microphone with relative high output from overloading the 12AX7 stages, a LO-HI switch which introduces attenuation after the transistor stage is included.

To offset the high-frequency loss that occurs when the LEVEL CONTROL (R17) is reduced from maximum setting, C7 and R16 provide a slight amount of treble boost.

Thorens TD-124 turntable

The Thorens Co. has a new transcription turntable with a number of interesting features, some novel, some to be expected of a modern high-quality component.

A number of designs rely upon a very heavy turntable to reduce wow and flutter to a minimum. This provides high inertia and consequent smoothing of instantaneous voltage fluctuations, motor vibration, etc. But this raises problems. First, a heavy turntable requires a relatively long while to get up to speed or to stop. Second, if the table is made of cast iron rather than aluminum to obtain the desired weight, the iron may pull on the magnetic portion of a pickup and unduly increase the tracking force. If the table is of aluminum, it does not provide the shield that cast iron does between the phono-motor magnetic field and the pickup.

Thorens has attacked these problems by using an aluminum turntable over a cast-iron one, the two being coupled by rubber. Instant coupling or decoupling is effected by a lever, shown on the left side of the baseplate in Fig. 4, which causes a semicircular ring to ride up on pins and lift the aluminum section away from the cast-iron table. The cast-iron table weighs 10 pounds, and the aluminum table 0.5 pound.

The instant-coupling mechanism facilitates exact cueing for those who need this feature. The pickup can be placed on a stationary record, resting on the aluminum turntable, and an immediate start is obtained when the clutch lever couples it to the rotating cast-iron table.

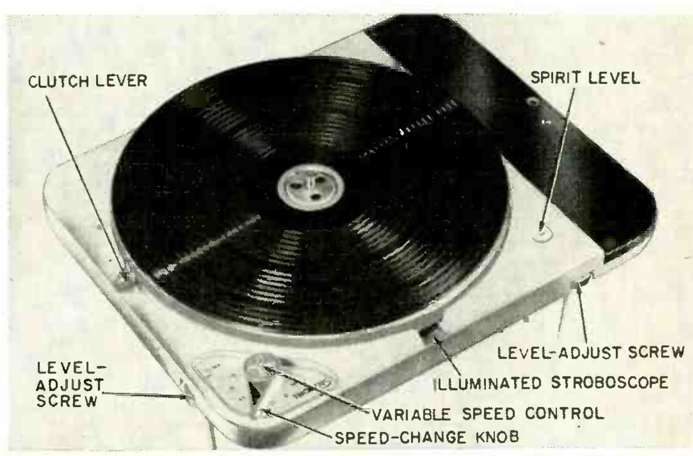
Some turntable designs favor belt drive because it provides a high degree of isolation from motor vibration and speed fluctuations. Others favor idler drive, in part because it permits quick, easy change of speed. The TD-124 seeks to retain the best features of each drive method in its own system, shown in Fig. 5. The motor shaft is connected to an intermediate pulley by a rubber belt, which isolates motor vibration from the rest of the mechanism. The shaft of this pulley has four stepped diameters, corresponding to the record speeds now in use, that engage the rubber idler wheel, which in turn drives the inner rim of the cast-iron turntable. The motor pulley, intermediate pulley and idler wheel are all relatively large to prevent slippage and deformation of the rubber belt or idler wheel.

Meticulous audiophiles, particularly those with a golden ear, insist upon exact speed. Therefore, the TD-124 has a built-in stroboscope with its own neon light and a variable speed control mounted coaxially within the speed-change knob. The intermediate pulley is hollow, and its rim rides between two magnets, one of which may be seen in Fig. 5. The other is concealed beneath the pulley. The magnetic field between these magnets exerts a drag upon the pulley rim. The variable speed control moves the magnet beneath the pulley either closer to or farther away from the rim, thereby varying the magnetic drag and the speed.

For optimum results, the turntable must be absolutely level. The TD-124 has a spirit level and screws to aid in proper leveling.

There is a detachable wooden mounting board for the pickup arm. It can be quickly removed and inexpensively replaced should the user install a different arm and not want the old mounting holes to show. END

Fig. 4—The Thorens turntable. Note the clutch lever at the left.



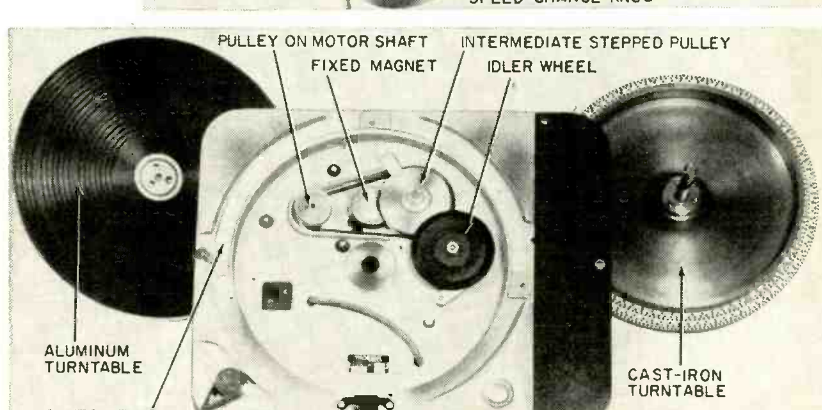


Fig. 5—With turntable removed, details of drive mechanism are revealed.

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STEREO SPEAKERS ...where do they go...?

In two-channel stereo systems, deciding where to put the speakers is a major problem

By GEORGE L. AUGSPURGER

THE growing interest in stereo has resulted in considerable confusion concerning the choice of speaker systems for stereophonic installations as well as their proper location and spacing. Despite statements that good results can be obtained with one good speaker plus an inferior unit for the second channel, experiments indicate that most effective reproduction requires two high-quality speaker systems as nearly identical in performance as possible. I refer, of course, to speakers used with true two-channel systems, not the simulated stereo effect sought by separating two dissimilar speakers connected to the same channel.

The question of proper spacing is more complicated. Optimum speaker spacing for stereo reproduction is partially dependent upon the microphone placement used in the original recording. If the recording engineer uses two widely separated microphones to pick up a symphony orchestra and this material is later played back through two speakers separated by only 3 or 4 feet, the reproduction will lack three-dimensional effect. Conversely, if microphones spaced close together to pick up a small jazz combo are used to make the recording, playing this through two units 20 feet apart can only produce the effect of two groups playing at opposite sides of the room.

In an effort to standardize the procedure somewhat and start a trend toward uniform loudspeaker placement, some manufacturers have adopted a compromise figure and suggested placing stereo speakers 6 or 7 feet apart. Of course, 6-foot spacing is about the maximum you can get into a single cabinet of reasonable size, even with hinged doors at each end acting as 45° reflectors. However, this arbitrary spacing doesn't seem to be based on any uniform practice in recording and in this respect the proper layout of a reproducing system is at the mercy of the recording engineer.

A more scientific approach would be to survey current stereo recordings and try to formulate rules for reproducer placement. Unfortunately, some stereo tapes were made on an experimental basis and serve only to demonstrate the widely divergent philosophies which can govern a stereo recording setup.

Recording in stereo

A better idea is to investigate how new material is being recorded, and

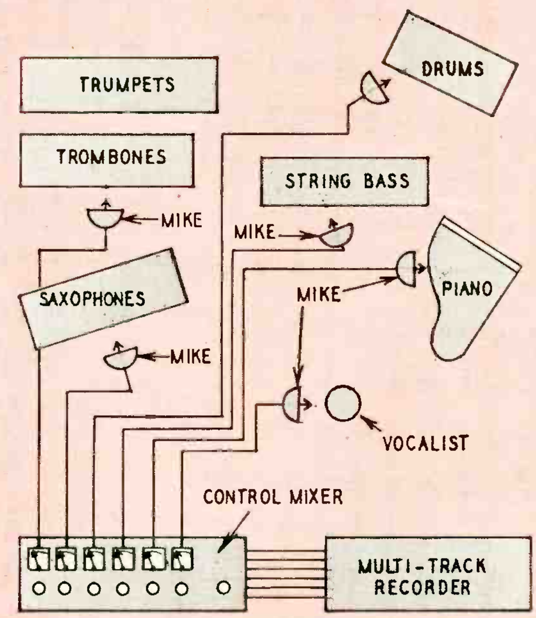

Fig. 1 — Microphone placement for multichannel recording.

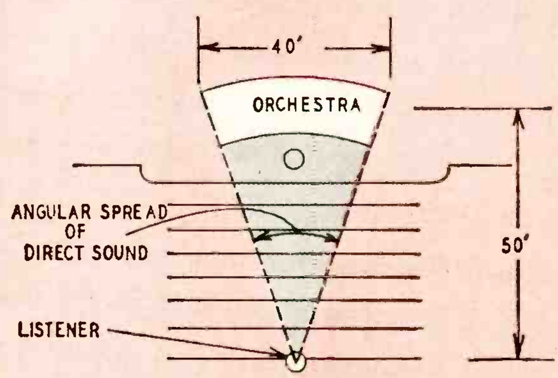

Fig. 2—Ideal listener position for symphony orchestra.

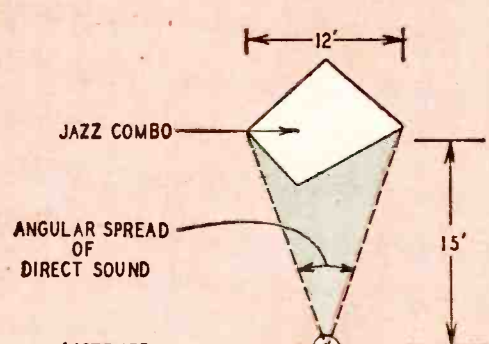

Fig. 3—Relationship of listener to small jazz combo.

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Two separate but identical speaker systems allow tailoring the stereo setup to its particular acoustic surroundings.

here we find a trend toward uniformity. Most recording by major companies in the United States are now being made by a multitrack process. This does not mean that all companies plan to make their entire catalogs available in stereo. Instead, the use of multichannel recording has proved a lifesaver in achieving the close hi-fi sound so popular in today's monaural discs.*

Recordings are usually made on three to five separate channels with microphones picking up various groups of instruments and soloists (Fig. 1). The practice is somewhat similar to that used in the old broadcasts of the NBC Symphony. The big advantage is that, with each group separately recorded on tape, reverberation, balance and presence can be adjusted by the engineers after the musicians have gone home. Moreover, with several tracks available, the recording can later be issued in two- or three-track stereo versions with no need for duplication of facilities or rerecording.

It is logical that in setting up such a multiple-channel recording, the engineer does not worry himself primarily about possible stereo release. If a two-channel stereo recording should be desired, the effect can be achieved by proper mixing of existing tracks, just as the monaural recording is a composite of separate sections. Note that these tracks generally represent individual instrument groups. One microphone may have been placed to pick up strings, another oriented toward the brasses and a third placed close to a soloist. If the stereo recording were issued as a duplication of these individual tracks, you could build a symphony orchestra in the listening room and place the various sections according to personal whim.

But the concept of "the artist *in* your own living room" is a dead issue in any but advertising circles. We are not attempting to take the orchestra into the average living room: we are interested in transporting the listener to the concert hall. Even with recordings made exclusively for stereo reproduction, the ideal effect is not that of a symphony orchestra in the listening area, but the listening area magically moved to the best seat in the concert hall.

What *is* the best seat for listening to a musical performance? A full orchestra sounds best if you are back far enough to get proper balance between the live orchestra and the reverberation characteristics of the concert hall. Also, an orchestra is spread out so widely that we must sit far enough away for the sound from various instruments to blend. The best seat in the house, therefore, is normally about 30 to 50 feet away from and directly in front of the orchestra. If there is a soloist, you may prefer to be nearer this artist than the rest of the instruments.

When listening to a string quartet or small jazz combo, the situation is quite different. This is intimate music designed for close listening. You might want to be only 10 to 15 feet from the performers.

What's the angle?

The important point is this: for a full orchestra we sit 50 feet from a sound source which spreads out about 40 feet across the stage in front of us. On the other hand, we sit only 15 feet from a small group which measures less than 12 feet (spatial separation of instruments). Were we to record both groups with standard multiple-channel technique, the maximum distance between microphones would be about 25 feet for the orchestra and 8 feet for the quartet. In both instances, the *angular* separation between these microphones, as measured from the ideal listener position, is between 30° and 40°. This can be readily seen from Figs. 2 and 3.

If three, four or five channels are blended into two for stereo release, the maximum effective separation between the two final channels cannot be more than the maximum physical separation of microphones at the original recording session. This means that purely mechanical considerations of normal multichannel recording determine that a stereo tape made from these channels should have an effective angular separation of 35° or so. Moreover, this angular measurement is substantially independent of the type of music recorded because of the implied shift in ideal listener position.

Recording engineers are quite conscious of the problem of stereo speaker placement and, on those recordings made especially for stereo release, the tendency is toward a standard of angular rather than linear separation. The value of the optimum listening angle seems to be generally designated as somewhere between 30° and 40°. Consequently, optimum placement for stereo speakers is not measured in feet and inches, but in angular degrees (Fig. 4).

In a small room, the speakers may be only 4 or 5 feet apart while in a large living room the spacing may increase to 10 or 15 feet. If the angular separation, as seen by the listener, is about 35°, modern stereo recordings will automatically place him in the best seat in the house regardless of the type of music to which he is listening.

This system of placement, while approaching the problem from a more logical basis, achieves substantially the same results in a normal-size living room as did the earlier empiric figure. A 6-foot separation gives about 35° angular separation in many rooms, so that a single cabinet system can be used with satisfactory results. However, the high price of speakers, to say nothing of the inyestment in the rest of the system, generally means that such equipment will be owned by fairly affluent people—those with large listening rooms. Consequently, the prospective purchaser of a stereo system should be advised of the necessity of proper spacing in terms of angular measurement for optimum stereo listening.

Some experiments have been made toward developing an acoustically blended stereo sound field generated in a single large enclosure, but it will probably be some time before such a device is commercially available. At present the most versatile arrangement is a set of two separate but identical speaker systems as shown in the photo. The music system can then be tailored to its particular acoustic surroundings for best possible reproduction. END

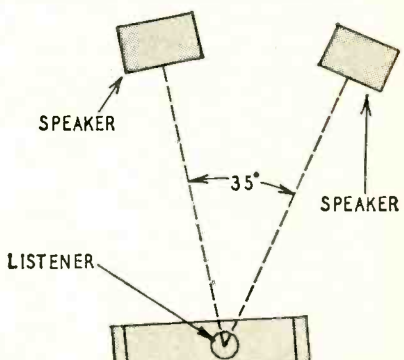

Fig. 4—How to measure speaker separation in degrees.

*Except, of course, for those employing single-microphone technique. The two methods are not incompatible as a full-coverage single-mike pickup may be used on one channel of a multitrack recording.

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NEW DISCS and STEREO TAPES

Reviewed by
CHESTER SANTON

Due to the efforts of Monitor, readers of this column expect a technical and factual approach to the review of records and tapes. I anticipate with pleasure the task of preserving this realistic attitude.

Stereodisc Test Record
Audio Fidelity AFLP 1872

Ordinarily we consider only commercial releases in this column. This demonstration record at time of release was not available to the public. It was heard for the first time at the public appearance of stereo discs on Dec. 13 in the course of an off-the-air demonstration of stereo held by "Adventures in Sound" in the WQXR auditorium. Mastered by Westrex and played back with a laboratory model of the Fairchild stereo cartridge, the record's single-groove two-channel sound was superior in every respect to that of the Westrex disc heard during last autumn's New York High-Fidelity Show. Material heard on the Stereodisc was *Marching Along* with the Dukes of Dixieland on side one and *Railroad Sounds of Steam and Diesel* on the other. This 12-inch "compatible" record (a normal pickup gives you the lateral components) approached very closely the technical standards of its LP counterparts. As a result, the stereo effect on the original master tapes came through unharmed on the disc. Appearing in the guise of a finished pressing like those processed every day for Audio Fidelity by B & C Recording, Inc., its announcement caused some cautious consternation in the ranks of record companies ambling along in this field. More important is the fact that public demonstration of the Stereodisc has changed the timetable of those working on the development of a normal-size stereo cartridge. Upon testing its so-called compatability at home, satisfactory one-channel sound was obtained with several standard pickups. However, the stereo record's ability to withstand conventional playback under average stylus force is unknown at the present time.

STRAVINSKY: *Firebird Suite*
Leonard Bernstein conducting New York Philharmonic
Columbia IMB-3 (7-inch; playing time, 21 min. $12.95)

Some of the early tapes tracked considerable sound muddiness into the living room. This problem is being solved in many of the new releases. Columbia Records, a comparative latecomer in the stereo-tape field, is turning out recordings featuring exceptionally clean sound. In this version of the *Firebird Suite*, the glittering score of the Stravinsky ballet is heard in a way never before possible on records. In stereo, the strings and brasses really deliver their own separate colors. The chime signaling the start of the *Dance of Kastchei* midway through the suite startles the stereo listener as it awakens the air above the orchestra. Columbia obviously has perfected an outstanding method of transfer from master tape to commercial copy. A really superb job. Incidentally, at the Dec. 13 stereo demonstration mentioned above, this tape proved to be the hit of the evening with the audience, surpassing in sonic appeal two other current stereo releases—RCA-Victor's Beethoven's *Fifth Piano Concerto* played by Artur Rubenstein and Mercury's *Gâité Parisienne*. If you have an unusually fine stereo setup, this tape will amaze you. If performance of this music in stereo is important to you, investigate the Horenstein version on Phonotapes, but this one is tops in sound.

We are happy to present Chester Santon, as our new disc and stereo-tape reviewer. Mr. Santon has been on the staff of WQXR, the pioneer good-music AM and FM station of *The New York Times*, for the past 16 years. He has conducted the Sunday evening record program "Adventures in Sound" during the last three years and also conducts the newer all-tape program "Frontiers of Sound." As readers can see from the reviews, Mr. Santon will carry on the RADIO-ELECTRONICS reviewing technique, accenting the sound rather than the purely musical aspects of the records selected for review and supplying information as to how the effects are produced.

Jotas
Enrique Estela conducting Orquesta de Camara de Madrid
Montilla FMT-1002 (7-inch; playing time, 20 min. $8.95)

Stereo from Spain, this is the real thing—these aren't arrangements by way of Hollywood. As LP listeners already know, Montilla Records takes modern equipment to Spain and records that country's leading artists on the spot. A naturally sunny sound amounts to a trademark for this firm. In stereo, it is more sparkling than ever. The jota is a typical national dance of Spain that varies with the region of the country. Frequently the jota is sung and its tempo is then slower. In the five selections on this tape, trumpeter Vincente Lillo is heard instead of the usual singing voices. You should hear the handling of transients in this reel. Now that really clean tapes are coming along, we can better gauge the benefits of stereo in terms of transient response. Here Montilla has established new standards for the reproduction of transients so characteristic of the Spanish dance.

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

SIBELIUS: *King Christian II Suite*
The Tempest Suite
Stig Westerberg conducting Stockholm Radio Orchestra
Westminster XWN 18529

WAGNER: *Tristan und Isolde—Prelude and Liebestod*
Die Meistersinger Overture
Tannhauser Overture
Herbert Van Karajan conducting Berlin Philharmonic
Angel 35482

Both recordings form an easy road to composers whose music often is considered too heavy at first hearing. The Sibelius is the lighter of the two, the music as fresh to the ear as it is to the catalogues, and the Swedish engineers responsible for the disc show us a trick or two. Completely natural, transparent sound. The familiar *Musette* in the *King Christian II Suite* is one of the tastier morsels on vinylite. A Sibelius symphony will seem easier after this record.

The combination of the Berlin Philharmonic and the opulent Angel sound is an unbeatable one in Wagner's music. — One of the first records to do justice to the cellos and double basses used so lavishly by Wagner when writing for the orchestra. The finest performance of this music in present-day sound, challenged in the *Prelude* and *Liebestod* alone by the older, still unique Toscanini *Tristan Prelude* in the two-disc RCA album LM-6020. Definitely not for casual listening.

The Lass With the Delicate Air
Julie Andrews, Soloist
RCA-Victor LPM 1403

The warm elegance of the voice of Julie Andrews, star of *My Fair Lady*. Could any record producer go wrong? RCA-Victor does not — with every nuance of Miss Andrews' style closely miked. The songs, however, are far removed from typical musical-comedy fare. All are favorites of the Andrews family, and they tell us something of her life offstage and a good deal of her personal aspirations that backstage interviews do not cover. Particularly appealing are McDowell's seldom sung *To a Wild Rose, If My Songs Were Only Winged* by Reynaldo Hahn — usually encountered in concert recitals. Noel Coward's *London Pride* here is given real meaning for the first time. Occasionally, the orchestra is doctored — as in Leoni's *Tally Ho* — but real Julie Andrews fans don't care — do we?

SAINT-SAENS: *Organ Symphony No. 3 in C Minor*
Eugene Ormandy conducting Philadelphia Orchestra
E. Power Biggs, Organist
Columbia ML 5212

Now we can listen to the famous Philadelphia Orchestra — long identified with the acoustics of the Academy of Music — recorded for the first time in Symphony Hall, Boston. This is an unusual event looked forward to by many an audiophile. The recording session was an interesting one. According to Columbia Records engineer Harold Chapman and recording director Howard Scott, this is how it was done: Saint Saens' organ symphony demands freedom of sound. They dispensed with the heavy curtains normally used in the hall during recording sessions. An essentially one-mike setup was evolved with several subsidiary micrpohones cracked open just a bit to help round out the sound. The Symphony Hall organ, played on home ground by E. Power Biggs, and the strings from Philadelphia, give back to Columbia the lead position they held with this symphony on records back in the early days of microgroove discs when the deep pedal notes of the organ in the New York Philharmonic performance were the standard reference for checking bass response in speakers of that day. The Toscanini version for RCA-Victor contains excellent reproduction of the organ's low tone but it cannot match the concert-hall effect of this Ormandy disc. Note particularly the natural perspective obtained when massed strings give way to the solo passages in the woodwinds.

RIMSKY-KORSAKOV: *Scheherezade*
Perlea conducting Bamberg Symphony
Vox PL-10,220

Still another *Scheherezade*, but this is one work that always finds a ready market. This version is notable for the liveness of its acoustics. Both high highs and lows are held down, but in good balance. The definition is quite good despite the liveness and, though the overall effect is more somber than that of some more brilliant versions, it produces a spacious sound. Very clean throughout. 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.*

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What it will and won't do in audio amplifiers

GETTING FEEDBACK STRAIGHT

By NORMAN H. CROWHURST*

IT'S surprising how often feedback is expected to do something it can't possibly do. For example, I recently met an enthusiast with an amplifier that put out about 48 watts comfortably and then ran into severe distortion. He was frantically trying to use feedback to make the amplifier deliver what he wanted—a full 50 watts. He couldn't understand why using enough feedback wouldn't push the output up just this little bit!

Most material on feedback has been based on a theoretical treatment using the algebra of feedback theory. This algebra cannot take into account everything at once—if it did it would become so involved that no ordinary person could possibly understand it. We use one piece of algebra to tell us the effect of feedback on the gain of the amplifier, then we go over the algebra again and find out what its effect will be on the amplifier's impedances, frequency response and distortion. Each investigation uses a separate application of the same math. But this does not prove that the amplifier will do all of these things in equal manner *at the same time*. It depends on just what form distortion (and other things feedback is expected to correct) may take.

Frequency response

Some presentations on feedback have suggested (with deceptive simplicity) that as feedback tends to smooth out fluctuation in gain it must flatten the frequency response—on the basis that deviation from flat in frequency response is merely deviation in the gain of the amplifier at different frequencies. Some readers are doubtlessly aware that this oversimplification of theory can often be the reverse of what really happens. Due to phase shifts in the amplifier, frequency response can often be *accentuated* by feedback, rather than flattened.

Let's take feedback, step by step, starting from a single stage and using practical examples to see how it can change the response in each case. Fig. 1 shows some examples of single-stage feedback: simple cathode circuit current feedback, voltage feedback from plate to grid on the same stage and the very useful Ultra-Linear circuit where feedback from plate to screen is provided by taps on the output transformer.

With current feedback in a cathode circuit the feedback is effective right down to dc at the low end. At the high end the only modifying factor is the stray capacitance of the tube and its associated circuit. This eventually deteriorates the tube's gain and hence also the feedback. So current feedback in the cathode does not modify the low-frequency response at all, and the high-frequency response is modified according to the distribution of tube capacitances.

In plate-to-grid feedback—shown in Fig. 1-b—a blocking capacitor between the plate and grid keeps dc from feeding back to the grid and there is stray capacitance to ground. The blocking capacitor introduces a rolloff at the low end in the feedback circuit while stray capacitance to ground introduces a rolloff at the high end.

The low-end rolloff causes feedback to fall off and stage gain to rise to its no-feedback value if no other rolloff is introduced into the circuit to compensate for this. The high-end rolloff is the same as that produced without feedback, but feedback extends the frequency range by the same factor as it reduces gain. Thus, if feedback reduces gain by 6 db, frequency range at the high end is extended by a ratio of 2 to 1.

In the Ultra-Linear circuit (Fig. 1-c) the signal fed back from plate to screen is coupled by the output transformer. At the low end of the frequency response the transformer introduces a reactance shunting the plate circuit, due to its primary inductance. When the tube is operating as a straight pentode, without coupling to the screen, its source resistance is much higher than with Ultra-Linear feedback introduced. This means that adding feedback extends the low-frequency response due to the reduced source impedance the primary inductance shunts.

At the high end of the frequency response the transformer introduces a leakage inductance between plate and screen so at some point the amount fed back to the screen begins to fall off. This causes feedback to begin to fall off somewhere in the higher frequencies. However, this does not show up in practice because there is a larger leakage inductance between the whole primary and other windings on the transformer than between the part of the primary feeding the plate and the part coupled to the screen. So the other rolloffs in the amplifier circuit go into effect before the reduction in feedback from plate to screen starts to make itself felt.

Two-stage feedback

Now let's start on feedback over two stages. Take the circuit of Fig. 2, which represents a driver and output stage with feedback from the output stage plates to the driver cathodes. Considering the round-the-loop effect, here we have the coupling capacitors from driver plates to output grids, and blocking capacitors from the output plates to the driver cathodes, which contribute to low-frequency response. At the high-frequency end we have stray capacitances which can be regarded as shunting the driver and output plates, respectively.

Consider the low-frequency response. A first study might suggest that low-end response could be made absolutely flat. By making the time constant of the interstage coupling between driver and output equal to the time constant of the feedback arrangement, the block-

*Author of *Understanding Hi-Fi Circuits* (Gernsback Library).

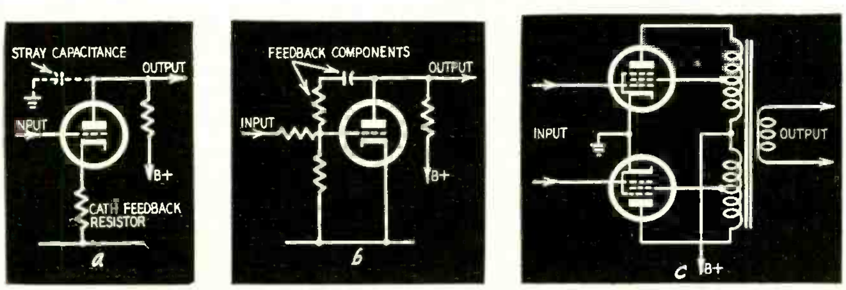

Fig. 1—Three forms of single-stage feedback: a—current feedback in the cathode; b—plate feedback to grid; c—Ultra-Linear, plates to screens.

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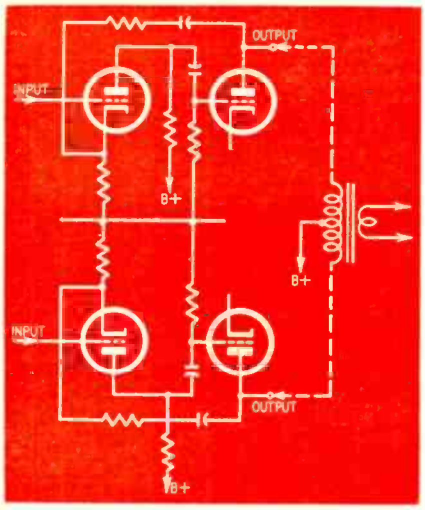

Fig. 2—A form of feedback using two reactances in feedback loop at each end of audio response. (Output transformer not part of feedback circuit.)

ing capacitor in the feedback loop would cause a rise in frequency response as feedback falls off, while the coupling capacitor between stages causes a similar rolloff in the forward response. The two having identical frequency characteristics should result in a flat response. But this assumption ignores one fact.

What happens with phase when there are two or more coupling elements in the feedback loop? If we use two identical time constants, as suggested, then more than 6 db of loop feedback starts to show a peak in the loop response at the low end, due to phase interaction. But 12 db of feedback shows a peak of about 1.25 db; 18-db feedback shows a peak of about 3.6 db; 24-db feedback shows a peak of about 6.3 db, and every successive 6 db of feedback shows approximately 3 db more peak.

This effect is independent of how the coupling arrangements are distributed around the loop. If one coupling element is in the feedback arrangement, the inverse of the response due to feedback coupling must be added to this peaking effect. For example, with 6-db feedback there is a slight peak of a little more than 2 db (curve D, Fig. 3). With 12-db feedback the peak rises to about 7 db (curve F, Fig. 3) and so on, due to the additional boost given by the coupling element in the feedback part of the arrangement.

At the high-frequency end of the response there is no loss in the feedback part of the arrangement. Losses due to both groups of stray capacitance from plate to ground affect the forward response. The only place where loss would affect feedback is at the cathode of the driver stage, where there is no loss worth mentioning. Therefore, assuming the time constant of the stray capacitance from plate to ground is the same for each circuit, the amount of peaking introduced by different amounts of feedback in the loop response would apply without the boost effect due to part of the loss being in the feedback path. See Fig. 4.

In this circuit (Fig. 2) the feedback does not include the output transformer, so any frequency response contributed by the output transformer is added to the response of the feedback measuring overall response.

Output feedback

The next question is: What happens when we apply feedback from the output transformer secondary? So far we have discussed circuits where the factors contributing to rolloff at the low and high ends are easily separable. But when we consider an output transformer they are a little more tied up and perhaps not so easy to recognize.

In the output transformers of conventional push-pull amplifiers, consideration of the low-frequency response, since it is caused by just the primary inductance shunting the plate resistance of the output stage, is simple enough. Hence, for low frequencies, performance is the same whether connected from primary or secondary of the output stage. In fact, by connecting from the secondary, the blocking capacitor can be eliminated and thus the possibility of achieving good low-frequency response is somewhat improved.

At the high-frequency end the output transformer contributes two reactances. There is the plate-to-ground capacitance, to which the output transformer contributes primary-winding capacitance, and the leakage inductance between primary and secondary. Since both of these contribute to high-frequency rolloff, by feeding from the secondary of the output transformer back to the grid of the output stage, we have two reactances contributing to high-frequency rolloff.

This means that peaking starts immediately there is more than a certain amount of feedback, according to the relationship between the circuit constants. The circuit shown in Fig. 5 never becomes unstable, no matter how much feedback we use, but we do run into peaking similar to that produced by the two-stage circuit of Fig. 2.

If we attempt to feed back over more of the circuit than shown in Fig. 5, from the output winding of the

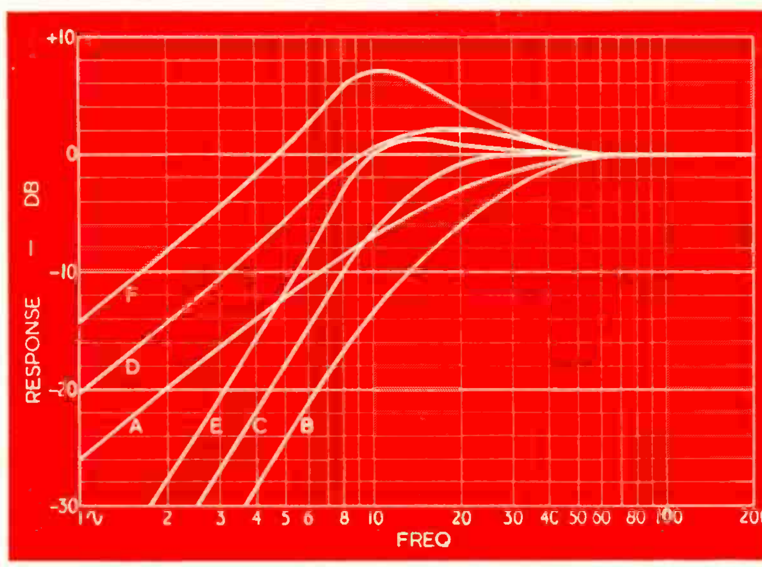

Fig. 3—Sample low-end response curves for Fig. 2. A—Original rolloff of each time constant; response of amplifier without feedback; B—open loop response; C—round-the-loop response with 6-db feedback; D—amplifier response with 6-db feedback (difference between curves A and B); E—round-the-loop response with 12-db feedback; F—amplifier response with 12-db feedback (difference between curves A and E).

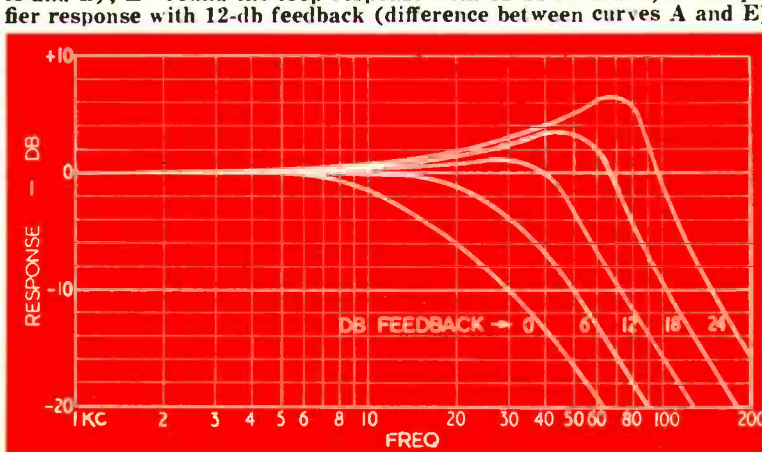

Fig. 4—Sample high-end response curves for Fig. 2, assuming loss due to stray capacitance gives identical rolloff with 3-db point at 20 kc for each stage.

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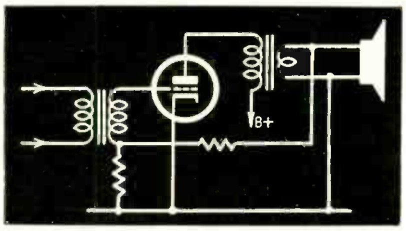

Fig. 5—Feedback over single stage with output transformer.

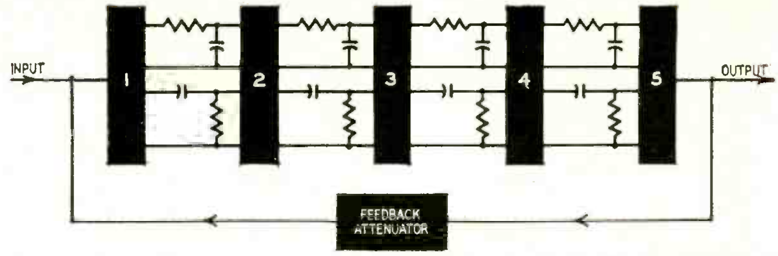

Fig. 6—Basic factors in long-loop-feedback amplifier. Numbered boxes indicate amplifier stages or phase inverters without frequency-discriminating components.

transformer, it becomes possible for feedback to push the peaking up to the point where oscillation begins. This is where *real* care is needed in the design.

The method of tackling this is to arrange the time constants contributing to rolloff response at both ends of the frequency spectrum so they are as widely divergent as possible. The best possibility of increasing the amount of feedback is to make one of the time constants effect a rolloff much closer to the passband of the amplifier than all the other time constants.

For example, if four reactances contribute to an ultimate rolloff, at each end of the response, which is a common arrangement, then by having one time constant at 100 times nearer the amplifier's passband than the remaining three, 24 db of feedback can be used before peaking begins to show up at all. And almost 40 db of feedback can be used before the amplifier becomes unstable. To achieve this range with this particular configuration, illustrated in basic form by Fig. 6, the rolloff point at the low end for one of the networks could be 100 cycles while the remaining three should be moved down to 1 cycle. Similarly, at the high end, one rolloff could be effective at say 10 kc, while the remaining three should be moved up to 1 mc.

To arrive at what the ultimate response will be, suppose we use 24-db feedback. The first acting rolloff is extended by approximately the ratio represented by 24-db feedback. This corresponds with a ratio of 16 to 1. So the 100-cycle rolloff is pushed down to about 6 cycles, and the 10-kc rolloff is pushed up to about 160 kc, both of which are well beyond the limits generally recognized as necessary in an audio amplifier.

Readjusting our figures to finish up with an amplifier that is just about right for audio, we could make the rolloff points for the low end 320 cycles with 3.2 cycles for the remaining three which leaves us with a 20-cycle rolloff for the low end, and 1,250 cycles with the three additional rolloffs at 125 kc gives us an ultimate rolloff at 20 kc.

Such a combination provides a satisfactory feedback amplifier for use on audio, but the trend in most feedback-amplifier designs is to have a much larger margin, and the figures first given are nearer to those used in actual design. Once these figures are chosen, we have to stick with them to get successful performance.

This explains why it is necessary to insure that some stages respond out to 1 mc to get satisfactory performance out of the amplifier. A while ago someone asked why Joseph Marshall added neutralizing to some of the stages in his Golden Ear amplifier (RADIO-ELECTRONICS, April, 1954). From this discussion we see that there can be a good reason for doing this, although it might appear to be going to extreme limits, until we realize the fundamentals necessary to achieve stability in a feedback amplifier.

So much for frequency response and stability problems. The statements made can be substantiated by the necessary mathematics and, if any readers are doubtful about them or want further detailed information for design purposes, they are referred to my article, "A New Approach to Negative Feedback Design" *(Audio Engineering,* May, 1953). But here we want to get on to the question of sorting out some of the things that the mathematics seem to have left open.

Distortion

Let's revert to the question introduced at the beginning of the article. Can feedback actually extend the output of an amplifier? We could go into a lot of theory on this but probably the best way to illustrate the matter is to take some typical waveforms from amplifiers we want to improve.

Fig. 7 shows the output waveform at two different levels for an amplifier where the overloading effect is not too sudden—it runs into a gradual curvature. This could be, for example, an amplifier employing power drive, so the output tubes are driven into positive grid current, and there is power in the driver stage to supply the necessary grid current. This type amplifier shows a rounding of the top of the waveform before it begins to flatten. And this rounding can introduce considerable distortion before actual clipping begins.

In this kind of amplifier, feedback can help. The feedback signal can make the driver give a slightly more peaky waveform to offset the roundings, and the resultant wave comes closer to the sinusoidal. This is shown in Fig. 8.

Now look at Fig. 9, which shows sample waveforms from an amplifier at two different levels, where clipping occurs quite suddenly. This might be a push-pull amplifier fed by a nonpower-driver stage, so commencement of grid current at the output tubes causes very abrupt clipping. Since the driver cannot supply any power to the grids of the output tubes, nothing feedback can do will ever overcome the clipping. If the driver delivers a small amount of power that starts to give a little positive grid current in the output tube, rounding the corners of the clipped waves slightly, feedback will be able to accelerate the rate at which this power is provided. So applying feedback makes the output waveform even more squarely clipped than it is without feedback.

In other words, feedback stands a chance of improving the waveform of an amplifier below maximum output but, once clipping starts, feedback tends to make the clipping sharper rather than to eliminate it.

Another effect of feedback on the overall distortion of an amplifier seems to get overlooked. At lower levels feedback does reduce the *total* harmonic content of an amplifier. But it also *changes* the harmonic present, and this change is not always an improvement. This is best illustrated with some simple figures.

Suppose we have an amplifier that introduces a distortion of 5% third harmonic. This could be due to too high a value for the plate load resistor for a pentode in an early stage and the percentage might be almost independent of operating level—5% third harmonic would appear on signals of all levels. Now suppose this amplifier has its gain increased, to make it possible to apply a total overall feedback of 40 db. This sounds quite good. We should be able to knock the 5% third harmonic down to .05% third harmonic and probably we can.

But we have overlooked something which is illustrated in Fig. 10. To reduce the third harmonic from 5% to .05% the input to the amplifier consists of a 100% original input signal, offset against a 99% fed-back signal. To offset the 5% third harmonic that the amplifier is going to introduce, the final input signal, made up by the 100% minus the 99%, must contain a third-harmonic component almost 5% in value but in opposite phase to the 5% the amplifier introduces. This 5% of third harmonic goes through the amplifier as does the original 100% fundamental. Besides offsetting the distortion produced by the fundamental, it produces some distortion of its own, to the extent of 5% of 5%, at a harmonic which is the third of the third. This produces 0.25% of ninth harmonic. So what our feedback

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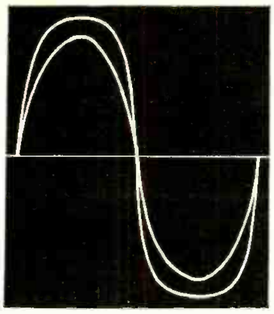

Fig. 7—Amplifier output waveform at two levels, where distortion sets in gradually.

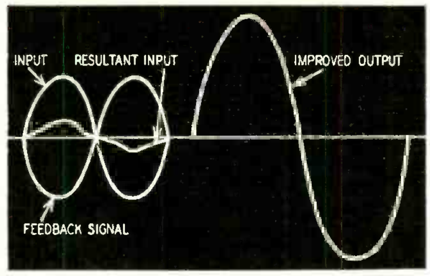

Fig. 8—How feedback can improve the output in Fig. 7.

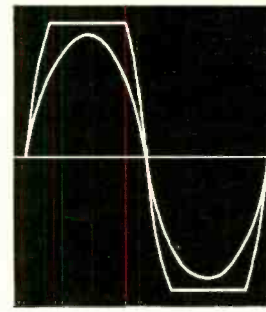

Fig. 9—Amplifier waveform where distortion appears suddenly as clipping. Feedback cannot help appreciably.

has done is to reduce the original 5% third harmonic to .05% and at the same time gives us a 0.25% ninth harmonic we never had before.

Measuring this on a distortion analyzer, it will look as if the feedback has produced an improvement, not quite as much as we calculated, but quite a good reduction and so we are happy. But if we *listen* to the amplifier, it may not sound as much better as we expected, because 0.25% *ninth* harmonic can be quite noticeable.

More than this, we have only considered the effects of feedback on a single sine wave. When we come to consider intermodulation products, we find them multiplying up out of all proportion, and a great variety of intermodulation products is introduced by an amplifier designed in this manner. The resulting reproduction sounds extremely muddy, although the figures might appear quite presentable—an overall distortion figure of 0.25% is not generally considered to be too bad.

You can't eat your cake . . .

Before leaving the question of distortion let's look at one more aspect. When we apply feedback, sometimes we achieve more than one purpose. We can make feedback do two or three things at the same time, but sometimes we use up the feedback on one purpose so that it is not available for others. This can happen, for example, where feedback is used to change an impedance.

Suppose we use a regular type of feedback amplifier to provide a lower source impedance than its nonfeedback cousin. Next we apply an output load equal to the source impedance.

We calculate the amplifier performance on the basis of either no load impedance or the optimum load impedance for the output tubes used. So it is not really legitimate to change just the load impedance and expect the same performance from the feedback amplifier. To find out what really happens we should recalculate the performance of the amplifier on the basis of the revised load impedance. What we will probably find is that the new load impedance allows much smaller output before distortion starts to be really serious and that feedback has become almost nonexistent, due to the change in loading impedance reducing the gain of the output stage.

Just take some figures to illustrate. Suppose that the optimum load of a certain output stage is 8,000 ohms and its source resistance is 3,000 ohms. By applying 26 db of feedback, the source resistance can be reduced from 3,000 ohms to 150 ohms. Now suppose we load the amplifier with a 150-ohm load (by the same matching transformer used for the 8,000-ohm load).

Let's take the feedback off for a moment and see what happens by changing the load in this condition. When we take the 8,000-ohm load off, the gain rises, due to an open-circuit condition, in the ratio of 11/8. Then, when the 150-ohm load is connected in place of it, gain is reduced in the ratio of 150/8,150. The net result, is reduced gain due to the change of load, by a factor of 1/40.

With the 8,000-ohm load the feedback was designed to be 26 db, which is a ratio of 20/1. As the gain has already been knocked down by a ratio of 40/1, the feedback factor will not be only 0.5, instead of 20. The amount of feedback resulting from 0.5 fed-back signal injected in series with the input is only 3.5 db.

This can do little toward reducing distortion. To be precise, it will reduce distortion by a factor of ⅔. If connecting a 150-ohm load to the output of this stage produces a distortion of 20%, which is quite a normal figure for such low loading, feedback reduces this only to 13.33%, which is still a very high distortion figure.

However, the amplifier *will* have an apparent source impedance of 150 ohms, which is what we have used the feedback up for. All of which reminds us of the old proverb about eating one's cake and having it too.

Hum and noise reduction

Another thing feedback is used for is to reduce amplifier hum and noise. In other words, to clean up any unwanted sounds not present in the input.

Many users have applied feedback with this object in view, only to be disappointed in finding either that it has had no effect whatever or that it has had the reverse effect. Let's just see how this can be.

First, let's take hum. One point not to be overlooked is: when adding feedback to an amplifier that must give full output for a specified input, more gain is necessary, so adding feedback leaves us with the same gain we had originally. Generally speaking, hum gets induced in the earlier stages of an amplifier so, if we're going to apply 20-db feedback, we need 20 db more gain in the first place, and the hum will get 20 db more amplification before feedback is applied. Application of feedback then knocks the hum back to where it started from.

This is assuming that the hum is injected somewhere within the feedback loop. If however, as sometimes happens, the hum creeps in outside of the feedback loop, it is possible for the addition of feedback actually to *increase* hum instead of reducing it.

Noise in feedback amplifiers actually tends to be higher, other things being equal, than in nonfeedback amplifiers. The reason for this is fairly easy to see.

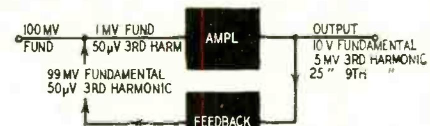

Fig. 10—How feedback affects harmonic distortion.

Suppose noise at the input to a nonfeedback amplifier is equivalent to 10 μv at the grid of the first stage, which is intended to accept an input level of 10 mv. If 20 db of feedback is added to the amplifier, it will need 20 db more gain, and hence should be able to load with only 1 mv on the first stage grid. But this grid will still have a noise level of 10 μv. If the feedback is successful in reducing the noise level by the complete amount of feedback added, then this reduces the effective noise back to its original 60-db discrimination. But this depends on every element in the noise signal being fed back completely out of phase with the original noise signal.

The lower component frequencies in noise may be successfully reduced by the 20 db in this way but, at the upper end of the response, where the random happenings that constitute noise are of shorter duration, feedback cannot keep pace with the changes and hence fails to make a reduction of the full 20 db.

Therefore, the noise level is higher in the feedback amplifier and it tends to concentrate in the upper frequencies.

Also—if due care has not been paid to eliminating the peaking effect mentioned earlier—the noise will definitely be colored by peaks at both ends of the

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frequency response, resulting in the familiar hissy, boomy background common with amplifiers using a large amount of feedback. This is quite independent of the fact that frequency response throughout the audio range may be quite flat.

Does multi-loop help?

A final question concerns the relation between single-loop and multi-loop feedback, in all these points of discussion. In an earlier article, I called attention to some of the deficiencies of feeding back over the whole amplifier ("Why Feed Back So Far?," RADIO-ELECTRONICS, September, 1953).

The use of multi-loop feedback does overcome some of these deficiencies. The short-loop feedback, toward the output end of an amplifier, stabilizes that part of the amplifier and usually extends frequency response beyond the audio range to give a satisfactory margin for application of longer-loop feedback. Also the short-loop feedback, over a section of the amplifier operating at higher level, will not aggravate hum or noise troubles in the same way as the equivalent amount of feedback applied in an overall loop would.

It is advantageous to apply as much feedback as possible over a shorter loop and minimize the long-loop feedback, if possible, avoiding any feedback right back to the input stage at all. It is better to take the feedback to a stage immediately following the input stage, so the first stage operates at maximum gain and gets the signal level above the inherent noise of tubes and other things, before we introduce any feedback.

This last remark applies especially to high-gain amplifiers or preamps which operate from low level inputs. Amplifiers designed to operate from high-level inputs are quite satisfactory with overall feedback, provided precautions are taken to minimize the possibility of conditional stability. END

Adding a simple guide to your turntable assures safe handling of delicate pickups

The Seeing-Eye Pickup

By ALBERT H. TAYLOR

MANY of us prefer manual changing for best reproduction with modern pickups but worry every time we try to plant that delicate, invisible point exactly on the edge of the record. With shaky hands or imperfect vision, the task becomes impossible. My father, at nearly 80, almost gave up his records after breaking a diamond. Our cure, which costs very little and can be adapted to any pickup and turntable, is to press the pickup against a guide while lowering it.

In the photograph guides have been fitted to a Western Electric 300-A reproducer panel. The original WE 5-A arm with 9-A head plays all old-style records with 2.5-mil tip radius. Its stand (just over the word OLD) has been relocated to guide the pickup onto the edge of 16-inch transcriptions. For 12-inch 2.5-mil records, the wooden gauge at the lower left marked OLD is slid to the right while bearing against the front cabinet wall, until it strikes the adjustable stop. Then it is locked in place with the wing nut. With the user's forearm resting on the edge of the cabinet and the pickup pressed against the guide arm, even shaky hands can set the point down gently in just the right place. (The panel is not in the cabinet in this picture.)

For 10-inch 2.5-mil records, wire extension A is swung into position against the brad stop B and the pickup pressed against its end in lowering.

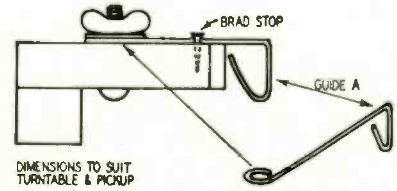

Fig. 1—Details of the guide for the Pickering arm.

The point of descent on 10-inch records is adjusted by bending A after the stop has been set for 12-inch records.

Of course I would need only another 9-A plug-in head with 1-mil diamond to play LP records with the same pickup and guide. I use a Pickering D-140-S cartridge in a Gray 108-C arm instead to avoid any chance of dropping heads and for the added safety of the viscous-damped arm.

The LP guide slides along the edge of a raised plate, hits adjustable stops at either end for 10- or 12-inch records, and is clamped by a wing nut (under the arm) which is not visible in the photo. I have no 7-inch (45-rpm) records, but for these I could easily add a mark or detent to fix an intermediate position. A further refinement might be a continuous cuing scale for setting the pickup on the record at any predetermined point—on the narrow silent bands separating different selections on some LP records. A mirror helps to observe the point in cleaning it or setting the stops. Of course either pickup is lifted over its guide to set it onto its stand, and only one would be used at a time, not both as shown.

Note that once the stops are set and guide A bent correctly, a blind person can shift the guides and play standard record sizes without difficulty. The viscous-damped arm is ideal for guided pickups. I simply adjust it to fall 1 inch per second, swing it against the guide and let go. Children could use it safely. If I could find a turnover cartridge for it, I would use it exclusively and discard the WE. I recommend one viscous-damped arm with turnover cartridge (if available) or two with fixed cartridges, with guides, for carefree record playing.

For children and unmechanical adults who would not remember to press a sliding guide against the cabinet wall or some other raised object while shifting it, the guide could slide *between two strips of molding*, but this would require a very good fit with no play. The present design is cheap and easily built, requiring only scraps of wood, small nails, screws, bolts, washers, wing nuts, a wire coathanger for the guides and the stops (Figs. 1 and 2), and tapped holes in the panel if it is not wood. Adjustments make all dimensions noncritical except the eye in guide A, which must fit the bolt accurately. Many other forms of guide are possible and you can probably improve upon this design for your own player. END

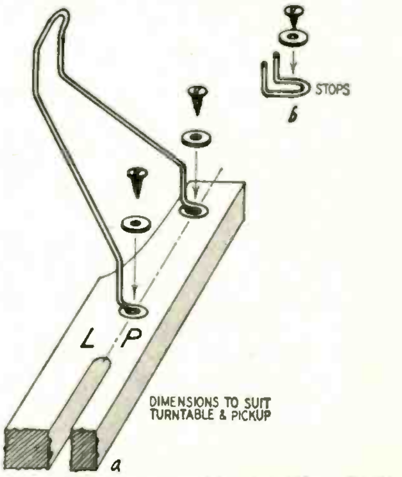

Fig. 2-a—The arm guide for the Gray arm: b—stop construction.

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FIVE NEW Transistor Checkers

Some of the leading commercial transistor testers and the circuits they use for leakage and gain tests

By JOHN T. FRYE

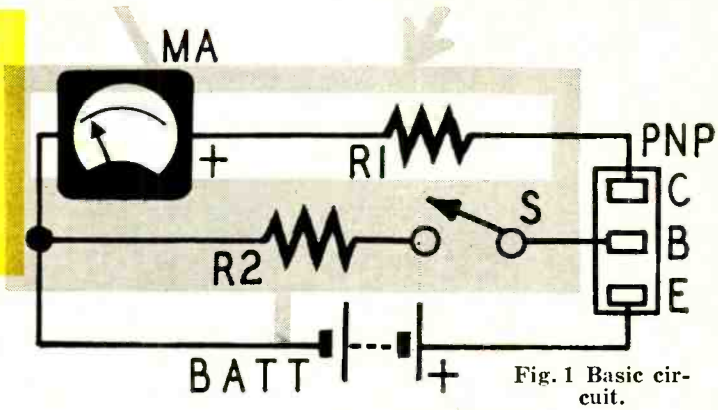

Fig. 1 Basic circuit.

A TRANSISTOR is much more a "black box" than a vacuum tube. You can usually tell *something* about a tube's condition. If it has a glass envelope, you can see if the heater is lit and may be able to detect the glow of unwanted gas. Even an opaque metal envelope will be noticeably warm to the touch if the heater is lit.

With a hermetically sealed transistor, however, the only way to discover anything about its condition is feeding various currents into it and measuring these currents and the changes in them as they come back out. Some sort of testing equipment is *absolutely necessary* to determine a transistor's quality.

Fortunately, a tester for the service technician does not have to reveal all there is to know about a transistor, any more than his tube tester has to be able to check interelectrode capacitances, conversion transconductance, etc. A laboratory transistor tester would probably yield information on the frequency response, input resistance, collector capacitance, collector cutoff current, alpha and beta of the unit being tested; but the technician can manage nicely if he can determine if the transistor is open or shorted, if its leakage current is excessive, and if the current gain is satisfactory.

All transistor testers shown and discussed in this article give this information. Some of them also check crystal diodes, and the selenium and copper-oxide rectifiers. It is interesting to note that all use the same basic method for checking leakage and gain, yet mechanical arrangement and circuitry vary widely.

Fig. 1 is a basic circuit for testing both leakage and gain of a p-n-p junction transistor. The negative terminal of a battery is connected to the transistor's collector through a milliammeter and current-limiting resistor R1. The positive battery terminal is connected to the emitter. With S as shown, the base is left open-circuited. Under these conditions, the meter indicates transistor leakage, which is approximately equal to the collector cutoff current (I_{CO}) times the base current gain, or beta, of the transistor.

With a good transistor, this leakage is in the order of microamperes. If the transistor is leaky, the reading will be much higher; and a shorted transistor will give a still higher reading.

When S is closed, a small bias current is inserted into the base through R2. If the transistor's gain is good, collector current will increase substantially. The ratio of collector-current increase to the base-current increase producing it is a measure of the transistor's beta, or current gain, in the grounded-emitter configuration. If no current flows, even when S is closed, the transistor is open.

Armed with this knowledge of fundamental circuitry, let us examine the commercial units available.

G-E tester

We can start with the G-E transistor tester whose circuit is shown in Fig. 2. This tester, which is intended to check all types of junction transistors for short circuits, opens, leakage and current gain, is sold along with five universal replacement transistors and a transistor-interchangeability chart. Transistors accompanying the tester received were: two 2N135, p-n-p, alloy-junction, rf–if–amplifier types; one 2N136, p-n-p, alloy-junction, rf–if–amplifier type; one 2N44, p-n-p, germanium-fused, intermediate-gain, low-to-medium-power type, and one 2N78, n-p-n, grown-junction, high-frequency type.

This tester is designed to let the busy service technician make a quick reliable test of a transistor, and manipulations are held to an absolute minimum. It is intended to be as near a go–no-go instrument as possible. On its face two transistor sockets, a pushbutton, and meter are mounted. The meter has two scales. The lower scale, used for determining leakage, is divided into a green GOOD section on the left, a yellow FAIR section in the center and a red POOR section on the right. The upper (gain) scale has 10 divisions.

To test a transistor, it is merely inserted in the proper socket. Leakage is indicated immediately. Then the button is depressed and any increase in meter deflection noted. An increase of at least one division on the gain scale indicates acceptable current gain. A shorted transistor is indicated by a full-scale meter reading in the leakage test. An open transistor is indicated by no meter deflection in both leakage and gain tests.

Comparing Fig. 2 with Fig. 1 reveals how closely the circuit of the G-E tester compares to that of the basic test circuit. When a transistor is in the p-n-p socket, the circuit is identical. The battery is a miniature 6-volt type, R1 of Fig. 1 becomes 560 ohms, R2 becomes 200,000 ohms, the meter is a 2.5-ma unit, and the pushbutton dpst switch does the job of S. When the transistor being tested is a n-p-n type, everything is the same except that the voltage on the collector is positive and negative on the emitter and the current introduced into the base for the gain test is from a positive source.

The unit even tests its own battery. As long as a 560-ohm resistor connected between the collector and emitter receptacles of either socket produces full-scale meter deflection, the battery is satisfactory.

Knight-Kit checker

Next let us examine the Knight transistor and diode checker sold by Allied Radio Corp. This tester comes in kit form and was easily assembled in about 1 hour. While its circuit (Fig. 3) is essentially the same as Fig. 1, there are some differences. The battery is a 22.5-volt hearing-aid type. The 10,000-ohm CALIBRATE potentiometer replaces R1 of Fig. 1. R2 becomes 220,000 ohms. The dpst spring-return LEAKAGE-GAIN switch takes the place of S. The meter has a 1-ma movement, but the CALIBRATE control acts as a variable shunt to change its sensitivity to accommodate a wide range of collector currents. The two sockets are wired so that properly polarized voltages are applied to the terminals of p-n-p and n-p-n transistors.

To check a transistor, it is placed in the proper socket and the LEAKAGE-GAIN switch held down to the GAIN position while the CALIBRATE control is adjusted to make the meter read 1 at full scale. Then this switch is released and leakage current observed. If leakage current is less than gain current, the transistor will amplify. The greater the difference between the two readings, the better the gain. As an example, a good CK722 with a gain reading of 1 gave a leakage reading of .05. A leaky CK722 that would still amplify a little had a leakage reading of 0.84. High leakage and gain currents indicate low

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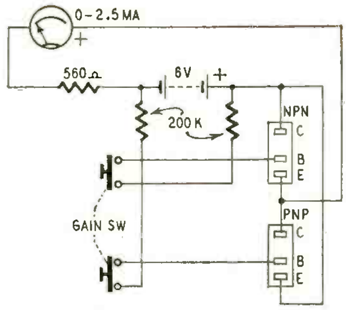


Fig. 2—General Electric transistor tester and its circuit. In some units the current-limiting resistor is 680 ohms and the meter has a 3-ma movement.

output impedance; low leakage and gain currents indicate high output impedance.

While the transistor is being tested for leakage, it can also be tested for noise. The leads of a pair of crystal phones (a pair of sensitive magnetic headphones with an .05-μf capacitor in series with one of the leads can be used) are plugged into the double phone jack to the right of the CALIBRATE control. A signal tracer or audio amplifier can be used in place of the headphones to hear the noise generated by the transistor.

The test leads furnished are plugged into the double phone jack to test selenium and copper-oxide rectifiers. The negative lead is connected to the positive terminal of the rectifier and the positive lead to the negative terminal to bias the rectifier in the forward direction. The CALIBRATE control is adjusted until the meter indicates 1. The leads are reversed and the reading noted. A good rectifier will give a very low reading. A multiple plate rectifier with at least a 20-to-1 front-to-back conduction ratio is considered good for this test.

To check the forward voltage drop, the two test leads are shorted together and the CALIBRATE control adjusted until the meter reads 1. The negative lead is connected to the positive terminal of the rectifier, and the positive lead to the negative terminal. Rectifiers rated at 65 ma or less should read at least 90% of full-scale deflection. Rectifiers of more than 65-ma rating should read at least 95% of full scale. Units reading lower than these figures have a high internal resistance and should be discarded.

Germanium and silicon diodes are tested in much the same way. The negative lead of the tester is connected to the cathode lead of the diode, and the negative tester lead is connected to the other diode terminal. The CALIBRATE control is adjusted until the meter reads 1. Then connections to the diode are reversed and the reading noted. Good general-purpose diodes will have at least a 50-to-1 front-to-back ratio. Video detector and other high-conduction diodes should display a minimum 10-to-1 ratio.

The Knight unit can be used as is to test most transistors, but *if surface-barrier transistors are to be checked, a 4.5-volt battery should be used in place of the 22.5-volt battery supplied.*

EMC model 210

The circuit of the Electronic Measurements Corp. model 210 transistor and crystal diode tester is shown in Fig. 4. There are several interesting changes from the basic circuit. An ON–OFF switch permits the battery voltage to be cut off while a transistor is being inserted in or removed from the test socket, to prevent any possibility of damage from surge currents. Only a single socket is used for testing both p-n-p and n-p-n transistors. A switch supplies properly polarized voltages to the socket for each type. No current-limiting resistor is used in series with the meter, but the meter has a resistance of about 2,000 ohms, so it does its own current limiting. The base is not left actually floating during the leakage test, but since it is returned to the emitter through a 51,000-ohm resistor, no potential exists between it and the emitter to cause current to flow through the emitter–base junction. So for all practical purposes the leakage test is the same as in Fig. 1. In addition to the conventional socket, color-coded leads are provided for connection to the terminals of a transistor.

The greatest difference lies in the method of checking gain. Instead of using a single resistor to insert a fixed amount of current into the base during the gain test, three different values of resistance are used to insert three different predictable amounts of current. Ohm's law will show that the 560,000-, 300,000- and 120,000-ohm resistors allow the 6-volt battery to deliver approximately 1/100, 1/50 and 1/20 ma, respectively, to the base.

Remember the beta gain figure of a transistor is equal to a change in collector current divided by the change in base current producing it. In formula form: $B = \frac{I_C2 - I_C1}{I_B2 - I_B1}$

In this instance I_B1 was zero, so the denominator is simply I_B2. Dividing by 1/100 is the same as multiplying by 100; dividing by 1/50 the same as multiplying by 50, etc. Therefore, to

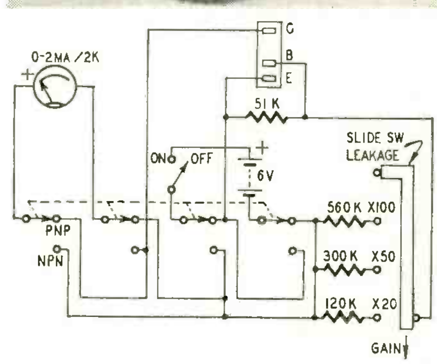
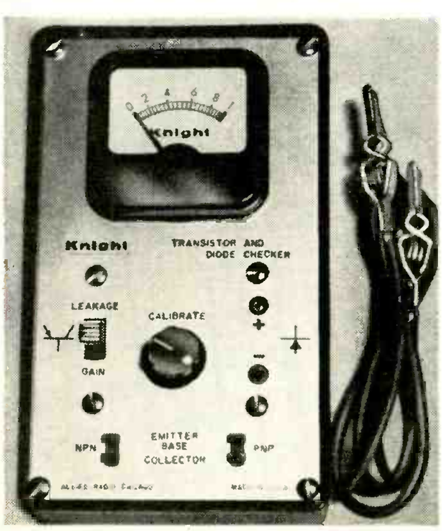


Fig. 4—EMC 210 checker uses a meter with 2,000-ohm resistance, does not need current-limiting resistor.



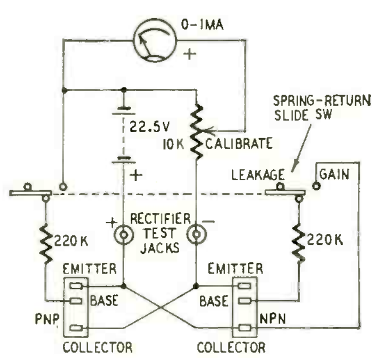


Fig. 3—The Knight-Kit transistor and diode checker uses a 22.5-volt battery.

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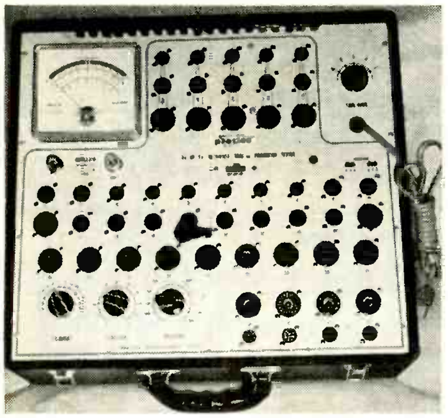

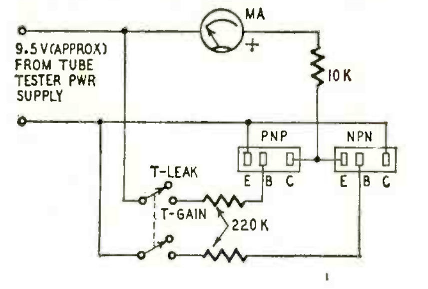

Fig. 5—The Precise model 116 tube and transistor tester and its transistor-checker circuit.

determine the transistor's beta gain, all we have to do is multiply the change in collector current in ma by the denominator of the particular fraction of a ma of base current producing it.

To check a transistor with the model 210, the transistor is inserted in the socket or the color-coded alligator clips are fastened to its leads. The PNP–NPN switch is placed in the proper position and the ON–OFF switch slid to ON. The leakage current is read on the meter scale. Next the LEAKAGE–GAIN switch is moved to the GAIN position that gives the best meter reading and the reading is observed. Finally the leakage reading is subtracted from the gain reading and the answer multiplied by the number at which the GAIN switch is resting. The answer is the grounded-emitter gain. If this figure is more than one-half the average beta gain figure shown in the table accompanying the tester, the transistor may be considered good.

In an actual test, a good CK722 read 0.1 on leakage and, with the GAIN switch in the $\times 20$ position, the reading was 1.3. $(1.3 - .1) \times 20$ gives 24, which is slightly better than the average gain figure of 22 given in the chart. A poor CK722 read 0.9 on leakage and 1.1 with the GAIN switch in the $\times 20$ position. This yields a gain figure of only 4, so the transistor is definitely inferior.

Crystal diodes are also checked with the model 210. The diode is inserted across the two outside points of the transistor socket. The slide switches are moved to LEAKAGE and ON positions. The selector switch is rotated between the PNP and NPN positions. If the diode is good, the meter will read well within the GOOD section of the lower scale in one position and go off scale in the other. If both readings are low or high, the diode is defective.

Beta, or the base-current amplification figure, can be taken from published data on new transistors to be tested. When this is not given, it can be calculated in accordance with information furnished with the tester.

Precise 116

Tube testers are coming out with facilities for testing transistors, too. One of these is the Precise model 116. The transistor-testing portion of the circuit is shown in Fig. 5. Outside of power being supplied from the tube tester's power supply instead of a battery, the circuit is that of our basic test circuit, with provision made for testing n-p-n as well as p-n-p transistors.

The transistor to be tested is inserted in the proper socket, the SELECTOR switch at the lower left is moved to the T-LEAK position and the leakage current is noted. Then the switch is turned to T-GAIN. The reading now should be at least four divisions higher on the 0–20 range of the GM scale than was the leakage reading. Shorted and open transistors will be revealed as in the G-E unit.

Sencore TDC22

The Sencore model TDC22 diagramed in Fig. 6 embraces still another approach to testing transistor gain, but a study of the circuit shows that, in spite of the rather involved switching arrangement, the leakage test is identical to that of Fig. 1. A 560-ohm current-limiting resistor is used in series with the 3-ma meter, and the 6-volt battery forces a reverse current through the collector–emitter leads of the transistor with the base floating. Since leakage current is a function of the gain of the transistor as well as the collector cutoff current, four different leakage scales are provided. Low leakage on scale A is 0–100 μa; on scale B, 0–200 μa; on scale C, 0–600 μa, and on scale D, 0–1,200 μa. The proper scale to use is indicated in the chart accompanying the tester.

A three-position PNP–DIODE–NPN switch permits proper polarity to be applied to the socket or the color-coded leads for testing either p-n-p or n-p-n transistors.

When the GAIN button is depressed, a selected amount of voltage of the proper polarity is applied to the 47,000-ohm resistor going to the base to produce a base current calculated to result in a 1.5-ma, mid-scale, collector-current reading on the meter at the rated current gain of the transistor. This voltage is selected by the 5,000-ohm GAIN SET potentiometer connected directly across the 6-volt battery. The amount of base current needed to make the meter in the collector circuit read 1.5 ma is roughly equal to 1.5/beta. Transistors with low beta need more base current to achieve the same collector current than do those with high beta. The chart accompanying the tester gives the proper position of the GAIN-SET control to achieve the right amount of base current for each transistor, and instructions are furnished for calculating settings for new transistors as they come out.

In testing diodes, the PNP–DIODE–NPN switch is set to DIODE. Then the red lead is connected to the plus lead of the crystal and the black lead to the other diode lead. A diode with good forward current conduction will show a reading to the right of the right-hand arrow below the transistor leakage scale. Now the GAIN button is depressed. This places a reverse voltage on the diode. The voltage divider, made up of the 1,000- and 1,800-ohm resistors across the battery, limits this reverse voltage to 2 volts so that uhf diodes can be checked. A good diode will be indicated by a reading to the left of the left-hand arrow below the transistor leakage scale.

In checking power transistors, advantage is taken of the fact that manufacturers report these can be tested by reading collector cutoff current directly. This is the current that flows through the collector–base junction with the emitter circuit open. The power transistor is located in the chart and the SELECTOR switch placed in the

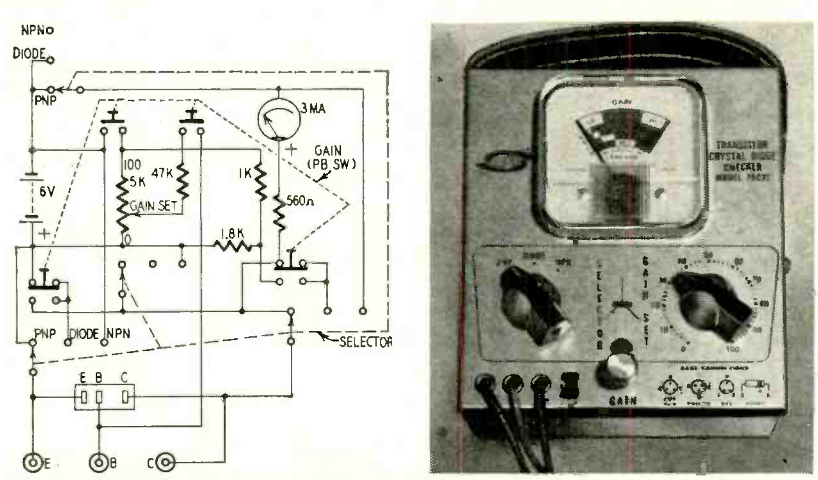

Fig. 6—The Sencore unit and its circuit for testing transistors and diodes.

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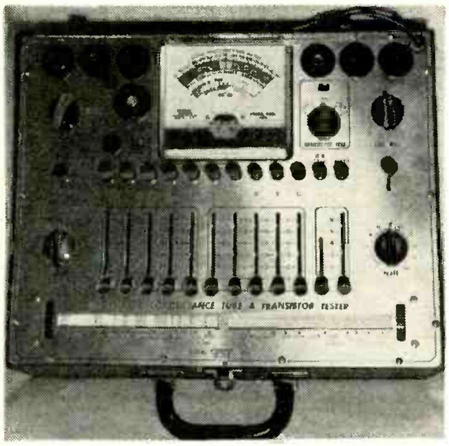

While a transistor is being tested for leakage in the transistor socket, it can also be checked for noise by clipping the red and black leads across a pair of crystal headphones, high-impedance magnetic headphones in series with a capacitor, or the input of an amplifier.

Eico 666

The Eico model 666 tube and tran-

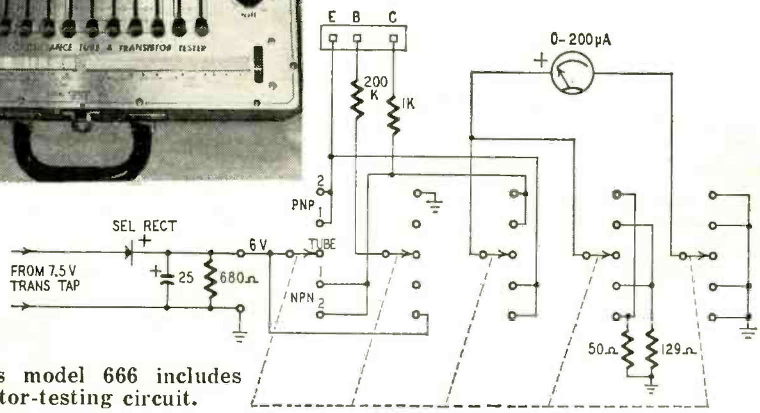

Fig. 7—Eico's model 666 includes a transistor-testing circuit.

indicated position. The red tester lead is connected to the collector and the black lead to the base. The yellow lead is left unconnected. Collector cutoff current is read directly from the meter on the particular LEAKAGE SCALE indicated on the chart. If the meter reading is not in the green area, the transistor should be rejected because I_{CO} is excessive. A shorted transistor will read all the way to the right; an open transistor will give no needle deflection.

sistor tester is another combination that permits testing transistors. The transistor portion of the tester is contained in the rectangle to the right of the meter. See photo. It consists of a five-position switch and a transistor socket. As shown in Fig. 7, power for testing is obtained from the 7.5-volt tap on the filament transformer. This voltage is rectified and filtered with the 25-µf capacitor to produce 6 volts of dc.

When the switch is in the center TUBE position, the transistor socket is de-energized and the meter disconnected from the circuit and made available for line adjustment and tube-testing functions. At the 1 position of either the PNP or NPN side, voltages of proper polarity are applied to the collector and emitter, the base circuit is opened, and the meter in series with a 1,000-ohm resistor reads the leakage current. It should read in the I_{CO} GOOD area of the meter between 0 and 40 on the 0–140 scale unless there is a note on the chart to the contrary.

Next the switch is turned to the 2 position on the same side and the beta read on the 0–140 scale. The chart that accompanies the tester indicates limits within which a good transistor should read. Finally the switch is returned to TUBE and the transistor removed.

In conclusion, I do not claim that this article covers all transistor testers on the market. Lack of space and the fact that new testers are being introduced weekly prevent this. However, an attempt has been made to cover rather thoroughly the circuits and operation of a representative group. I have used all the testers described. Many transistors of known quality, both good and bad, were run through all six checkers, and, when instructions were carefully followed, every tester easily sorted the good transistors from the bad.

A wide span of cost, complexity and versatility is represented by the testers reviewed. One of them should satisfy the needs of nearly every transistor worker and experimenter. END

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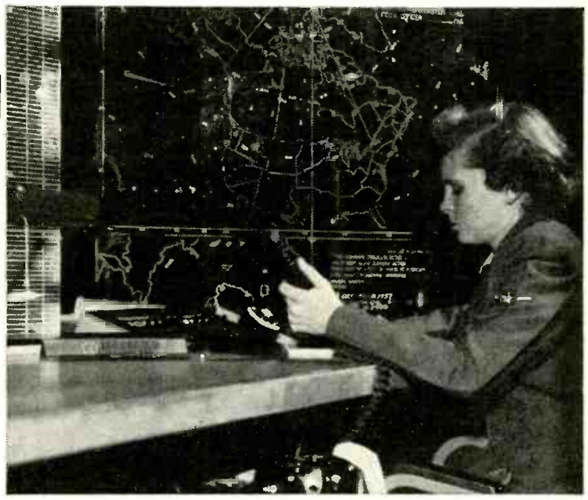
HEART OF NORTH AMERICAN AIR DEFENSE



Another view of A/3C Janet F. Streib at work in the North American Air Defense Combat Operations Center.

VIA the red phone and a choice of 176 communications facilities, any of the major air-defense commanders in the United States, Canada, Alaska and parts of the polar region can be reached instantly by the North American Air Defense Combat Operations Center in Colorado Springs, Colo.

The mission of the Combat Operations Center is to detect an air attack on the United States and to notify all military and civil-defense units. Its aim is to detect the development of an air raid as quickly as possible to give maximum warning time.

The heart of the center is the main plotting board, mounted on a 20 by 30-foot sheet of plexiglass. Etched on this board is an outline map of the United States, Canada, Alaska and the polar region. Tracks of all unidentified aircraft—reported by radar sites, picket ships and Ground Observer Corps Filter Centers—are plotted on the board by a battery of WAF's.

These WAF's work behind the board on three levels above the main floor. Writing backward, they do not block the tracks they plot from personnel analyzing the information shown. The board is visible to at least 50 operating personnel at all times. At the red phone is A/3C Janet F. Streib, aircraft control and warning operator.

A 600-mile maze of wiring within the center is required for direct communications with air-defense commanders and an extensive intercommunications system. Over 6 miles of teletype paper is used daily, indicative of the vast amount of information handled.

All voice communications between the center and other centers are automatically recorded, using 70,000 feet of recording tape per day. Any transmission can be located for playback in approximately 30 seconds. END

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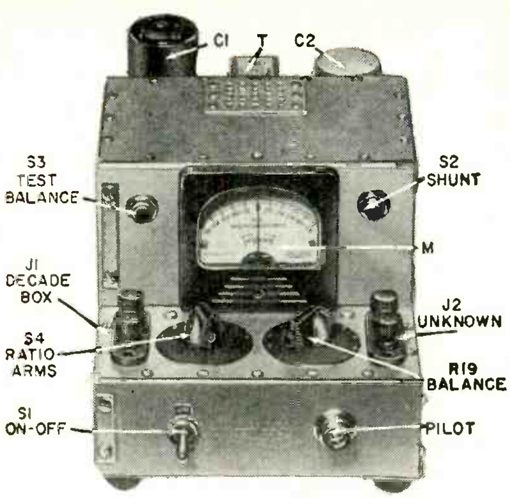


for the shop . . .

an AMPLIFIED WHEATSTONE BRIDGE

Precision bridge with built-in amplifier uses low-cost meter

By RONALD L. IVES

ALTHOUGH the general principles of the Wheatstone bridge have been known for more than a century, its use has been confined mostly to large laboratories, and shop measurements are made with the less expensive and less dependable ohmmeter. Chief obstacles to the wider use of the Wheatstone bridge are the high cost of the decade resistors used for comparison purposes and of the microampere-sensitive galvanometers customarily used as null detectors.

These obstacles have been eliminated by recent developments. Highly dependable decade resistance boxes are available in kit form at low cost and the combination of a relatively inexpensive meter with a difference amplifier provides null detection. If desired, transistor amplification can be applied to the meter and sensitivities greater than any normally useful value can be obtained.

The fundamental circuit and relationships in a standard Wheatstone bridge are shown in Fig. 1. Best overall utility is obtained when R1 and R2 are of about the same values as R3 and R4. The circuit of a modern improvement of this resistance comparator, using a difference amplifier, local power supply and medium sensitivity meter, is shown in Fig. 2. All components used are standard over-the-counter items, and construction is simple and straight-forward.

A standard SeeZak chassis, 6 x 10 x 2 inches, with a doghouse made from a 4 x 6 x 3-inch chassis, holds all the components. There's plenty of extra room and ample spacing for ventilation. A front view of the amplified Wheatstone bridge is shown in the photos. For operating convenience, the TEST BALANCE pushbutton is at the left of the meter and the BALANCE adjust-

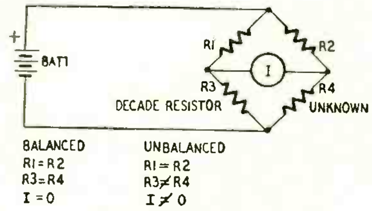
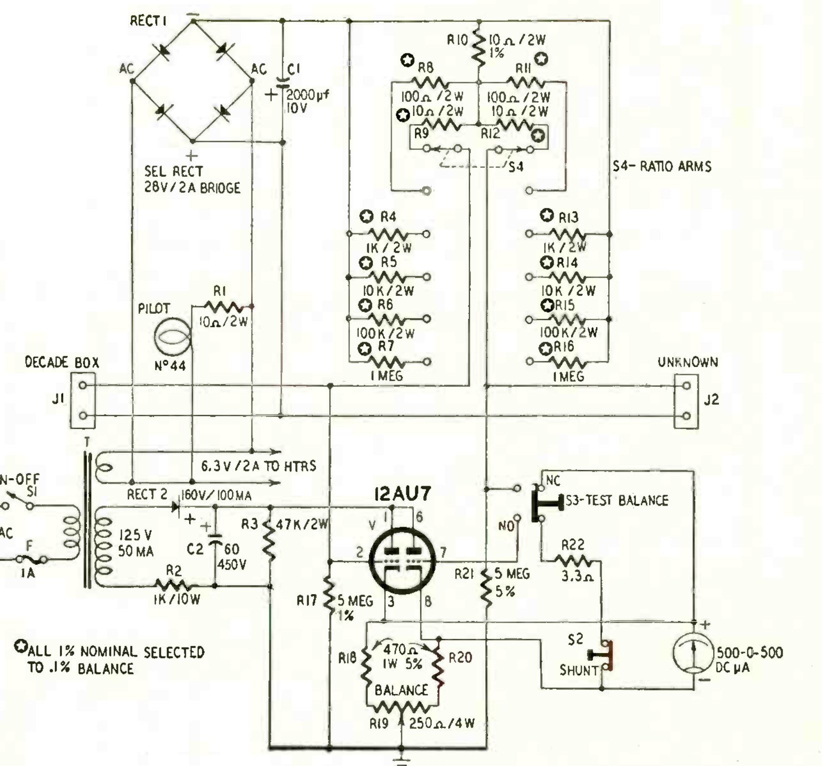


Fig. 1—Fundamental circuit and relations in a Wheatstone bridge.



R1—10 ohms, 2 watts
R2—1,000 ohms, 10 watts
R3—47,000 ohms, 2 watts
*R4, 13—1,000 ohms, 2 watts
*R5, 14—10,000 ohms, 2 watts
*R6, 15—100,000 ohms, 2 watts
*R7, 16—1 megohm, ½ watt
*R8, 11—100 ohms, 2 watts
*R9, 12—10 ohms, 2 watts
R10—10 ohms, 2 watts, 1%
*R17, 21—5 megohms, ½ watt
R18, 20—470 ohms, 1 watt, 5%
R19—pot, 250 ohms, 4 watts (Mallory M 250PK or equivalent)
R22—3.3 ohms, ½ watt
**1% precision resistors, matched to 0.1%*
All resistors 10% unless noted
C1—2,000 μf, 10 volts, electrolytic (Mallory HC1020 or equivalent)
C2—60 μf, 450 volts, electrolytic (dual 30-μf sections connected in parallel, Mallory FP 237 or equivalent)
F—1 amp
J1, 2—dual binding posts (Eby 21-R or equivalent)
M—500-0-500 μa dc meter (Triplett 327-T or equivalent)
RECT 1—selenium bridge rectifier, 28 volts, 2 amps
RECT 2—selenium rectifier, 160 volts, 100 ma
S1—spst toggle
S2—spst pushbutton, normally closed
S3—dpdt pushbutton momentary contact (Switchcraft FF type 1006 or equivalent)
S4—2-pole 6-position rotary
T—power transformer: primary, 117 volts; secondary, 125 volts, 50 ma; 6.3 volts 2 amps (Stancor PA8421 or equivalent)
V—12AU7
†SeeZak chassis, 6 x 10 x 2 inches
†SeeZak chassis, 6 4 x 3 inches
†SeeZak chassis, rail foot set, RF-1
†SeeZak mounting plate, MP-12
†*Available from parts distributors or U M & F Manufacturing Co., 10929 Vanowen St., N. Hollywood, Calif.*
Rubber feet (4)
Dial plate, 30° between markings, 1–6 (Mallory 376 or equivalent)
Dial plate, 30° between markings, 1–10 (Mallory 380 or equivalent)
Pilot-light socket with ⅝-inch jewel, single-contact bayonet base
Socket, 9-pin miniature, with shield
Ac plug, chassis mount, male (Amphenol 61–M10 or equivalent)
Capacitor socket (Cinch-Jones 2C7 or equivalent)
Knobs
Spaghetti
Miscellaneous hardware

Fig. 2—Circuit of the amplified Wheatstone bridge.

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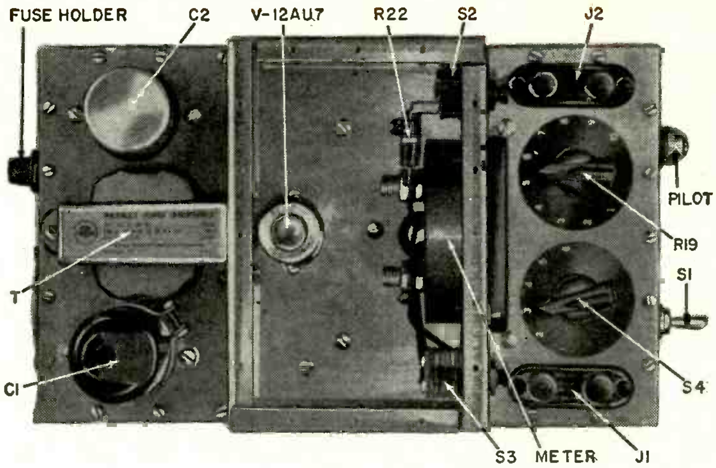
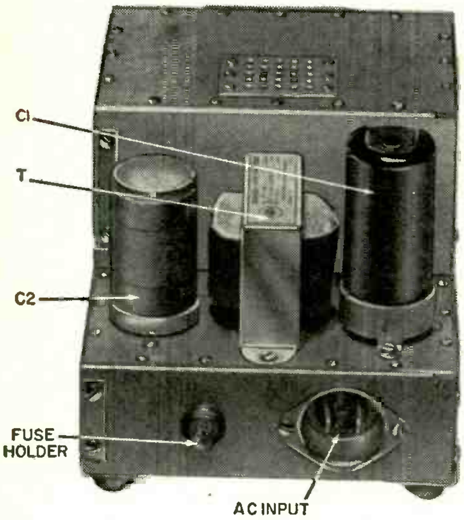
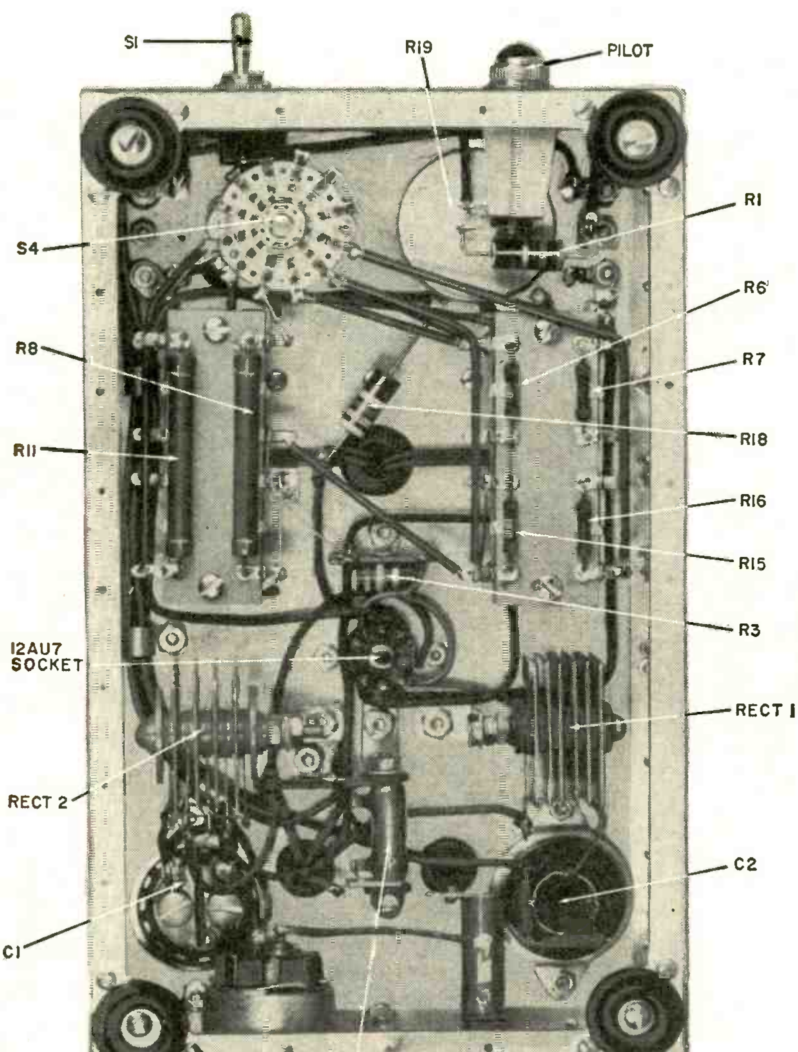
A look inside the doghouse.





The ac input and fuse are located on the back of the chassis.



Under the chassis. Note the careful arrangement.

ment knob at the right front. This arrangement can be reversed, if desired, to suit other operating practices.

Power supply

Power supply components, except for the selenium rectifiers, are mounted at the rear of the chassis behind the doghouse. The main high-voltage filter capacitor is mounted in a Cinch socket to make replacement easy. Power input is an Amphenol male plug, recessed into the rear apron of the chassis along with the fuse.

The doghouse supports the meter—a 500–0–500-μa unit—and the control buttons and houses the amplifier tube, a 12AU7, which is bolted to the main chassis approximately 2¾ inches from the front. The rear of this enclosure must be cut out in the center to clear the mounting lip of the power transformer. To supply ventilation, a small louver, made from a SeeZak mounting plate with holes enlarged and lightly countersunk to remove burrs, is bolted over a hole in the center rear of the cover (see front-view photo). This louver, plus the large grommet hole under the meter, provides adequate ventilation.

In the assembly of the chassis and related components, it is advisable to drill out the corner bosses, replacing them with 6-32 screws held by nuts on the inside, and to discard the sheet-metal screws supplied, replacing them with 4-40 binding-head screws, tapped into the chassis rails. The doghouse is held to the main chassis with 4-40 screws (with the nuts inside the chassis). Standard SeeZak rail foot brackets are mounted at each corner of the chassis, but large rubber feet are bolted to them in place of the small snap-in feet supplied.

Construction is easiest if all parts on the front and rear skirts of the chassis are mounted first, followed by those at the top rear. Next, the doghouse is fitted in place, the tube socket mounted and then the components at top front of chassis.

Most of the connections can now be made (omitting only the ratio-arm resistors and their mountings) and the

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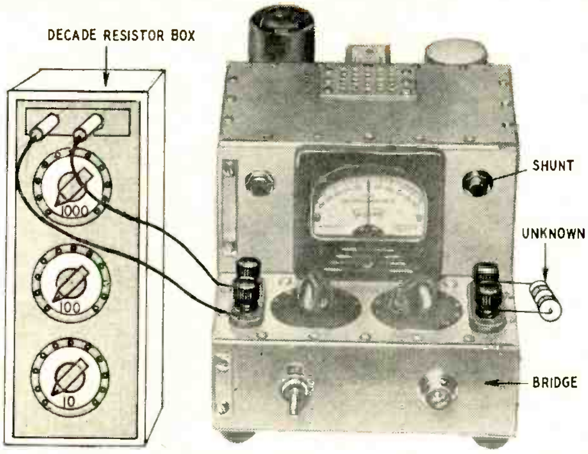

Fig. 3—Setup for determining an unknown resistance.

power supply circuits fully tested.

Precision resistors used are ½ watt for the high values (5 meg and 1 meg) and 2 watts for all other values. These were matched to 0.1% with a laboratory ohmmeter, which indicates "same or different" to high precision but may be a bit off as to the exact resistance value. As equality of the ratio arms is important here and exact resistance value is not, this method is permissible and useful. When soldering the precision resistors in place, apply only the *minimum amount* of heat. Long-nose pliers on the resistor's lead between the soldered joint and the resistor act as a heat sink. Excessive heat will change the value of these resistors permanently.

Precision resistors are mounted on terminal plates (J. W. Miller) held to (and separated from) the chassis by spacers. Mounting is shown in the chassis bottom-view photo. The plates here are shown double-decked. Power wiring is with standard insulated hookup wire. Bare wire is used elsewhere, covered with sleeving where insulation is desirable.

Testing and balancing

When wiring is completed, put the 12AU7 tube in the socket, place a tube shield over it and screw the top onto the doghouse. The instrument is now ready for testing and preliminary balancing.

First let it warm up for a few minutes. Then turn the BALANCE control until the meter pointer is centered, press the test BALANCE button and repeat the process. If the meter pointer cannot be centered, check wiring for an open circuit, then check the tube for severe unbalance (not a common trouble).

With both sets of terminals shorted, check balance at each position of the RATIO ARMS switch. Balance should be maintained throughout. If one or more ranges show severe unbalance, look for an open circuit. If the unbalance is slight, check the values of the ratio-arm resistors again.

When all ranges are balanced, check polarities of controls. While the bridge will work equally well electrically regardless of the action of the controls, systematic polarization will make operation simpler. While there are two schools of thought regarding logical polarization of controls, it is usually desirable to polarize them so that turning the controls clockwise moves the instrument pointer in the same direction. This may require reversing the leads to one or more symmetrical components: the meter, balancing potentiometer or terminals for the decade resistor.

With component polarity arranged to suit your own taste and operating habits, the instrument is ready for use. Connections of the amplifier Wheatstone bridge, a decade resistor and an unknown resistor are outlined in Fig. 3.

With these connections, set the ratio arms at about mid-value, such as point 4 on the dial (10,000 or 10^4 ohms), and adjust the decade resistance box until the instrument pointer is at center scale. The indicated resistance on the decade box will now show the *approximate* value of the unknown. Reset the ratio arms to approximately this value, reset the decade resistor until balance is again obtained, then press the SHUNT button and make minor readjustments of the decade box until balance is again obtained. The setting of the decade box which balances the instrument with the SHUNT button depressed is the value of the unknown resistor within the accuracy limits of the instrument and decade box (better than 1%).

To match resistors, a procedure becoming increasingly necessary in electronics, place one resistor across the UNKNOWN terminals and the second across the DECADE BOX terminals. If no great unbalance is indicated, press the SHUNT button for a close determination. With the component polarization outlined above, the instrument pointer always leans toward the lower of the two resistance values. Obviously, if a number of resistors are compared to a standard and two of them give the same deviation in the same direction, they are of equal value and will match if they are tested on opposite sides of the bridge.

The life of this precision unit is long. Care during construction will insure troublefree operation. END

50th ANNIVERSARY

1908 APRIL 1958

50 YEARS OF ELECTRONICS PUBLISHING

In April, 1908, Hugo Gernsback brought out *Modern Electrics,* the first popular radio publication in the world. The April, 1958, issue of RADIO-ELECTRONICS, its direct descendant, still under the guiding hand of Hugo Gernsback, will celebrate that event with unique and unforgettable bits of electronic memorabilia. Old-timer and young'un alike will glory in tracing electronic progress from the spark coil to stereo, from the coherer to the transistor.

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MASTER CONTROL UNIT for AUDIO TESTS

The fourth part of a series on audio testing, this article describes a control unit that facilitates audio tests, and a high-pass filter used in making IM distortion measurements

By Dr. L. B. HEDGE

As I have said in earlier articles[1, 2, 3] of this series, basic audio-frequency amplifier tests (gain, frequency response, output power and harmonic distortion) require an audio vtvm, an audio-frequency oscillator and a distortion analyzer. Adding a network to mix a 60-cycle signal (power-line transformer output) with the af oscillator's output to the amplifier input permits determining IM distortion with an oscilloscope[4] and the analyzer or a simple high-pass filter.

Connecting the components to provide the test layouts of Fig. 1—with enough shielding to prevent spurious hum pickup and feedback effects—is complicated and time-consuming. If the amplifier under test is to be modified or if effects of variations in applied voltages, feedback factors, circuitry and other variables are to be checked, setting up the various tests and changing from one to another add to the testing time.

While working on a recent development,[5] I found this part of the testing operation getting out of hand, so took time out to design and build the master control unit shown in Fig. 2 and the photos. Its usefulness was established the first day I used it and I now consider it indispensable.

The unit provides connections for: audio oscillator output, 60-cycle ac (transformer) output, ac vtvm input, analyzer input and output, electronic switch input (two channels) and output, oscilloscope (vertical) input, speaker (external amplifier load) input, and amplifier input and output.

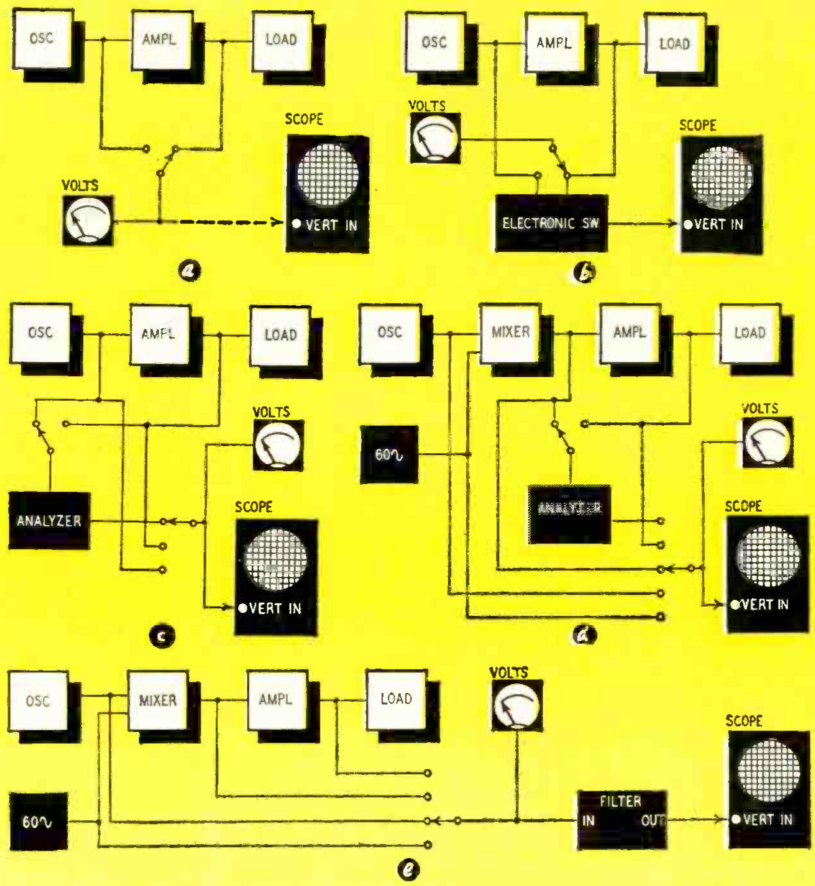

Fig. 1–a—Basic test setup for gain, frequency response and output power checks; b—electronic switch and scope added to the basic setup; c—analyzer provides accurate harmonic-distortion measurements; d—adding a 60-cycle source and mixer prepares for IM distortion tests; e—a switchable high-pass filter in the scope input circuit provides an alternative IM analysis setup.

Internal functions of the unit provide: mixing of 60-cycle (low-frequency) and audio-frequency oscillator (high-frequency) signals for intermodulation tests, adjustment of 60-cycle (low-frequency) voltage input to mixer, adjustment of mixer output

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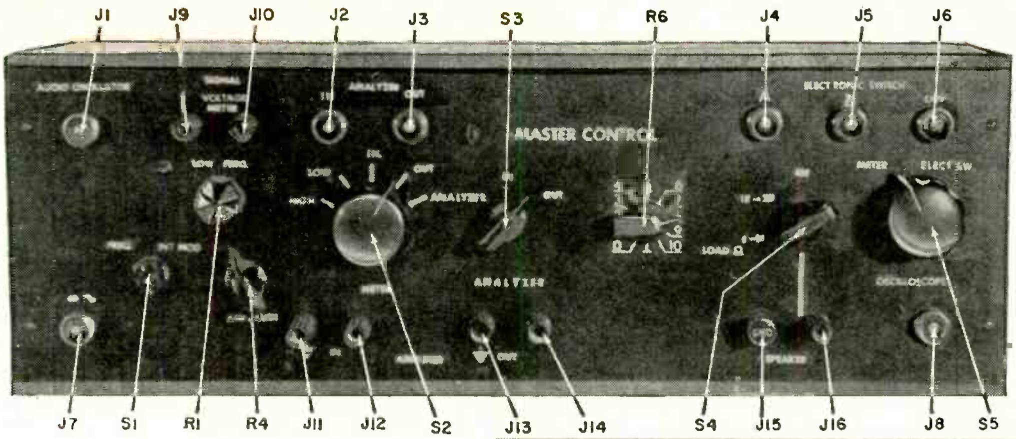
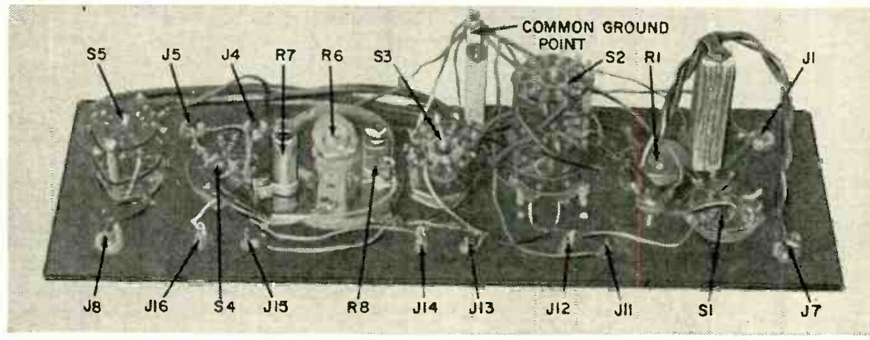
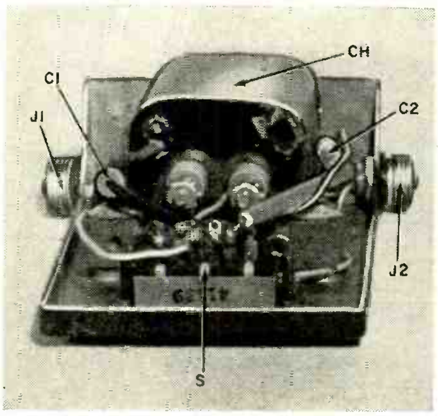


Front panel of the master control unit.

A maze of switches fills the control unit's interior.



Six components form a high-pass filter.



R1, 4—pot, 10,000 ohms
R2, 3, 5—10,000 ohms, ½ watt
R6—rheostat, 10 ohms, 3.16 amps
R7—10 ohms, 20 watts
R8—600 ohms, 20 watts
J1-8—coaxial connectors (male, panel-mounting)
J9-16—binding posts
S1—2-pole 2-position 1-deck rotary
S2—3-pole 5-position 3-deck rotary
S3—3-pole 2-position 2-deck rotary
S4—1-pole 4-position 1-deck rotary
S5—4-pole 2-position 2-deck rotary
Panel, ⅛ x 5½ x 18 inches, Masonite
Cabinet, 4½ x 6 x 18 inches
Miscellaneous hardware

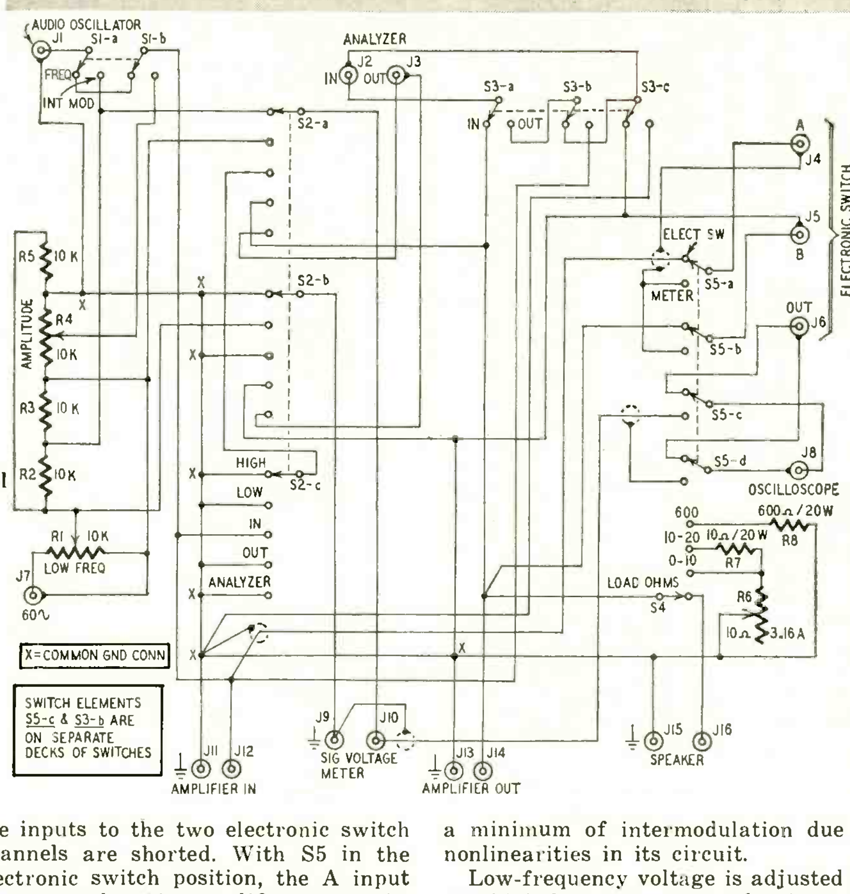


Fig. 2—Circuit of the master control unit.

voltage, and adjustment of resistive load for amplifier output.

Switch S1 connects the amplifier input to the output of the IM signal mixer or the output of the audio oscillator.

Switch S2 connects the audio vtvm across the 60-cycle (low-frequency) input to the IM signal mixer or the audio oscillator (high-frequency) input to the IM signal mixer or the amplifier input.

Switch S3 connects the analyzer input to the amplifier input or output.

Switch S4 connects the amplifier output to either a 600-ohm resistive load, a 10–20-ohm variable resistive load, a 0–10-ohm variable resistive load or to speaker (external load) terminals.

Switch S5 connects the oscilloscope's (vertical) input to the ac vtvm input connections or to the electronic switch output.

With S5 in the voltmeter position, the inputs to the two electronic switch channels are shorted. With S5 in the electronic switch position, the A input is connected to the amplifier input, the B input is connected to the amplifier output and the electronic switch output is connected to the oscilloscope.

The functions of the IM signal mixer are made possible by the elements shown in Fig. 3. This bridge type mixing network effectively isolates the low-frequency (audio oscillator) input. At the same time, the network introduces a minimum of intermodulation due to nonlinearities in its circuit.

Low-frequency voltage is adjusted by R1; high-frequency voltage by the audio oscillator's output control. R4 regulates the mixed signal voltage applied to the amplifier under test. The mixer bridge maintains the ratio of low- to high-frequency voltages between input and output, and is arranged to provide one grounded lead to the audio oscillator output and the amplifier input. The low-frequency (60-cycle) supply must

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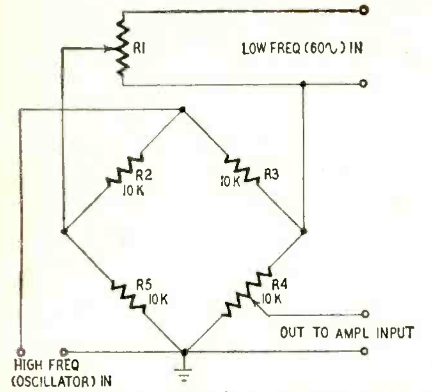


Fig. 3—Intermodulation signal mixer bridge.

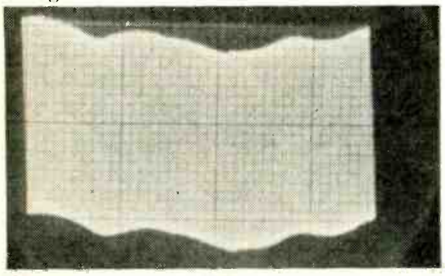
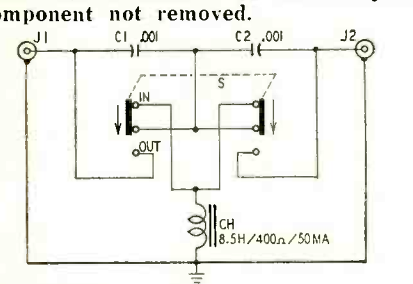


Fig. 4—Analyzer IM output scope pattern with harmonics of the 60-cycle component not removed.



C1, 2—.001 μf
CH—8.5 h, 400 ohms, 50 ma (surplus unit—similar to Stancor C1279 which has same ratings)
J1, 2—coaxial connectors (male, panel-mounting)
S—dpdt slide switch
Case, surplus BC 1366 jack box or equivalent
Miscellaneous hardware

Fig. 5—Circuit of high-pass filter.

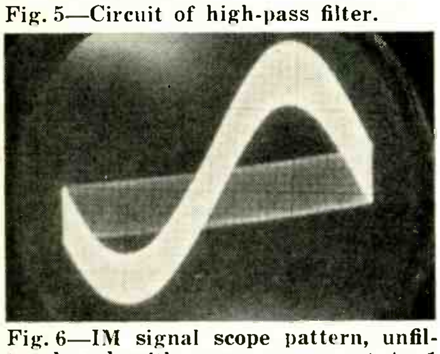


Fig. 6—IM signal scope pattern, unfiltered and with scope sweep set to 1 cycle of the low-frequency (60-cycle) signal.

be isolated from ground—conveniently done by using a transformer for this supply[2].

Using the control unit

The apparent complexities of wiring and switching connections shown in Fig. 2 are necessary for satisfactory performance of the master control unit—the extra switch decks and the grounding of interconnecting leads when not active in the circuit insure a minimum of stray couplings. Without these isolation features—including ground-lead connections carefully laid out to eliminate ground-loop couplings—testing preamps and other high-gain amplifiers with high input and output impedances may easily be complicated by oscillation caused by feedback induced by the test circuitry. Shielded-cable connectors are provided as shown for use with shielded connectors to the audio oscillator, 60-cycle supply, analyzer input and output, electronic switch inputs and output, and the oscilloscope input. Binding posts are provided for the voltmeter, amplifier input and output, and the speaker or other external load. This distribution of terminals is not critical but does contribute to the overall flexibility of the whole setup and makes inadvertent disconnection of major elements unlikely.

Test procedures for gain, frequency response, power output and harmonic distortion tests have been outlined in previous articles of this series[1, 2, 3]. With each of these tests the control unit provides all necessary switching (with S1 in the frequency position) and also provides a resistive load that can be adjusted to most conventional output impedances. Amplifiers designed to operate into a high-impedance load may be tested with a resistance of the proper value and power rating connected across the speaker terminals of the control unit. Power amplifiers may be tested with a speaker connected, providing a comparison of the actual as-used performance of the amplifier with its performance with an as-designed resistive load.

Intermodulation measurements can be made on an oscilloscope with the analyzer or high-pass filter between the signal source (amplifier input or output) and the scope (Figs. 1-d and 1-e). The analyzer and filter serve the same purpose in these setups—to remove the low-frequency component of the mixed signal, permitting measurement of amplitude variations (modulation) of the high-frequency component. If the 60-cycle (low-frequency) signal is a pure sine wave, both will function similarly in this capacity. But if the 60-cycle signal has a noticeable harmonic content (2% to 5% is not uncommon in power-line waveforms), the analyzer will remove the 60-cycle signal but will leave the harmonics of this signal mixed with the high-frequency signal (Fig. 4). The high-pass filter shown in Fig. 5 is simple and effective. Although not designed to provide impedance match with its input and output, it consequently has a variable insertion loss. It reduces the 60-cycle signal by a factor of several hundred, and harmonics through the fifth (300 cycles) by factors well over 60. Use of the high-pass filter is recommended. However, the analyzer can be used as indicated in the following test analysis.

IM test

IM measurements are made with S1 in the IM position, the audio oscillator set for 1,000 cycles or above (normal IM ratings are made with a 2,000-cycle high-frequency signal component) and with the low-frequency (60-cycle) signal input voltage to the mixer four times that of the high-frequency (oscillator) signal. Since the mixed IM signal results in higher

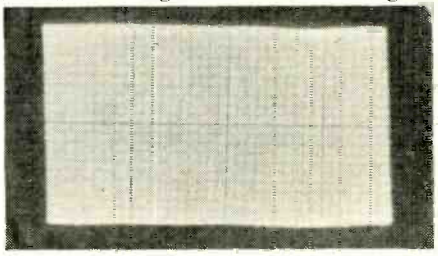


Fig. 7—Scope image of filtered IM signal, no intermodulation or low-frequency harmonics present.

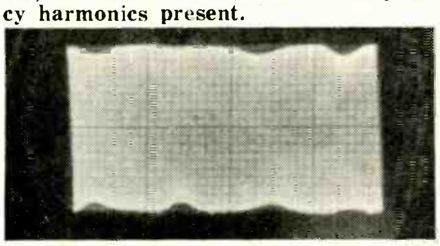


Fig. 8—Filtered IM signal with intermodulation notches, but without low-frequency harmonics.

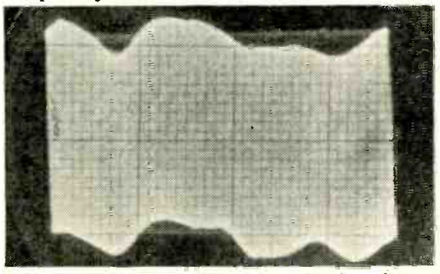
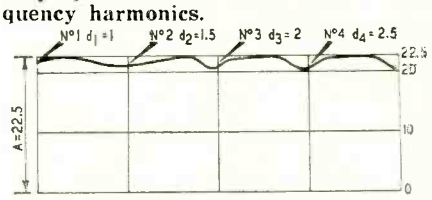


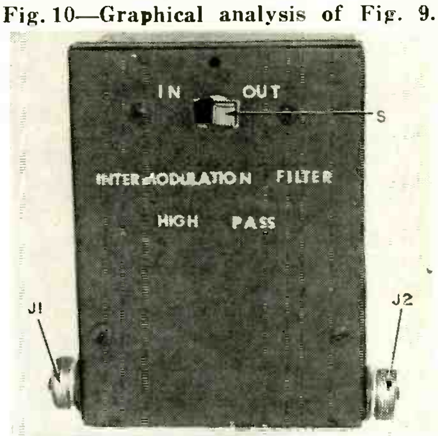
Fig. 9—Filtered IM signal (analyzer output) with IM notches and low-frequency harmonics.



$$\frac{d_1+d_2+d_3+d_4}{A} = \frac{1+1.5+2+2.5}{22.5} = \frac{7}{22.5} = .311$$

40 X .311 = 12.44 = % IM DISTORTION

Fig. 10—Graphical analysis of Fig. 9.



The completed filter can be switched in and out.

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peak voltages than single-frequency test signals of the same indicated voltage, the equivalent power output for the IM test is computed for the 4-to-1 input signal voltage ratio as 25/17 times the corresponding single-frequency power output. Thus, if E is the meter voltage across load resistance R for the mixed signal output,

Equivalent power output =

$$\frac{E^2}{R} \times \frac{25}{17} = \frac{(5E)^2}{17R}$$

With the IM signal applied to the oscilloscope and the filter out, sweep and sync controls are set to show 1 cycle of the 60-cycle component (Fig. 6). The filter is then switched in and the envelope of the high-frequency signal adjusted by the scope's amplitude control to provide a large and even value of the peak-to-peak amplitude of the envelope on the scope scale. If no low-frequency harmonic or intermodulation distortion is present, the envelope will be rectangular (Fig. 7). Intermodulation appears as notches on one or both edges of the pattern (Fig. 8). Harmonic mixture appears as deflections of the envelope (Fig. 4), and IM with harmonic mixture will provide a pattern showing both notches and deflections (Fig. 9).

C. J. LeBel[4] has developed a method for evaluating the filtered oscilloscope pattern to provide an accurate figure for percentage of IM distortion represented in the pattern. The procedure indicated here is based on LeBel's method with slight modifications and provides evaluation of comparable accuracy over the useful range of these measurements.

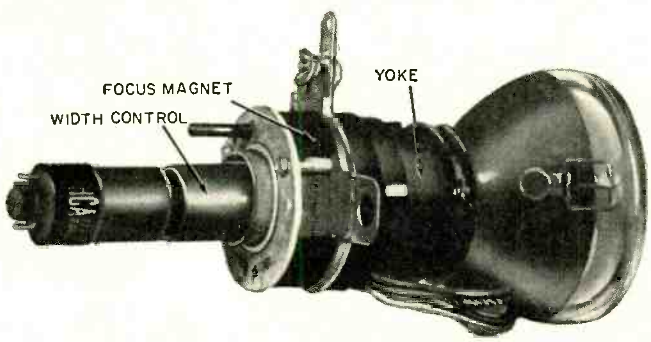
With a pattern of the unmixed type (Fig. 8) the depth of each notch, in either or both top and bottom edges of the envelope, is measured, the sum of the notch depths is divided by the peak-to-peak amplitude of the envelope, and the quotient multiplied by 40. If the result is 20 or less, this is the percentage of IM distortion. If the result is over 20 and not greater than 35, the intermodulation percentage is 20 plus 4/3 of the amount the first computation exceeds 20. If the first computation is over 35, the intermodulation is greater than 40%, and its exact value is of little significance in quality testing—40% intermodulation distortion is very poor quality.

A pattern containing harmonic-mixed and IM-notch effects (Fig. 9) is most effectively evaluated by plotting the bottom-to-top amplitude of the pattern on a piece of paper (Fig. 10) and using the notches which appear in this plot for computation. This plotting procedure can be used with either type of pattern—it provides a plot of the envelope with the bottom side straightened and all notches transferred to the top side, and with mixed harmonics it removes from the plot those variations in the upper and lower contours which are identical and make no changes in the envelope amplitude.

The electronic switch will be covered next and an oscilloscope will follow. The control unit has been covered at this stage because its functions are of primary importance in making distortion tests. The oscilloscope and the electronic switch are, however, elements of vital importance in an effective af test setup and their applications will be thoroughly covered later in the series. END

[1] "Build This Amplifier-Rectifier Vtvm for Audio Testing," RADIO-ELECTRONICS, October, 1957.
[2] "Extended-Range Audio Oscillator," RADIO-ELECTRONICS, December, 1957.
[3] "Wien-Bridge Analyzer," RADIO-ELECTRONICS, January, 1958.
[4] C. J. LeBel, "A New Method of Measuring and Analyzing Intermodulation," *Audio Engineering*, July, 1951.

Economy TEST TUBE



By DANIEL MEYER

MANY TV technicians have wished while working on a vertical chassis set, for a small test picture tube. Checking components in one of these sets, with a whole inch or two to work in and with a high-voltage lead brushing your wrist, is just a little too much for the nerves to stand.

One day, while looking into this situation, I noticed in a magazine ad a surplus radar tube called a 5FP7. This tube is a 53° type with magnetic focus and deflection and a long-persistence phosphor. It also is fitted with an octal socket instead of the 12-pin type commonly used on larger tubes. And it cost only $1.79.

The big question was the high voltage. The *Radio Amateur's Handbook* gives an operating voltage of 7,000 volts, but no maximum rating.

Just to play safe, when working on sets with very high second-anode voltages, I put a series resistor in the high-voltage lead to lower the voltage at the tube enough to stop any tendency to arcing. A suitable resistor can be made by soldering five 4.7-megohm resistors in series and covering them with plastic tubing. The resistors should be at least 1-watt units and enclosed in the plastic tubing for safety. Be sure to use high-voltage types. The resistor is connected to the second anode button on one end and to the high-voltage lead on the other. (To avoid any possibility of X-ray radiation keep the anode voltage below 8,000 volts.—*Editor*.)

The 5FP7's base can be converted by removing the base from a dud picture tube or buying one and putting it over the end of the original eight-pin base. To do this drill a hole in the end of the alignment pin on the 12-pin base big enough to pass a 6-32 bolt. Then drill a hole slightly smaller than the bolt in the end of the eight-pin base on the tube. This hole *must* be drilled *slowly and very carefully* so the drill does not go too deep and break off the tip of the tube. When this is done, solder insulated leads between the pins of the corresponding tube elements in each socket. These leads should be from 1–1½ inches long. The pins that should be connected together are listed in Table I. Screw the bolt into the end of the socket to hold the new 12-pin socket firmly in place. Use care, so as not to break the pin on the inside base. Heating the bolt with a soldering gun may help to get it threaded into place if the hole seems a little small.

TABLE I

Socket	Pin numbers					
8-pin	2	3	5	7	8	NC
12-pin	1	10	2	11	12	6

There is oversweep when this tube is used with most sets, so I borrowed a trick from some of the newer TV sets to make it possible to see the edges of the raster when using this small tube. Glue a piece of aluminum foil (borrowed from your wife) to a piece of light cardboard, leaving the aluminum about ¼ inch shy on all edges. The cardboard should be about 5 x 5 inches. When this is dry, wrap it around the neck of the tube with the foil on the inside and glue the edge. Leave it loose enough so it will slide up and down the neck of the tube. This sliding tube acts as a width control. If the picture is too wide, simply slide the tube under the yoke until the picture is the desired size.

I focus my tube with a spare PM type focusing device. It not only focuses the tube but also helps hold it in place. If you do not have a spare PM focus unit, one can be bought for less than $2.

To use this tube, simply slip it into the yoke, hook up the high voltage, put the PM focus unit behind the yoke, connect the tube and you are ready. It does not require an ion trap. END

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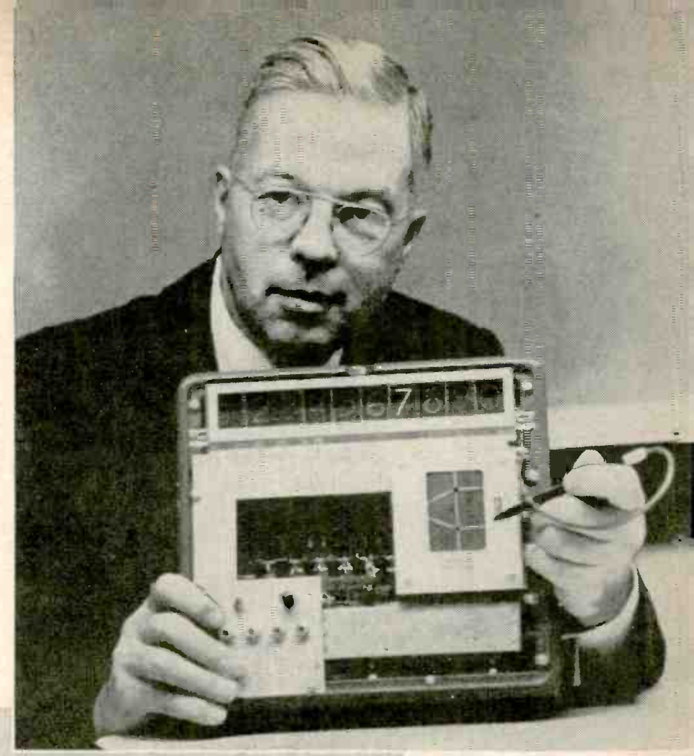
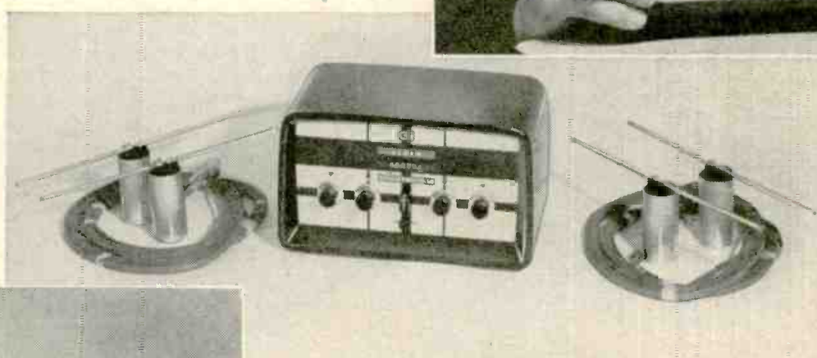
what's new?

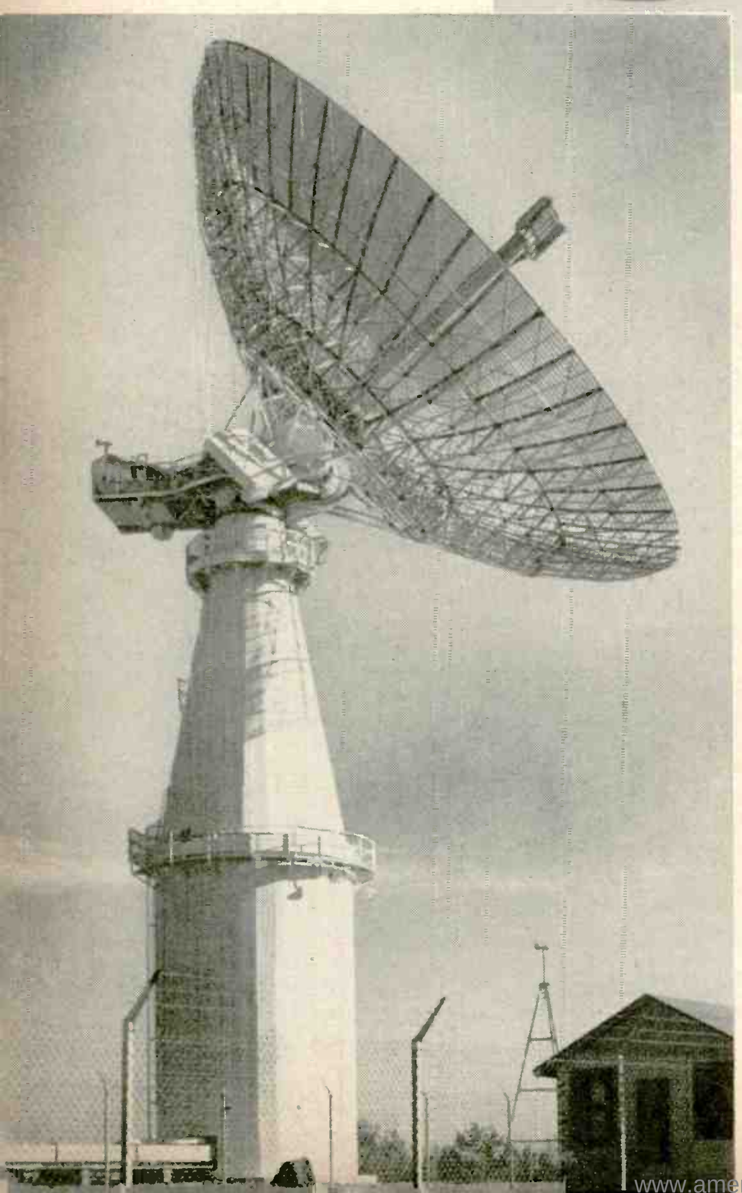
A DEVICE THAT READS handwritten numbers is held by its inventor, Tom L. Diamond of Bell Telephone Laboratories. About the size of a portable typewriter, this experimental electronic unit recognizes numerals as they are written on the special writing plate on the right. Considerable latitude in styles of handwriting is permitted, though the numbers must be formed around the two vertically spaced dots on the writing plate. The computer is then informed as to which of the lines radiating from the dots has been crossed, and from that information identifies the digit. It will also read numbers after they have been written with a special conductive pencil.



MOVEMENT OF ANY KIND triggers this combination alarm and control center. The unit generates an rf, continuous-wave signal in a figure-8 (dipole) pattern. When any mass moves in the antenna's field, a change of voltage in the circuit triggers a relay operating an alarm or other device.

The operation of the Electro-Sentry, made by Gulton Industries Inc., Metuchen, N. J., is in some ways similar to a Doppler radar effect. Its frequency is above 200 mc and output power is within FCC specifications.





LONG - RANGE RADAR antenna system probes the sky. The radar is operated by the Lincoln Laboratory of the Massachusetts Institute of Technology under a research contract for the Army, Navy and Air Force. Designed as a research tool, it has been used for detecting the Russian satellites, helping to pinpoint their position. Transmitting power is supplied by 11-foot-tall, high-power klystron tubes.

The high degree of precision required by the radar made it necessary to position the antenna with such accuracy that the minute bending of the antenna tower caused by uneven heating by the sun could not be tolerated. This bending was minimized by painting the surface of the tower white to secure maximum reflectivity of the sun's rays.

RUGGED TAPE RECORDER, similar to the one shown, recently survived a 12,000-foot drop into the ocean. The recorder, developed by the Ampex Corp. for General Electric, is designed for use in the Atlas intercontinental ballistics missile. The men holding a conference over it are Ralph Whitaker (left) and John Tipp, Ampex engineers.

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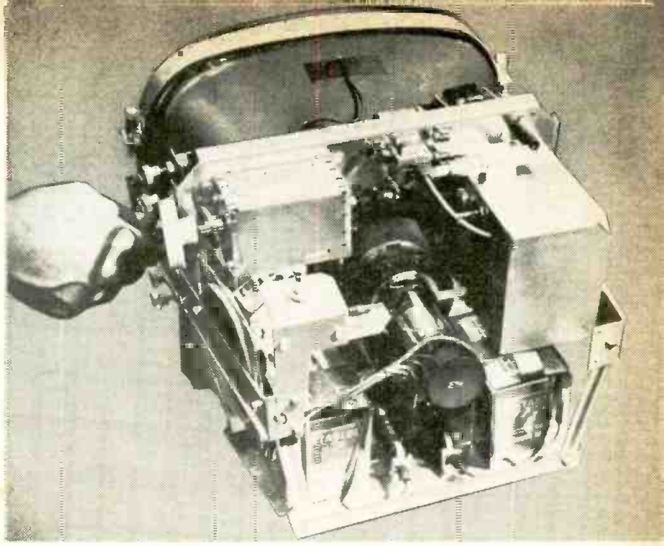
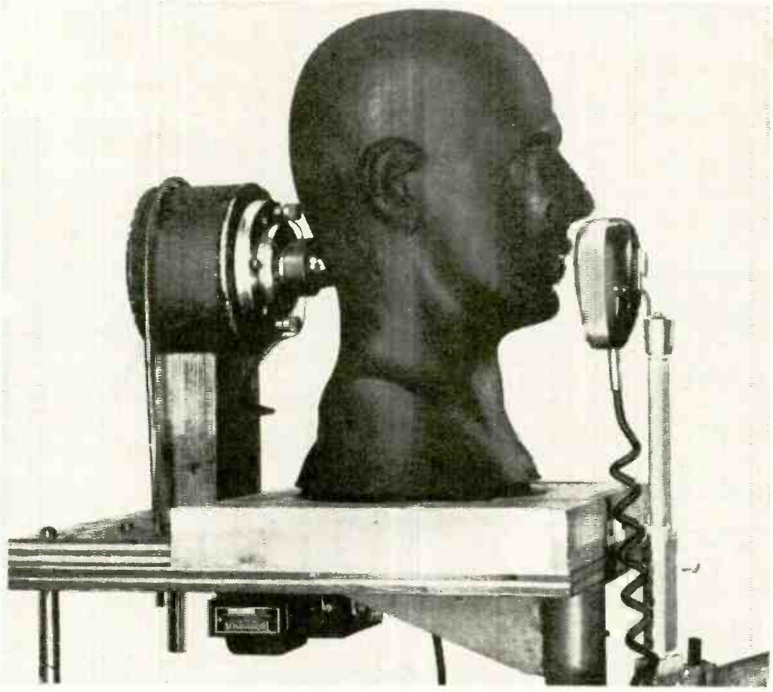
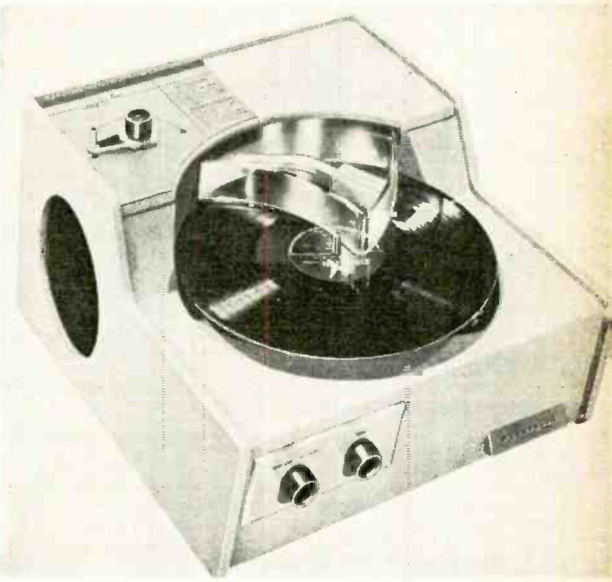
TRUE PORTABLE TV uses 31 transistors and is battery-powered. The only tube in the set is the 14-inch rectangular kinescope. Two nickel-cadmium batteries provide 6 hours of operation before recharging is necessary. Recharging takes 2 hours and batteries can be recharged a minimum of 2,000 times. The set can also be powered by a 12-volt automobile electrical system. Named the Meteor, it is made by Motorola. All transistors in the receiver were developed by the firm. Estimates indicate that this set could be marketed at a practical price around 1960.

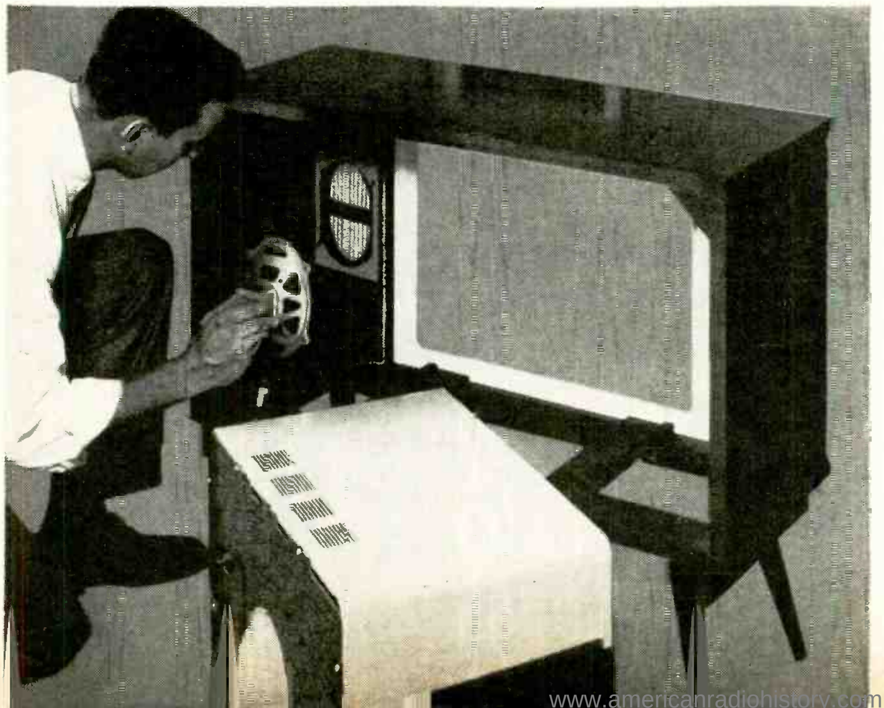




A NEW TEST INSTRUMENT, Oscar, the artificial head that talks, thanks to a built-in speaker, is used to test microphones for Shure Brothers Inc. The head closely approximates conditions under which a mike is actually used. This makes practical acoustic measurements possible. The microphone shown has its own tiny built-in transistor amplifier.



FIRST CONVERTIBLE TV is easily transformed from a 21-inch portable into a console. Speaker is taken from the receiver (bottom) and front-mounted in the console cabinet. The receiver then slides into place, becoming part of the floor model. The convertible receiver has its own cabinet with side carrying handles for easy portability. The sets, produced by Sylvania, come with console cabinets finished in mahogany, blond and natural birch.



TRANSPARENT GUARD AROUND PICKUP ARM of this record-demonstrator phonograph protects records against damage due to careless handling of the arm. Remote operation of the pickup lets you place the arm anywhere on the record without the possibility of dropping the stylus on the disc. Announced by the Grayline Co. of Chicago, the unit is intended for the record shop, listening booth or counter.

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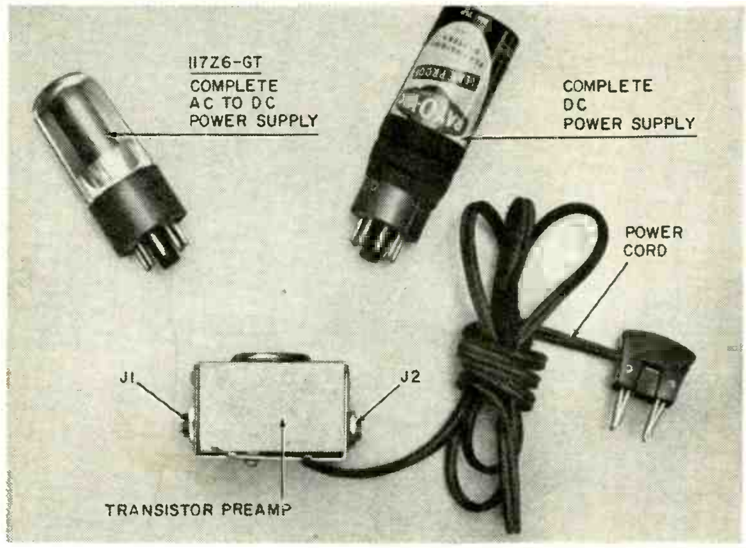
new POWER SOURCE



Transistor preamp and two possible power sources.

Electron pressure produces dc without rectification in the normal sense. A true conversion of thermal energy direct to electric power, which can be put to practical use in transistor power supplies

By **HAROLD C. HUBBARD**

A FEW articles have been written on ac power supplies for transistors and commercial supplies are available. It is evident, after examining either the circuit or the finished product, that ac power supplies for transistors cannot be thrown together from the junkbox.

For most circuit applications (especially point-contact units) applied potentials have a polarity that might cause excessive current through low-impedance inputs (if supply potentials remain constant regardless of current).

This requires a dc supply that delivers constant or at least limited current. Generally these supplies have a dc resistance greater than the internal resistances of the transistor.

The experimenter, especially the beginner, wants to work with transistors. He has a transistor kit, a small preamp or some form of transistor oscillator, and is not interested in the precise designing of a fused, metered power supply nor the cost of buying one. Therefore, a small ac-to-dc supply for many transistor experiments, costing only a few cents to build, would be useful to have. Especially when it can be hooked up in any manner without any chance of damage and can even be short-circuited for hours with no ill effects.

This article describes such a supply designed around electron pressure. The supply and a transistor preamp, also covered here, are built into a 1¼ x 1¼ x 2-inch box. I mention again the power supply is inexpensive and small as it consists of only a rectifier tube.

The unit's basic circuit is shown in Fig. 1. As in the Hubbard oscillator (RADIO-ELECTRONICS, July and August, 1957) ac is fed to the heater only. Thus the dc supply is isolated from the 117-volt line. Electrons are *ejected* into space, by the cathode, until the plate is charged negatively, or the cathode is positive by the number of electrons it has lost. These migrate back to the cathode in a circuit outside the tube envelope and constitute a steady dc flow. It is enough to run many transistor devices. In this article it is specifically used to power a transistor preamp and an oscillator.

How it works

Some readers will refer to this as merely the "contact potential" of a tube. For some reason, this may seem to make the device old and uninteresting. However, the effect is due to electrons ejected from a cathode in vacuum until a certain pressure is reached or built up.

If this pressure of electrons from the cathode in a vacuum were caused

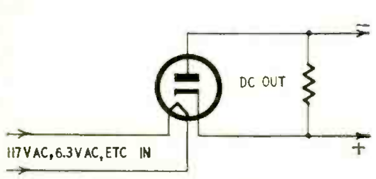
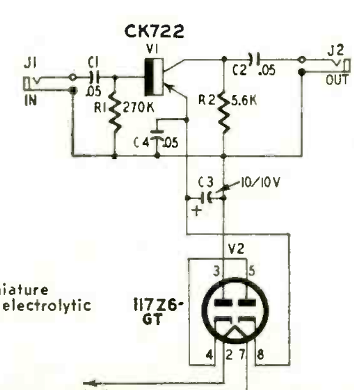


Fig. 1 — Basic ac-to-dc supply circuit.



R1—270,000 ohms, ½ watt
R2—5,600 ohms, ½ watt
C1, 2, 4—.05 μf, 200 volts, miniature
C3—10 μf, 10 volts, miniature electrolytic
J1, 2—phone jacks
V1—CK722
V2—117Z6-GT
Socket, octal
Case, 1½ x 1½ x 2 inches
Miscellaneous hardware

Fig. 2 — Circuit of preamp used with electron - pressure supply.

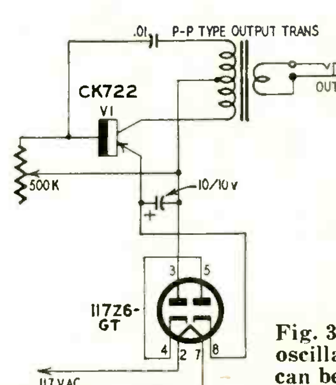


Fig. 3—A simple oscillator that can be used with ac supply.

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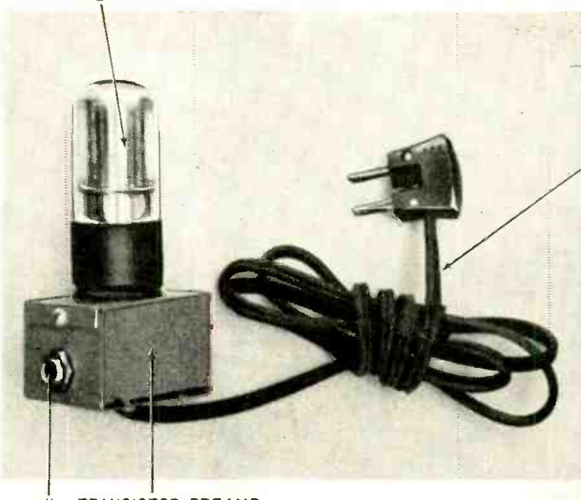
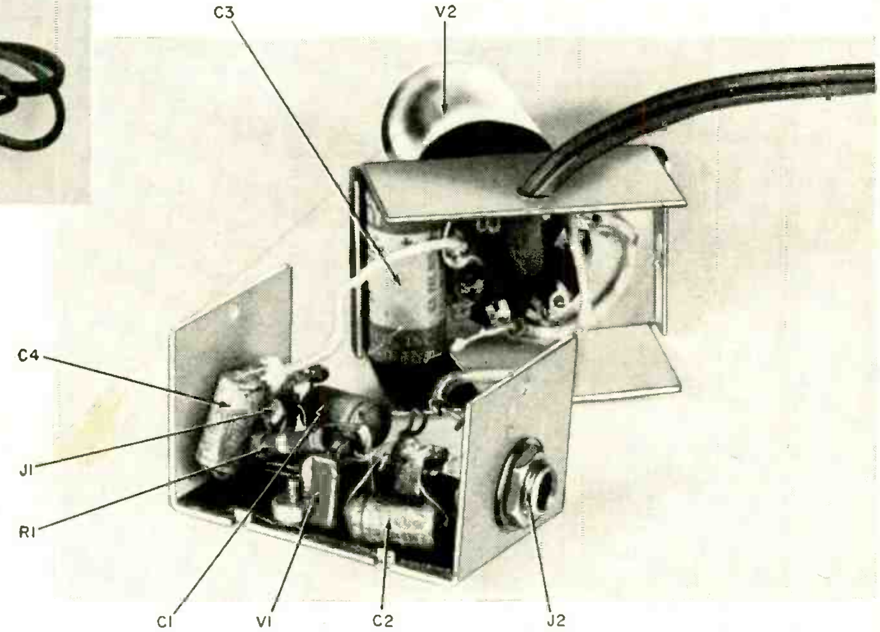


Transistor preamp ready to plug into any 117-volt ac outlet.

Inside the case space is at a premium. Careful layout is a must for this preamp.



by electron ejection by light, it would be called a photoelectric effect. If caused by a radioactive device, the pressure would be described as "when the plate was charged negative." Yet, in all these devices, electrons are ejected to a certain pressure as measured between the cathode and anode.

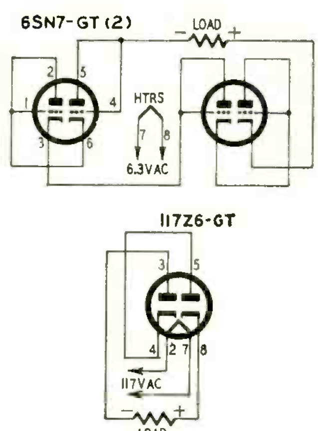
The term contact potential is defined as a small voltage established whenever two conductors of different material are brought into contact—when dissimilar metals are extremely close together without actually touching (100 atomic diameters or so), electrons from the more electropositive metal spill over into the other. Therefore, I believe the term contact potential used to describe electron ejection in vacuum is out of place.

However, call it what you will, you will be agreeably surprised at the way it will operate a transistor oscillator or preamp for many months with no attention or parts failure. The schematics of the preamp and oscillator are shown in Figs. 2 and 3.

The preamp can be used for headphone amplification (see "Headset Booster," RADIO-ELECTRONICS, September, 1957) or as a preamp ahead of an existing amplifier. The complete unit, with the built-in preamp, is shown in the photos. A battery can be substituted for the tube for field use by fitting an octal plug to a flashlight cell. This is, of course, used in place of 117Z6-GT.

The small electrolytic capacitor across the cathode and anode is not a filter in the usual sense as nothing is rectified, but as a low-impedance signal path around the diode.

The charts (Figs. 4 and 5) show the output of 6SN7-GT duo-triodes connected as diodes and the potentials and currents produced under certain loads. It is interesting to note the difference between series and parallel connections as compared with batteries. While a single large cathode produces a low pressure at high-resistance loads as compared with small cathodes in series, the single large cathode will sometimes end up with a higher potential under a heavy load. END



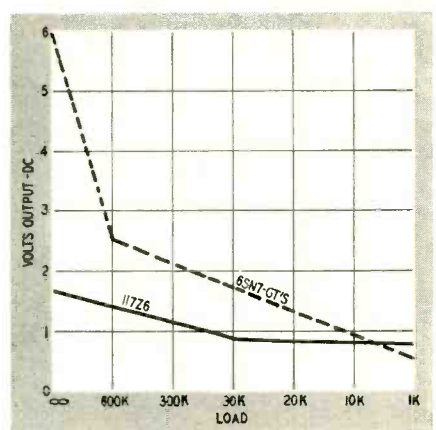
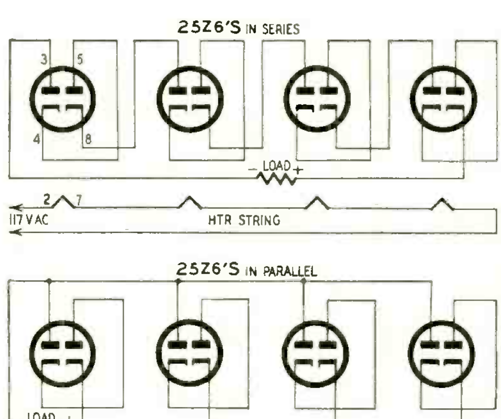


Fig. 4—Graph of voltage output vs load resistance.



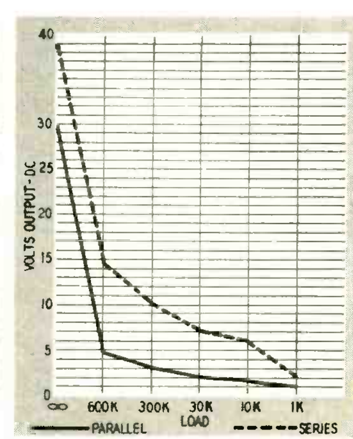


Fig. 5—Effect of series and parallel tubes on voltage and current output.

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Transistor Locator Finds Metal Fast

Lightweight unit for spotting buried metal uses potted construction techniques

The author testing his unit.

By EDWIN BOHR

IMPROVED circuitry, up-to-date transistors and better stability are combined in this transistor metal locator. Operating at about 2 mc, detection takes place by the beat-frequency method.

Beat-frequency locators have a single exploration loop forming the inductive part of an oscillator circuit. Metals brought within the loop's field cause the oscillator frequency to change. This change is proportionately small. Typically, frequency may change only a few cycles per million.

To detect this small change, another oscillator, called a reference oscillator, is used to beat against the detection oscillator. Both oscillators may be set to the same frequency initially. This is called "zero beat." Then, as a metal is approached, the detection-oscillator frequency will change, producing an audio tone when it is mixed with the output of the reference oscillator.

Success with this type of locator depends upon high stability of the oscillators and freedom from excessive pulling. Pulling is the tendency of oscillators to lock together as their frequencies become nearly identical.

Electrically, stability is improved by shunting the transistors with large values of capacitance and making these capacitances only a small portion of the total tuning capacitance.

Mechanical rigidity, also necessary for oscillator stability, is increased by welding the circuits into vibration-resistant units with Fiberglas potted construction.

The circuit (see Fig. 1) divides into four parts by electrical function. First, there is a potted oscillator assembly that fits into the handle of the locator. The other three functional units are in the instrument box: the reference oscillator, beat detector using transistor V4 and a 2-stage direct-coupled audio amplifier.

The detector will locate large-area high-conductivity metals such as aluminum and copper sheets at distances up to 6 feet. Under ordinary conditions—finding pipes, etc.—the range is much less depending upon the *area of metal facing* the coil. The thickness or volume of the material is not too important.

Loop construction

Making the locator's loop is usually the big headache. However, I have simplified this problem by using quilting-hoop and Fiberglas construction.

A Gibbs quilting hoop is the heart of the loop. This wood hoop measures 18 x 27 inches. The inner hoop is used for the detection loop but the outside hoop may also be used. (You can build two loops from one hoop.)

R1, 2, 16, 18—1,000 ohms
R3, 4, 19—4,700 ohms
R5, 8, 12—15,000 ohms
R6—2,000 ohms, 5%
R7—2,700 ohms
R9—2,200 ohms
R10—470 ohms
R11—pot, 15,000 ohms, miniature (Lafayette VC-35 or equivalent)
R13—270 ohms
R14—47,000 ohms
R15—3,300 ohms
R17—12,000 ohms
All resistors ½-watt 10% unless noted
BATT 1, 2, 3—8 volts, Mallory TR-136R
C1—150 μμf, mica or ceramic
C2—68 μμf, mica or ceramic
C3, 4, 5, 6, 10, 12, 13—300 μμf, mica or ceramic
C7—100 μμf, mica or ceramic
C8, 9, 15, 18—.01 μf, miniature ceramic
C11—39 μμf, mica or ceramic
C14—variable capacitor, see text (Lafayette MS-274 or MS-270 or equivalent)
C16, 17—20 μμf, mica or ceramic (see text)
C19, 20, 21, 22—80 μf, 6 volts, miniature electrolytic
J1—phono jack
J2, 3—tip jacks
L1—5 turns No. 22 hookup wire on an 18 x 27-inch oval (see text)
L2—ferrite antenna coil, modified (see text)
RFC—1 mh
S—spst toggle
V1, 2, 3, 4—2N137
V5, 6—2N43
Case, 3¼ x 5¼ x 2⅛ inches
Microphone cable, 4 feet
Fiberglas kit
Aluminum tubing
Aluminum foil
Headphones
Gibbs quilting hoop (Sears Roebuck No. 63D05083 or equivalent)
Phono plug
Miscellaneous hardware

Five turns of No. 22 plastic hookup wire are space-wound around the outside of the hoop. The turns can be held in place with a few strips of electrical tape.

Now, the operation of applying the resin and Fiberglas begins. Fiberglas and resin are available at auto and boating stores, either separately and in kits. Initially, I recommend the kits, since they contain measuring cups, spatula and detailed instruction booklets.

Coat the hoop, a short section at a time, with plastic resin and wrap the

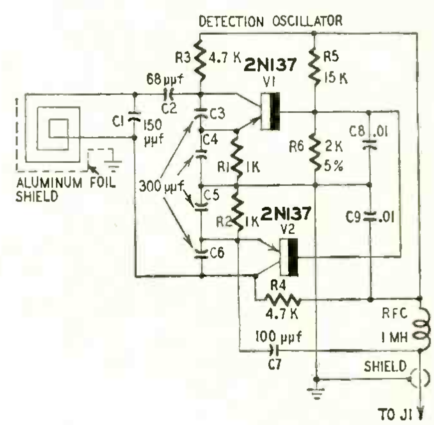
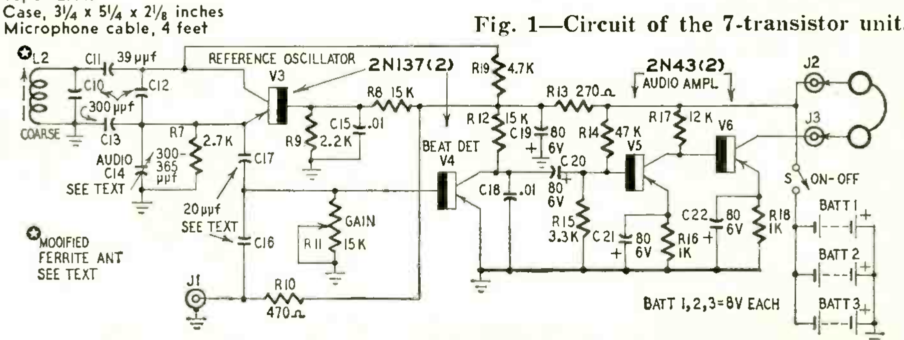


Fig. 1—Circuit of the 7-transistor unit.



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hoop with 3-inch Fiberglas tape. Be sure to follow the *measuring and mixing* instructions for the resin to the letter. Of course, the tape should be wound tightly and with some overlap. Wrap the hoop as if it were a sprained wrist or ankle. As the winding progresses, brush on more resin until the tape is well impregnated.

At least 24 hours are necessary for the resin to set. During the first 30 minutes, however, the tape may be smoothed into place with a wooden spatula.

After the first application of Fiberglas has hardened, the aluminum-foil electrostatic shield is added. This shield reduces the effect of capacitance on the loop.

I used a wide strip of aluminum foil to enfold the loop. As an alternative, a strip of foil several times longer than the loop circumference may be wrapped in the same way as the Fiberglas.

The two ends of the aluminum foil *must not touch* and, preferably, the edges should not touch either. The ground connection to the foil is made by taping several inches of bared stranded hookup wire to the surface of the foil that faces the just-finished Fiberglas.

A final outside coat of Fiberglas and resin is added on top of the foil, just like the layer under the foil shield. When this is completed, the loop will be very rigid and strong. Now, add a stump to stick into the aluminum-tube handle (see Fig. 2).

Make the stump by rolling Fiberglas (impregnate as you roll) into a tube with a small hole in the center for the three lead wires (two from L1 and one from the shield). Start rolling the Fiberglas on a pencil and then remove the pencil. The roll should be tied with Fiberglas threads to keep it from unwinding.

Strips of impregnated tape then attach the stump to the loop. In addition, Fiberglas floss mixed with resin to form a sort of putty should be used to fill voids and smooth the appearance.

The completed assembly can be sanded to a smooth appearance and imperfections filled with more material. A fast-drying spray paint finish is desirable or coloring can be added to the resin to give a built-in color to the loop.

The stump is drilled and tapped through the handle for two 10-32 screws. Be careful and do not drill through the lead wires!

Working with Fiberglas may sound like making mud pies, but it is strong, adaptable and attractive. In some respects it can be stronger than steel. And, you do not have to worry about it cracking or breaking like nonre-enforced plastics.

Potted oscillator

The oscillator for the loop, including transistors V1 and V2, is cast in a cylinder of resin and Fiberglas floss slightly smaller than the inside diameter of the handle. Parts for the oscillator are bundled together and soldered so they will fit into the mold.

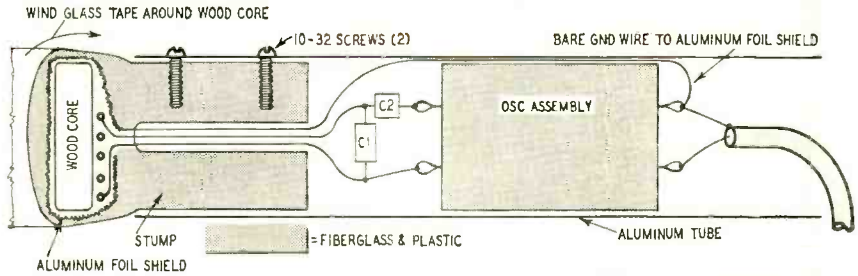
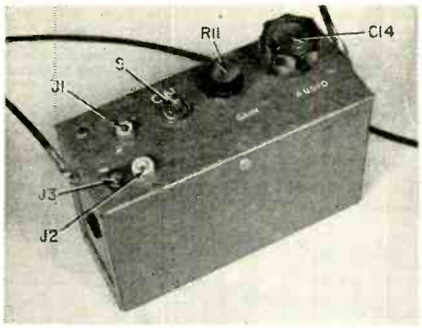
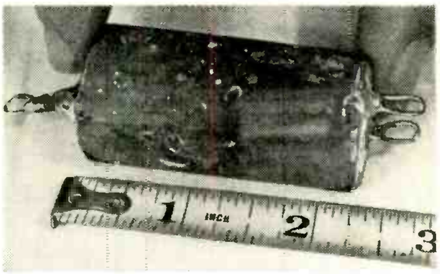


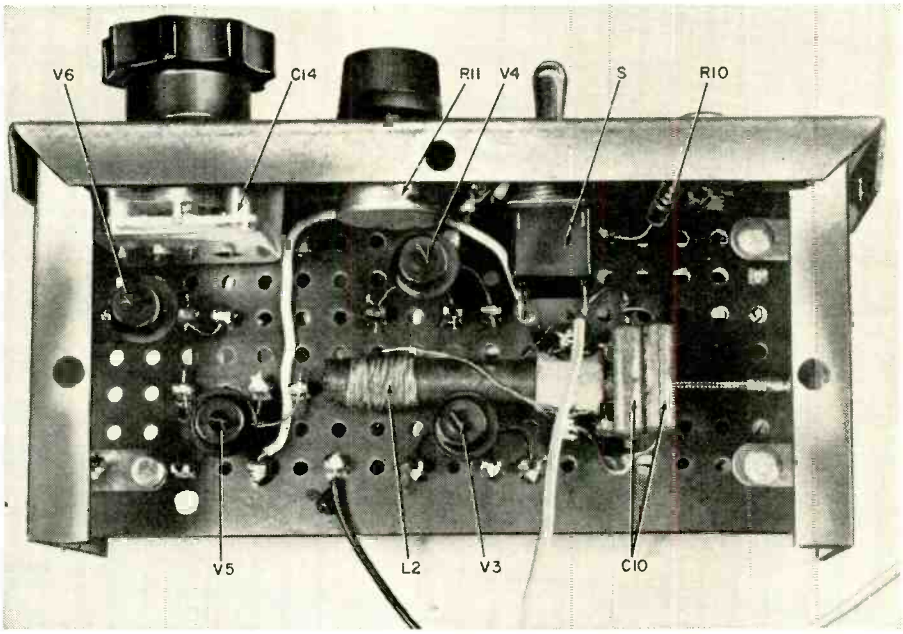
Fig. 2—Detector loop and handle construction.



The completed instrument-case section.



Detector oscillator is potted in Fiberglas.



Top view of the instrument-case chassis.

Check the oscillator before it is potted. Connect C1, C2 and the loop to the oscillator and connect to J1 if the instrument case is finished. If not, connect the wires ordinarily going to J1 to an 8-volt battery—the negative battery terminal to the collectors.

To check for oscillation, connect a 1N34 or similar diode in series with a 20,000-ohms-per-volt dc meter (the diode's cathode goes to the positive lead) and measure the voltage across the coil. The meter should read several volts. If it does not, check your wiring and voltages or possibly remove C1 and increase the value of C2 to about double its original value.

If the oscillator is ready for potting, cut off a piece of the handle to use as the form. Slot the piece with a hacksaw and squeeze the slot closed. This makes the form smaller than the handle's inside diameter. Gently insert the oscillator into the form and cover one end with a cardboard and putty seal. (Let the terminals protrude through the cardboard.) Then fill the form with a resin and Fiberglas floss mixture.

When this is complete, connect the loop and potted oscillator together with C1 and C2 (see Fig. 2). Strip the in-

(*Continued on page* 80)

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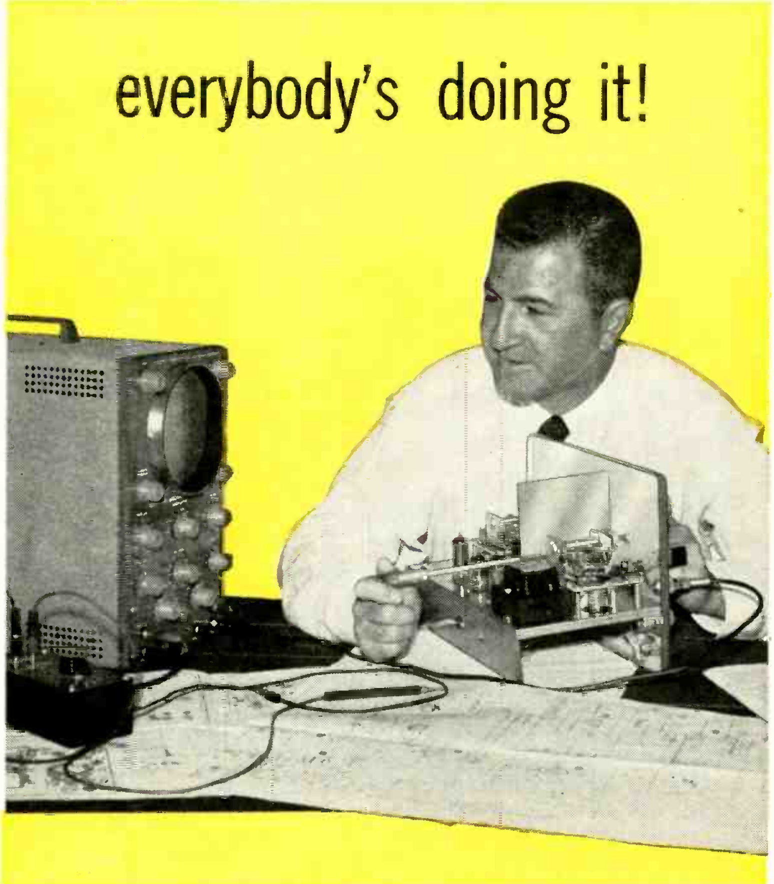
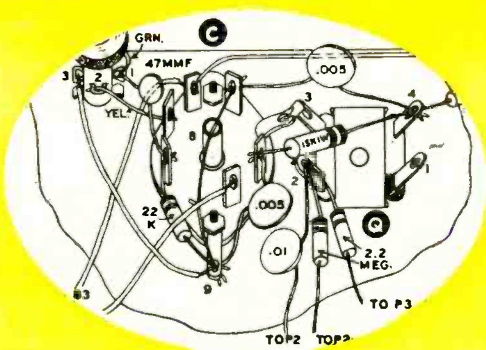
DICK JURGENS and his band have played in virtually every state in the union, and just about every important hotel, night club, theater, and one-night stand, in the country, has echoed to the sounds of his music. He has done a number of radio shows, and made over five-hundred recordings with Columbia Records in seventeen years. He was head of the first all-marine entertainment unit during World War II, and toured the South Pacific for almost two years with this group. His own band was reorganized again after the war. Dick Jurgens was co-author of such hit tunes as: "One Dozen Roses", "Elmer's Tune", "Careless", "If I Knew Then", "A Million Dreams Ago", and his theme song, "Daydreams Come True at Night." He has come a long way in the world of music and entertainment since his first "big time" engagement at the St. Francis Hotel in San Francisco some years ago, and is now well known for his musical talents.

A lesser known side of Dick Jurgen's life, however, is his interest and ability in electronics—that had its beginnings in the late 20's, and has continued as his main hobby until the present time. Dick has built about twenty-five Heathkits, and considers electronics his serious hobby. He especially likes test equipment and high fidelity projects, and hopes some day to make a business of his electronics interests. We are quite proud to list Dick Jurgens among our "do-it-yourself" customers.

everybody's doing it!





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

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By DAYSTROM

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

and here's why...

1. You get higher quality at lower cost by dealing direct, and by doing your own assembly.
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3. You benefit from the latest in engineering designs because of our concentration on kit-form equipment only.
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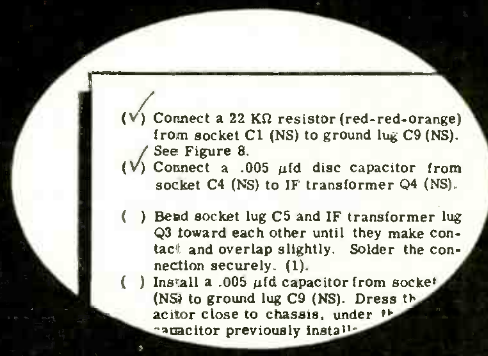

Read the step . . . perform the operation . . . and check it off—it's just that simple. These plainly-worded, easy-to-follow, steps are combined with pictorial diagrams to take you through every phase of assembly. Let our experience be your teacher!

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TIME PAYMENTS . . .

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

HEATHKIT EXTRA PERFORMANCE 70-WATT AMPLIFIER KIT

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

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

MODEL W-6M

$109.95

HEATHKIT HIGH FIDELITY FM TUNER KIT

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

MODEL FM-3A

$25.95

(with cabinet)

HEATHKIT BROADBAND AM TUNER KIT

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

MODEL BC-1A

$25.95

(with cabinet)

HEATHKIT MASTER CONTROL PREAMPLIFIER KIT

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

MODEL WA-P2

$19.75

(with cabinet)

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See Us at the Los Angeles Hobby Show at the Shrine Auditorium March 7-16

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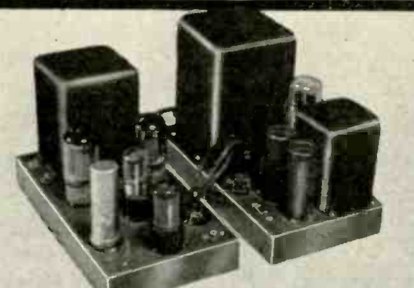
ADVANCED-DESIGN
25-WATT AMPLIFIER

SINGLE-CHASSIS
20-WATT AMPLIFIER

Hi-Fi equipment for your listening pleasure!

Top performance in its power class!



DUAL-CHASSIS
20-WATT AMPLIFIER

GENERAL-PURPOSE
20-WATT AMPLIFIER

HEATHKIT ADVANCED-DESIGN 25-WATT HIGH FIDELITY AMPLIFIER KIT

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

MODEL W-5M **$59.75**

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

HEATHKIT SINGLE-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

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

MODEL W4-AM **$39.75**

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

HEATHKIT DUAL-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

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

MODEL W-3AM **$49.75**

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

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bring you the lasting satisfaction of personal accomplishment

HEATHKIT GENERAL-PURPOSE 20-WATT HIGH FIDELITY AMPLIFIER KIT

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

MODEL A-9C **$35.50**

www.americanradiohistory.com

HEATHKIT "BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

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

MODEL SS-1

$39.95

HEATHKIT "RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

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

MODEL SS-1B

$99.95

HEATHKIT "LEGATO" HIGH FIDELITY SPEAKER SYSTEM KIT

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

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

MODEL HH-1-C
MODEL HH-1-CM

$325.00
EACH

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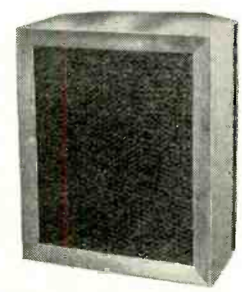
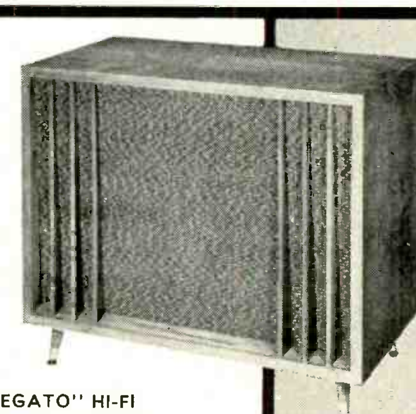
"BASIC RANGE" HI-FI SPEAKER SYSTEM



Superlative sound reproduction through the speaker system of your choice

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM



"LEGATO" HI-FI SPEAKER SYSTEM

SINE-SQUARE GENERATOR

AUDIO ANALYZER

Sine and square waves for countless applications.

HEATHKIT SINE-SQUARE GENERATOR

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

MODEL AG-10

$49.95

HEATHKIT AUDIO ANALYZER KIT

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

MODEL AA-1

$49.95

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HEATHKIT "GENERAL PURPOSE" 5" OSCILLOSCOPE KIT

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

MODEL OM-2

$42.50

HEATHKIT AUDIO WATTMETER KIT

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

MODEL AW-1

$29.50

HEATHKIT AUDIO SIGNAL GENERATOR KIT

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

MODEL AG-9A

$34.50

HEATHKIT HARMONIC DISTORTION METER KIT

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

MODEL HD-1

$49.50

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are well known for their high quality and reliability.

HEATHKIT AUDIO VTVM KIT

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

MODEL AV-3

$29.95

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HEATHKIT COLOR BAR AND DOT GENERATOR

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

MODEL CD-1

\$59.95

Heathkits...

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are guaranteed to meet or exceed advertised specifications

HEATHKIT TV ALIGNMENT GENERATOR KIT

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

MODEL TS-4A

\$49.50

HEATHKIT "EXTRA DUTY" 5" OSCILLOSCOPE KIT

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

MODEL O-11

\$69.50

HEATHKIT ELECTRONIC SWITCH KIT

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

MODEL S-3

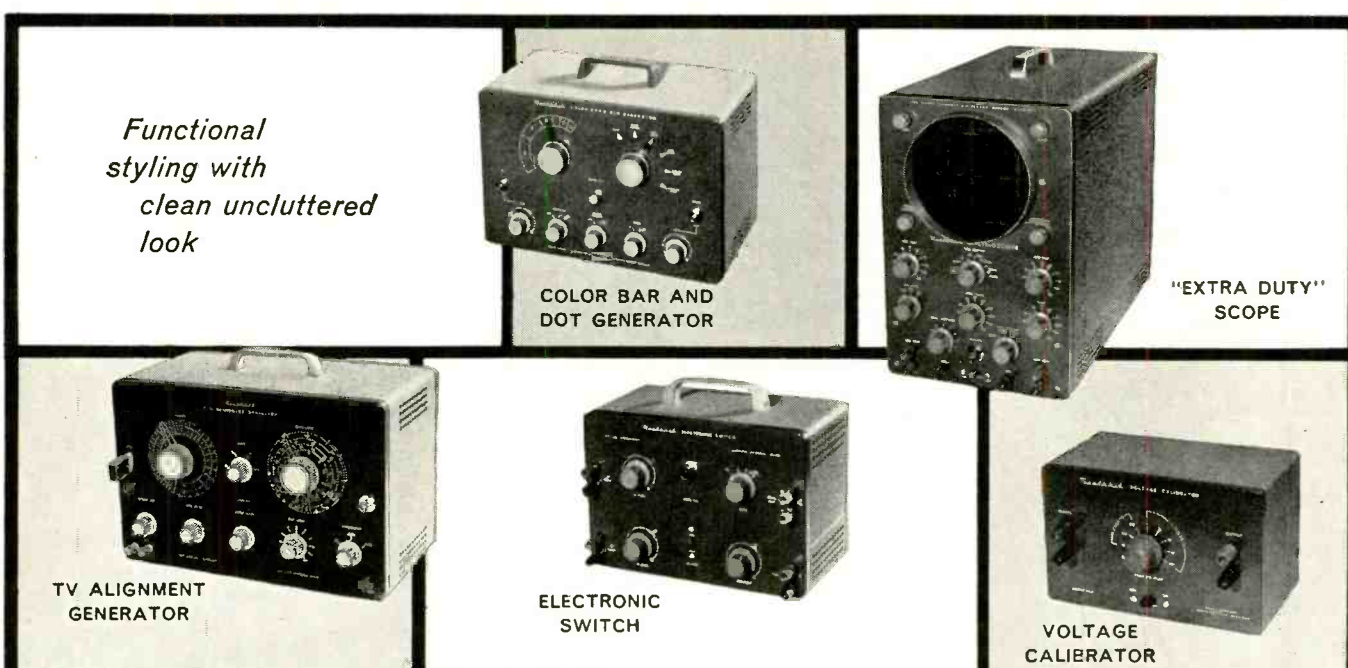
\$21.95

HEATHKIT VOLTAGE CALIBRATOR KIT

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

MODEL VC-3

\$12.50



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HEATHKIT TUBE CHECKER KIT

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

MODEL TC-2

$29.50

HEATHKIT HANDITESTER KIT

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

MODEL M-1

$17.95

HEATHKIT PICTURE TUBE CHECKER KIT

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

MODEL CC-1

$24.95

HEATHKIT ETCHED-CIRCUIT VTVM KIT

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

MODEL V7-A

$24.50

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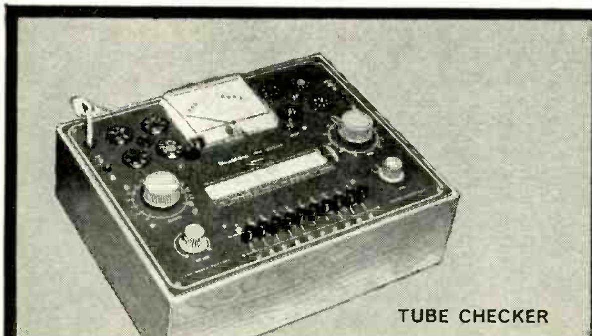
let you fill your exact needs from a wide variety of instruments

HEATHKIT 20,000 OHMS/VOLT VOM KIT

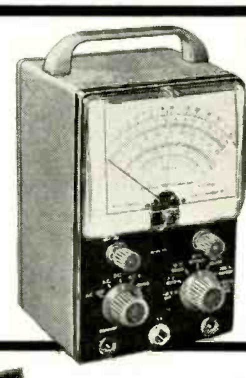
This fine instrument provides a total of 25 meter ranges on its two-color scale. It employes a 50 ua 4½" meter, and features 1% precision multiplier resistors. Requires no external power. Ideal for portable applications. Sensitivity is 20,000 ohms-per-volt DC and 5000 ohms-per-volt AC. Measuring ranges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

MODEL MM-1

$29.95



TUBE CHECKER



High quality test gear you will be proud to own

ETCHED CIRCUIT VTVM

Priced low to fit your budget

HANDITESTER

PICTURE TUBE CHECKER

20,000 OHMS/VOLT VOM

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HEATHKIT RF SIGNAL GENERATOR KIT

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

MODEL SG-8

$19.50

HEATHKIT LABORATORY RF GENERATOR KIT

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

MODEL LG-1

$48.95

HEATHKIT DIRECT-READING CAPACITY METER KIT

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

MODEL CM-1

$29.50

Heathkits...

By DAYSTROM

are educational
as well as functional

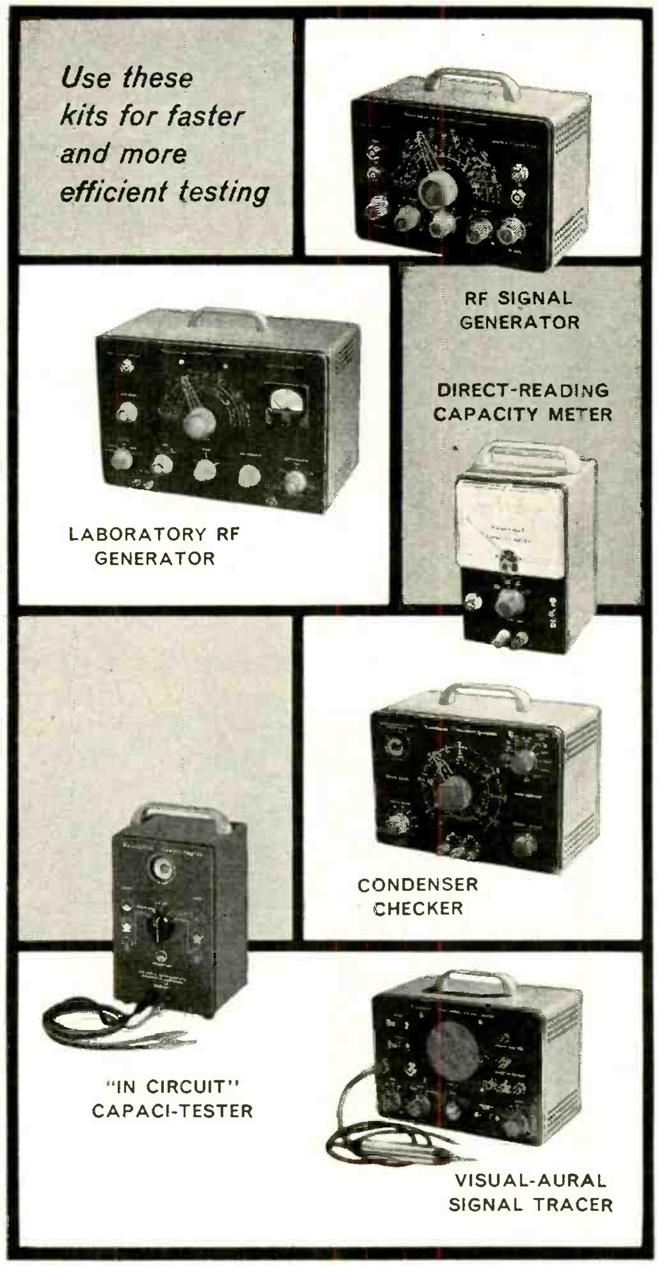
HEATHKIT "IN-CIRCUIT" CAPACI-TESTER KIT

NEW

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

MODEL CT-1

$7.95



HEATHKIT CONDENSER CHECKER KIT

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

MODEL C-3

$19.50

HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

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

MODEL T-3

$23.50

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

www.americanradiohistory.com

HEATHKIT IMPEDANCE BRIDGE KIT

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

MODEL IB-2A **$59.50**

HEATHKIT "LOW RIPPLE" BATTERY ELIMINATOR KIT

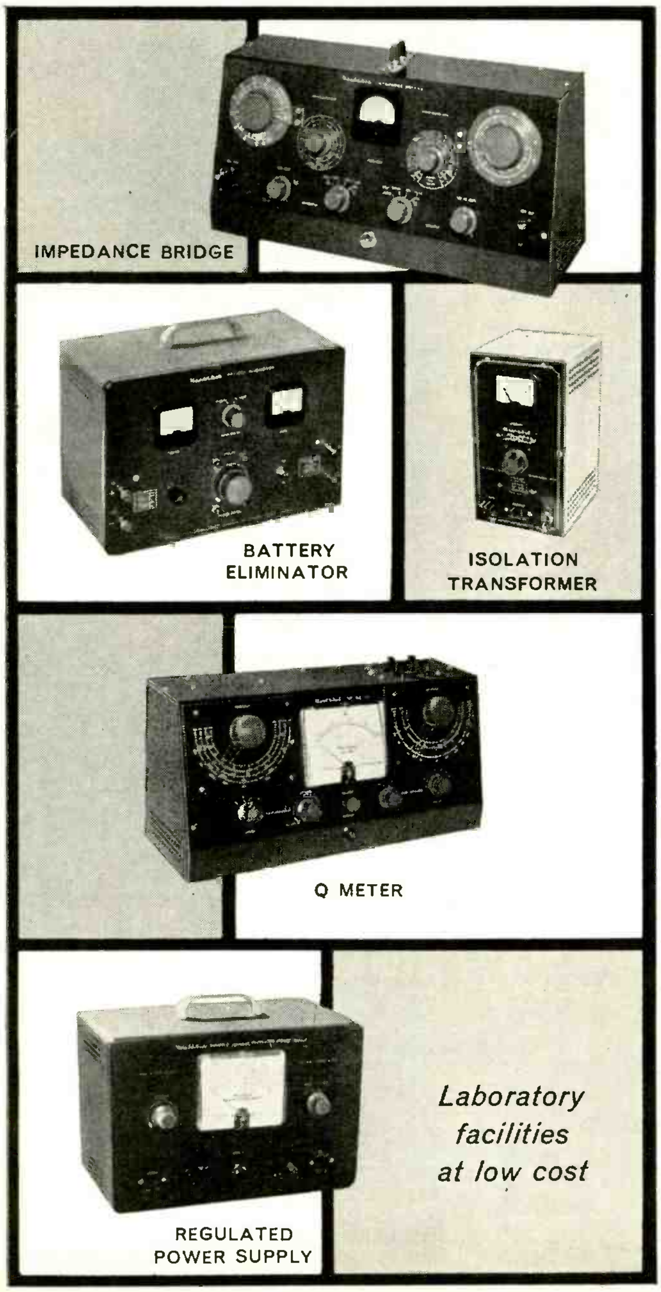
This modern battery eliminator incorporates an extra low-ripple filter circuit so that it can be used to power all the newest transistor-type circuits requiring 0 to 12 volts DC, and the new "hybrid" automobile radios using both transistors and vacuum tubes. Its DC output, at either 6 or 12 volts, contains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

MODEL BE-5 **$39.95**

HEATHKIT ISOLATION TRANSFORMER KIT

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

MODEL IT-1 **$16.50**



Heathkits...

By DAYSTROM

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

HEATHKIT "Q" METER KIT

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

MODEL QM-1 **$44.50**

HEATHKIT REGULATED POWER SUPPLY KIT

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

MODEL PS-3 **$35.50**

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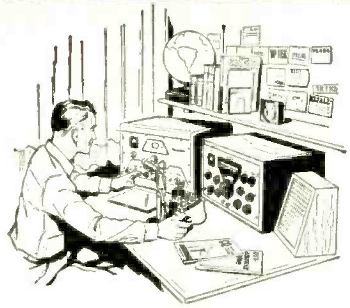


Terrific values
in amateur
equipment!

DX-100 TRANSMITTER

DX-20 TRANSMITTER

DX-40 TRANSMITTER

HEATHKIT DX-20 CW TRANSMITTER KIT

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

MODEL DX-20
$35.95

Heathkits...

By DAYSTROM

are designed by
licensed ham-engineers,
especially for you

HEATHKIT DX-40 PHONE AND CW TRANSMITTER KIT

A most remarkable power package for the price, the new DX-40 provides both phone and CW facilities for operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 75 watt plate power input on CW, or control carrier modulation peaks up to 60 watts for phone operation. Modulator and power supplies are built right in and single knob bandswitching is combined with a pi network output circuit for complete operating convenience. The tight fitting cabinet presents a most attractive appearance, and is designed for complete shielding to minimize TVI. A 4-position switch provides convenient selection of three different crystals or a jack for external VFO. The crystals are reached through access door at rear of cabinet. You can build this rig yourself and be proud to show it off to your fellow hams. Get your DX-40 now for many hours of operating enjoyment. Shpg. Wt. 25 lbs.

MODEL DX-40
$64.95

HEATHKIT DX-100 PHONE AND CW TRANSMITTER KIT

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

MODEL DX-100
$189.50

FUNCTIONAL DESIGN . . .

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

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

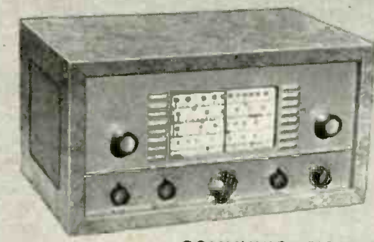
www.americanradiohistory.com

Automatically turns off transmitter and gives visual signal

"AUTOMATIC" CONELRAD ALARM

GRID DIP METER

"Q" MULTIPLIER



COMMUNICATIONS-TYPE RECEIVER

An ideal receiver for the beginning ham or short wave listener

HEATHKIT "AUTOMATIC" CONELRAD ALARM KIT

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

MODEL CA-1
$13.95

HEATHKIT "Q" MULTIPLIER KIT

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

MODEL QF-1
$9.95

HEATHKIT GRID DIP METER KIT

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

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

MODEL GD-1B
$21.95

HEATHKIT ALL-BAND COMMUNICATIONS-TYPE RECEIVER KIT

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

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

MODEL AR-3
$29.95
(Less cabinet)

Heathkits...

By DAYSTROM

are outstanding in performance and dollar value

www.americanradiohistory.com

HEATHKIT REFLECTED POWER METER KIT

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

MODEL AM-2

$15.95

HEATHKIT VARIABLE FREQUENCY OSCILLATOR KIT

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

MODEL VF-1

$19.50

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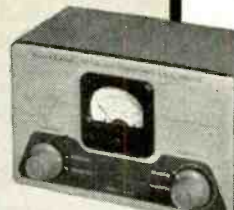
By DAYSTROM

are the answer for your electronics hobby.

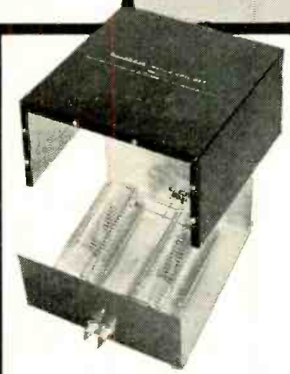


REFLECTED POWER METER

Insure your "on the air" performance with these fine accessories.

VARIABLE FREQUENCY OSCILLATOR

VIBRATOR POWER SUPPLY



BALUN COIL SET

HEATHKIT BALUN COIL KIT

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

MODEL B-1

$8.95

HEATHKIT 6 OR 12 VOLT VIBRATOR POWER SUPPLY KITS

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

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

$7.95 Each

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

www.americanradiohistory.com

HEATHKIT ELECTRONIC IGNITION ANALYZER KIT

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

MODEL IA-1

\$59.95

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

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

MODEL RC-1

\$79.95

IGNITION ANALYZER

Kit includes everything you need for construction — even batteries!

RADIATION COUNTER

ENLARGER TIMER

BATTERY TESTER

Heathkits...

By DAYSTROM

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

HEATHKIT ENLARGER TIMER KIT

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

MODEL ET-1

\$11.50

HEATHKIT BATTERY TESTER KIT

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

MODEL BT-1

\$8.50

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CRYSTAL RADIO

Now you can have radio wherever you go — with the portable that plays anywhere!

TRANSISTOR PORTABLE

BROADCAST BAND RADIO

HEATHKIT CRYSTAL RADIO KIT

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

MODEL CR-1
$7.95

Heathkits...

By DAYSTROM

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

HEATHKIT TRANSISTOR PORTABLE RADIO KIT

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

MODEL XR-1
$34.95
(Less batteries)
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This table-model broadcast radio is fun to build, and is a fine little receiver for your home. It covers the standard broadcast band from 550 to 1600 kc with good sensitivity and selectivity. The 5½" PM speaker provides surprisingly good tone quality. High-gain IF transformers, miniature tubes, and a rod-type built in antenna, assure good reception in all locations. The power supply is transformer operated, as opposed to many of the economy "AC-DC" types. It's easy to build from the step-by-step instructions, and the construction manual includes information on operational theory, for educational purposes. Your success is assured by completely detailed information which also explains resistor and capacitor color codes, soldering techniques, use of tools, etc. A signal generator is recommended for final alignment. Shpg. Wt. 10 lbs.

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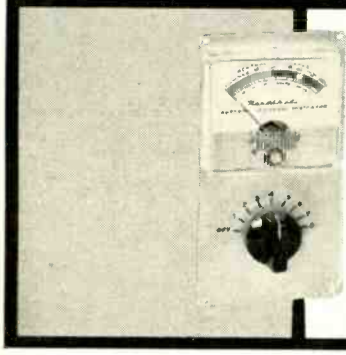
protects against possible explosion and fire from undetected fuel vapor

FUEL VAPOR DETECTOR

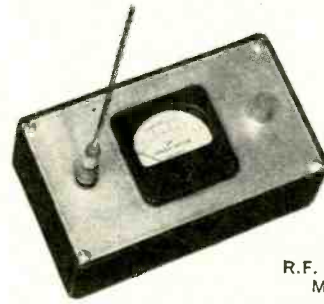
detects electrolysis currents which cause deterioration of underwater metal fittings on your boat

ELECTROLYSIS DETECTOR



indicates condition and charge of batteries for safe cruising

BATTERY CHARGE INDICATOR



R.F. POWER METER

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12 volt MODEL FD-1-12
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The Heathkit model CI-1 Marine Battery Charge Indicator has been designed especially for the boat owner, although it has found use in service stations, power stations, and radio stations where banks of batteries are kept in reserve for emergency power. It is intended to replace the hydrometer method of checking storage batteries, and to eliminate the necessity for working with acid in small, below-decks enclosures. Now it is possible to check as few as one, or as many as eight storage batteries, merely by turning the switch and watching the meter. A glance at the meter tells you instantly whether your batteries are sufficiently charged for safe cruising. Dimensions are 2-7/8"W x 5-11/16" H x 2" D. Operates on either 6 or 12 volt systems using lead-acid batteries, regardless of size. Simple installation can be accomplished by the boat owner in fifteen minutes. Shpg. Wt. 3 lbs.

MODEL CI-1
$16.95

HEATHKIT ELECTROLYSIS DETECTOR KIT

The Heathkit model ED-1 Electrolysis Detector indicates the extent of electrolysis currents between the boat's common ground and underwater fittings, except on boats having metal hulls. These currents, undetected, could cause gradual corrosion and deterioration of the propeller or other metal fittings below the water line. It is particularly helpful when installing electrical equipment of any kind, or to determine proper polarity when power is obtained from a shore supply. Easy-to-build, the model ED-1 consists of a hermetically-sealed, waterproof meter, special sensing plate, and sufficient wire to install, including the necessary hardware. Mounts on instrument panel where it can be easily seen. Requires no power for operation, and gives instant warning to guard your boat for a lifetime. Shpg. Wt. 2 lbs.

MODEL ED-1
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HEATHKIT RF POWER METER KIT

The Heathkit RF Power Meter Kit is designed to sample the RF field in the vicinity of your transmitter, whether it be marine, mobile, or fixed. Output meter is merely placed in some location close to the transmitter, to pick up RF radiation from the antenna. Requires no batteries, electricity, nor direct connection to the transmitter. It provides you with a continuing indication of transmitter operation. You can easily detect if power is dropping off by comparing present meter readings with past ones. Operates with any transmitter having output frequencies between 100 kc and 250 mc, regardless of power. Sensitivity is 0.3 volts RMS full scale, and a special control on the panel allows for further adjustment of the sensitivity. Meter is a 200 ua unit, mounted on a chrome-plated brass panel. The entire PM-1 measures only 3¾" W x 6¼" L x 2" D. An easy way to put your mind at ease concerning transmitter operation. Shpg. Wt. 2 lbs.

MODEL PM-1
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MODEL DF-1

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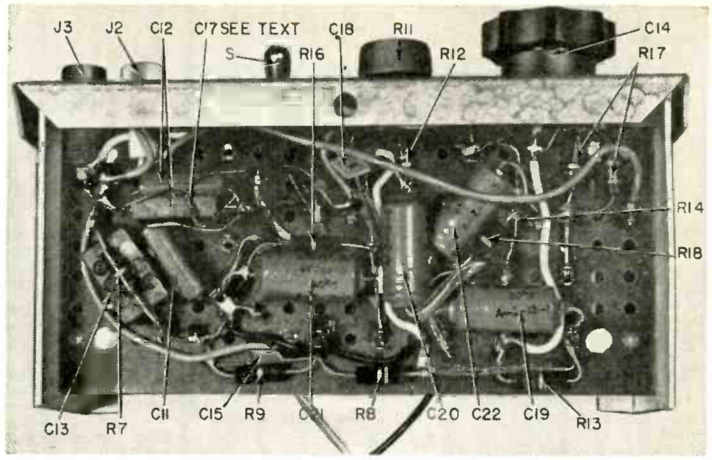

Underchassis view shows components layout.

(*Continued from page* 63)

sulation from a stranded hookup wire, run it *around* the potted assembly and connect it to the ground side of the J1 wire. This is shown in the loop construction drawing. If you wish, fasten the oscillator assembly and loop together with additional Fiberglas and slip it into the handle as one piece.

The shielded wire connecting to J1 exits from the handle through a rubber grommet hole approximately two-thirds of the way up from the loop.

Instrument-box wiring

The reference oscillator, beat detector and audio amplifier are all wired into the instrument case. Placement of parts is illustrated by the photographs.

The photographs show that I paralleled components, in some places, to get the desired value. This simply was an expedient use of parts on hand. Capacitors C16 (out of view) and C17 in the photograph are simply pieces of insulated magnet wire twisted together. In the final model these were replaced with 20-$\mu\mu$f mica or ceramic capacitors.

Less-expensive transistors may be used. Both 2N135 and 2N136 transistors have been used in place of the 2N137 transistors. Lower-priced audio transistors are suitable for the two audio stages. If this results in low volume, the size of C16 and C17 may be increased.

The reference oscillator has two frequency adjustments. Coil L2 is the COARSE adjustment available through a hole in the case. The fine adjustment C14 is marked AUDIO on the front panel. The coil is a variable ferrite antenna coil with about one-fifth of its turns removed. It should not be mounted closer to any side of the instrument case than shown in the photos.

For capacitor C14 I used a Lafayette MS-270 with both sections wired in parallel. A single-gang capacitor like the MS-274 will do just as well.

Connector J1 pipes dc battery voltage to the detection oscillator and also brings rf into the instrument case. This is the reason for the rf choke and resistor R10. The shielded cable is lapel type microphone wire—the shorter the better.

Outputs from the two oscillators mix across variable resistor R11. Essentially this is a GAIN control, but it also serves as a very fine beat-frequency control. Its range is only a few cycles per second.

For improved low-frequency response, direct coupling in the audio stages eliminates one capacitor.

Three TR-136R mercury batteries wired in parallel and boxed into a small case fit into the bottom of the cabinet. A piece of felt or sponge rubber placed on top of the cells, with the transistor chassis pushing down on it, holds them in place. These TR-136R batteries power the circuit for several hundred hours.

Before using the locator, check the audio and detector sections. When the unit is turned on, a frying sound should be heard in the phones in about 4 seconds. This is the time it takes the electrolytic capacitors to reach full charge. The frying sound indicates plenty of audio gain. (Of course, it could originate from a noisy transistor with low gain.)

With R11 set for maximum gain, a loud hum or squeal should be heard when V4's base is touched with a finger. If these stages do not react correctly, check to see that all base voltages are about 0.1 volt greater than the emitter voltage and that all collector voltages are at least 0.75 volt higher than the base voltage. A wrong base-to-emitter voltage usually indicates a bad transistor and a too-low collector-to-base voltage results from a shorted transistor or a wrong value of emitter resistance or bias voltage.

Bring the two oscillators to audio beat by turning the screw adjustment on L2 until a tweet is heard. Turn the screw *slowly* because this is a very coarse adjustment. If the tone is not heard, either one or both oscillators are not working or are way off frequency. Oscillation can be checked by the diode and voltmeter method. Frequency changes can be made by varying C10.

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Placing the instrument in the case will make it necessary to retune L2 slightly.

After the instrument case is working and checked, all parts should be covered over with a Fiberglas-floss and resin mixture, especially L2. This prevents warbling of the beat note due to vibration. This Fiberglas coating is not shown in the photos.

Using the locator

Freedom from excessive pulling allows the locator to be operated at zero beat. Usually this is not possible, but it is quite successful with this indicator. From the operator's point, it is certainly the most attractive mode of operation, since the detector is quiet until metal is approached. Then it emits a low growl or rising squeal. This less sensitive operation is often more desirable, since it discriminates against ground capacitance effects, vibrations, etc.

More sensitive operation is obtained by using the detector at a low putt-putt beat frequency. The tone will either stop or increase in pitch as metal is approached, depending upon which side of zero beat the detector is operated.

Method is very important in locating buried objects. When searching for metals, move slowly and repeat your movements several times over an area that gives a promising indication. Repeated methodical movements can reveal something of the shape of the object if you chart the exploration. END

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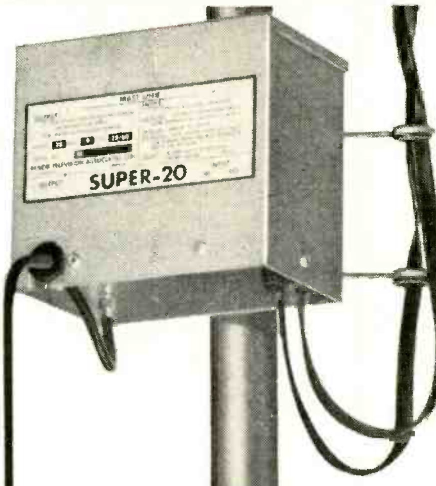

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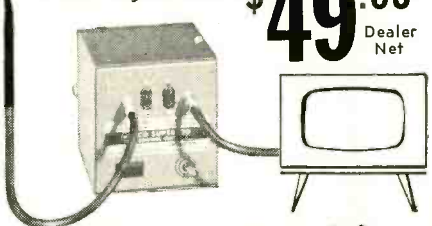

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Part II—What part will earth satellites play in the International Geophysical Year?

Electronics and the IGY

By JORDAN McQUAY

IN the search for scientific data during the IGY no single activity has stirred the imagination and interest of the world more than the earth satellites—the rocket-borne metal spheres sent into outer space to circle the earth, whirling free through an orbit in upper atmosphere. Long considered a theoretical possibility, it was not until recent development of rockets and missiles of tremendous size that this dream has become a reality.

In October, 1957, the first satellites were launched by Russia. A series of satellites will be launched by the United States during the late winter and spring of 1958.

Weighing about 185 pounds and about 2 feet in diameter, the Russian type of satellite is launched into space by multiple-stage rockets of tremendous size and thrust. Once it overcomes the gravitational pull of the earth at an altitude of several hundred miles, the satellite circles the globe in an orbit 200–400 miles above the earth at about 18,000 miles an hour. Altitude gradually drops over a period of several weeks or months, and the satellite eventually disintegrates due to air friction.

Although technical details of the Russian satellite have not been revealed, it contains a radio transmitter which broadcasts a coded signal (on 20 and 40 mc). Since it is powered by some sort of miniature storage battery, failure of the power supply after 4 or 5 weeks means the satellite moves silently through its orbit until it disintegrates. General theory behind the Russian satellite, however, is much the same as that of the several types of satellites soon to be launched by the United States.

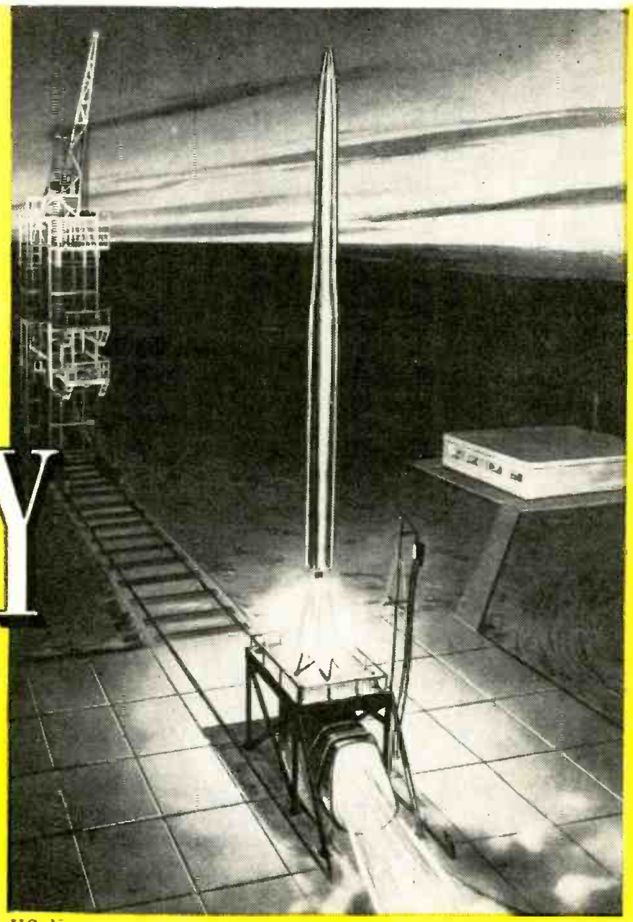

Fig. 1—How the rocket containing a US satellite would be launched

US Navy

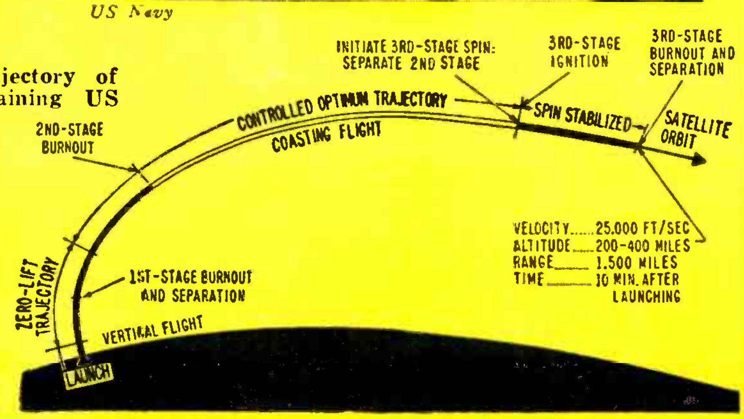

Fig. 2—Trajectory of rocket containing US satellite.

Satellite principles

High-altitude rockets, described last month, provided the first direct experimental observations of the upper atmosphere. These included data on air pressure, density, temperature, composition, wind fields, cosmic rays and other solar activities. A major limitation of these rockets is the brief period of time during which the measurements could be taken—usually for only 6 or 7 minutes. Rocket coverage is also restricted to a small part of the earth's atmosphere.

An artificial satellite, propelled into space and whirling in an orbit far above the earth, will provide weeks, months, even years of continuous, reliable data for scientific study. Also, the satellite traverses a vast amount of interplanetary space during each revolution around the earth and thus collects a great amount of geophysical information.

Once in its orbit, the satellite's velocity is such that its centrifugal force balances the earth's gravitational pull. Without additional propelling power, the satellite continues to circle the earth, making a complete revolution about once every 80 or 90 minutes.

The principal problem is launching the satellite and propelling it upward into its orbit. This is done by transporting the satellite in the nose of a multistage rocket which has sufficient power to carry the satellite into the upper atmosphere.

The United States uses a three-stage rocket (Fig. 1). It is 72 feet long and is launched vertically. Finless, it uses internal electronic controls for guidance. The trajectory of the rocket is shown in Fig. 2.

When fired, the first stage of the rocket thrusts the entire assembly upward almost vertically. It then tilts slightly until, at burnout, the rocket is inclined at about 35°. Then, its fuel exhausted, the first stage detaches itself from the rocket assembly. The second stage then drives the rocket to an altitude of about 140 miles, propelling it at a rapidly increasing speed to

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about 2,000 miles an hour, and—through electronic controls—diminishes the angle of inclination to only a few degrees. As the rocket levels off and coasts for some distance, the second stage detaches itself and ignites the third and final stage of the rocket. The third stage carries the satellite to its ultimate altitude of several hundred miles and to its top speed of about 20,000 miles an hour. The satellite separates from the third stage and, established in its orbit, continues under its own momentum—about 1,500 miles from the launching site and about 10 minutes after launching. Because of its extreme speed at time of separation, the third stage may continue to orbit somewhere in space behind the satellite. After some time, however, the third stage will drop in altitude until it disintegrates in more dense atmosphere.

Although a satellite may continue to circle the earth for protracted periods of time—several weeks, months or longer—ultimately atmospheric drag will bring its orbit closer and closer to the earth. When it enters the denser atmosphere of lower altitudes, the satellite (due to air friction) will burn out far above the earth's surface. Both it and burned-out stages of the rocket will drift to earth as indistinguishable dust and ashes.

While in flight, the tiny satellite broadcasts a periodic signal giving the specific data it measures—such as air density, pressure, temperature or solar activities. The radio transmitter in each US satellite weighs about 13 ounces and has a 10-mw output at a fixed frequency of 108 mc. It is crystal-controlled and completely transistorized. Some types of satellites may have transmitters powered by seven 1.2-volt miniature batteries. Others will be powered by solar batteries, which give the transmitter a continuous life until the satellite eventually disintegrates.

The type of data transmitted by a satellite depends upon the instruments contained within its spherical metal shell. Measurements are fed to electronic telemetering equipment, which translates them into coded signals.

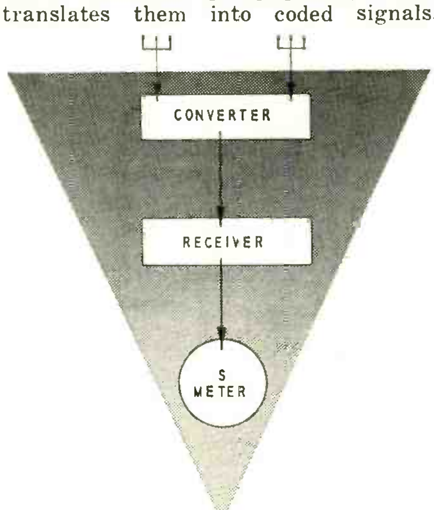


Fig. 3—Amateur type setup for tracking earth satellites.

Then, the radio transmitter broadcasts these signals to ground tracking and observing stations.

Tracking the satellites

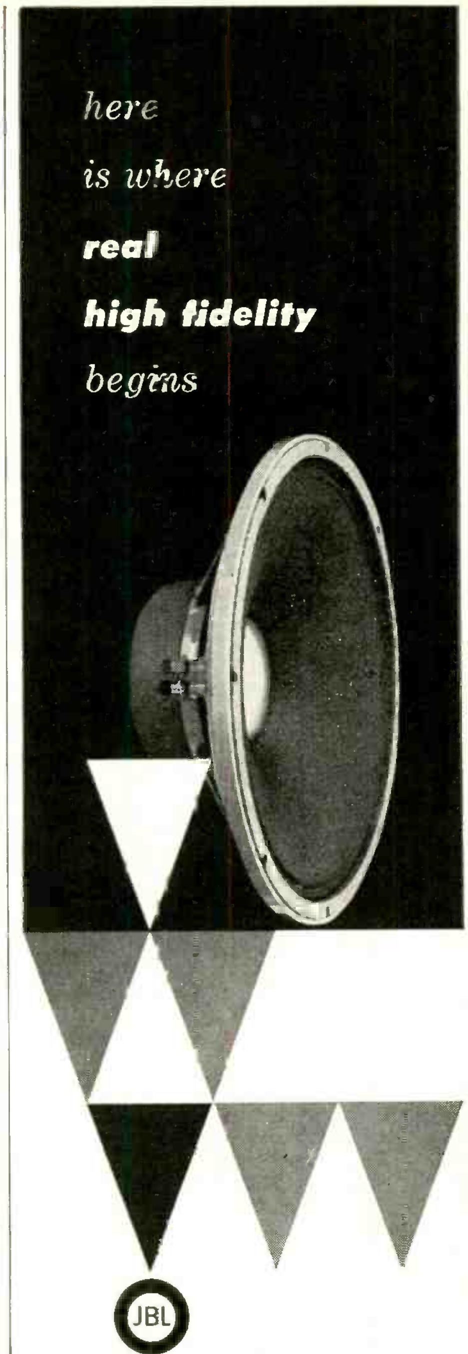
Once established in its orbit, a satellite must be tracked—both optically and electronically—to provide position and path information to correlate with other readings and measurements. With previous knowledge of the probable path of a satellite gained through electronics, observers at ground stations can use photo-theodolites for optical tracking. This method of tracking, however, depends upon fair visibility for good accuracy.

A more reliable method of tracking is the Minitrack system, which utilizes radio receiving equipment. The radio transmitter within the satellite produces a periodic signal at 108 mc, which is radiated by small antennas outside the metal sphere. On the ground, the signal can be detected by highly sensitive receiving equipment whenever the satellite passes in the general vicinity of a receiving station.

Orbits of all US satellites are expected to have a latitude range of about 35° above and below the equator. Within this broad belt, Minitrack stations have been erected by many governments at strategic points around the world. Although development and launching of the US satellite is primarily a contribution of this country to the IGY, all countries are participating in observing and measuring data obtained by each of the US satellites.

Each ground station of the Minitrack system is equipped with several sets of two specially designed and highly balanced receiving antennas, a frequency converter, a high-gain amplifier and a visual recording device. When tuned to the 108-mc frequency and with the satellite within receiving range, there will be an indication on the output recording device—the amount depending on the proximity of the satellite to the station. The satellite can be located in its orbit by comparing the signal from one antenna with the signal from the second antenna of each set. This is equivalent to comparing the path length of the signal from the satellite transmitter to one receiving antenna with the path length of the signal to the second antenna of each set of matched antennas. Similar measurements with other sets of matched antennas at the receiving station will fix the satellite even more accurately.

A simplified version of the Minitrack system can be used by radio amateurs residing in the region to be covered by each US satellite. As shown in Fig. 3, as few as two balanced antennas are connected, via a frequency converter, to the input of a conventional communications receiver. An S-meter or other visual indicating device is used at the receiver's output. As the satellite passes over the vicinity of the station, the receiver output varies from a minimum to a peak. The maximum reading



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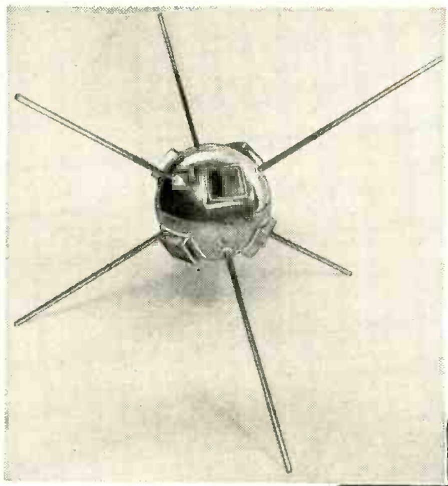

Fig. 4—A miniature US satellite.

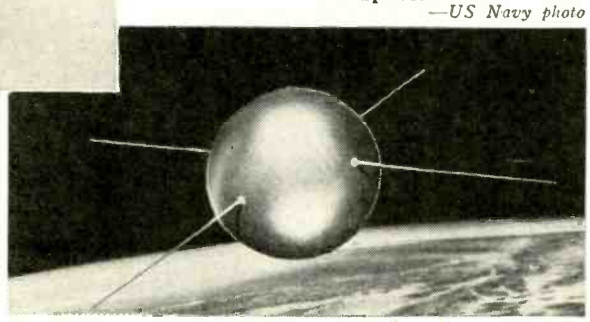

Fig. 5—A conventional US satellite in space.
—US Navy photo

determines the general position of the satellite. It recurs about every 90 minutes.

The equipment at each Minitrack station is considerably more complex and provides a high degree of precision measurement. In addition, the satellite signal is continuously recorded at each Minitrack station. In event of failure of the satellite's radio transmitter, ground-based radar equipment tracks the satellite.

All tracking information is transmitted to key or central stations. There, using instantly available data from *all* reporting sources, electronic computers calculate orbital information and predict the exact path of any satellite for each successive revolution. This prediction includes the time and place of meridian passage, the zenith angle and the angular velocity of a satellite in its orbit. With each successive revolution, these data are re-evaluated and recomputed, and new predictions are made by electronic data processing and computing equipment.

Data from the satellites

As each satellite travels through space, specialized types of scientific data are also obtained and measured by instruments within the sphere and then transmitted to ground stations for collation and record.

These specialized data may relate to the sun's ultra-violet rays, meteor particles, air density, cosmic rays, the ionosphere or any of many other fields of scientific endeavor during the IGY. The type of data obtained and telemetered to earth by each satellite depends entirely upon the type of instruments within the satellite. The instrumentation is usually different for each of the US satellites, depending upon its mission. By nature of their movement in space, however, *all* satellites provide important scientific data concerning air density, the shape of the earth, the ionosphere and other scientific fields.

Since the orbit of a satellite is influenced by local nonuniformities in the gravitational field, observations of the orbit at ground tracking stations make possible calculations of mass distribution of the earth. This, in turn, yields information about the composition of the earth's crust. Similar information, after electronic analysis, also provides data about the oblateness or flatness of the earth near the poles. Orbit observations also make possible precise determinations of latitude and longitude, particularly for isolated islands, many of which in the Pacific have never been located and mapped accurately.

Since radio signals from a satellite are affected as they pass through the ionosphere, this phenomenon permits measurement of refraction as well as other characteristics of the ionosphere. Such measurements are important to the study and prediction of radio-wave propagation.

All types of data collected and recorded during the IGY—by Minitrack, optical and other tracking stations as well as scientific observing stations—are transmitted to key or central stations. There the various data are fed to electronic data processing equipment for immediate or future reference.

From this mass of accumulated and correlated information, detailed and accurate scientific data can be compiled electronically and almost instantly months, even years, after a satellite has completed its flight through interplanetary space.

During this winter and spring, the United States will launch four miniature satellites. These are trial flights

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primarily to test the Minitrack and rocket-launching systems. Each of the test satellites is about 6 inches in diameter—the size of a grapefruit. Each has six protruding antennas and contains a tiny radio transmitter powered by solar batteries to convert energy from the sun into electricity. (See Fig. 4.) Each will be launched by a conventional high-power three-stage rocket.

Larger satellites, to be launched during this summer, will be equipped to obtain specialized scientific data. These are about 20 inches in diameter and weigh 21 pounds. Each is equipped with a transmitter and has four protruding antennas to radiate data to the ground. (See Fig. 5.)

The first of the large satellites will carry instruments to study the sun's ultra-violet rays and obtain environmental data. Succeeding satellites will record erosion of meteor particles in space, measure air density and composition, the earth's magnetic field, cosmic rays, and obtain other scientific data.

Other studies

There are numerous other studies of scientific significance during the IGY. Simultaneous studies in oceanography and glaciology are exploring the heat and water interrelationships that also affect the earth's weather and climate. A study of seismology leads to new knowledge of the earth's core and crust. Gravity measurements and related studies are also part of the activities of all participating countries. But electronics assists to only a very small degree in these international ventures.

Electronics, however, is widely utilized in most of these studies for recording, filing and storing the wealth of data obtained.

At key control centers throughout the world, the latest types of electronic data-processing equipment handle, record and store the vast amount of data collected continuously during the IGY. Electronic computers are utilized for fast computation and analysis. Data is recorded on punched cards or on metallic tape, then filed in electronic storage memories for future reference. This makes the handling of billions of items of measurement and observation largely automatic—through electronic processing.

The IGY is destined to yield unprecedented knowledge about the mysteries of the earth and the atmosphere and their relationship to the sun. In geophysics, the universe itself performs the experiments in which mankind is interested. The events that determine our physical environment are therefore world-wide in nature, and only through the cooperative efforts of all countries can their secrets be discovered.

Thus, through the joint effort of many nations, the International Geophysical Year is not only an expression of the scientific interests of various countries, but the scientific community of the world as a whole. END

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servicing stacked B-SUPPLY systems

By JAMES A. McROBERTS

Parasitic oscillation in lower section of picture produced by circuit defect in a stacked-B system.

IN series- or stacked-B supplies the plate resistance of a vacuum tube is considered as part of a voltage-divider network. Generally, the audio output tube is placed in series with if and other tubes, and the full B plus applied across the group.

The audio output tube in a stacked-B supply is an electronic regulator, acting as a variable resistor in series with the plate resistance of a string of tubes whose plate supply voltage is the 150-volt B bus, in this example. Fig. 1 shows the audio output circuit of the Crosley 426 chassis. R_x denotes the several tubes fed from the 150-volt line. The rheostat action of the audio output tube is controlled by the voltage at the junction of R2 and R3, which is held relatively constant, and the voltage at the cathode.

If the B-plus voltage decreases, the cathode voltage falls off. This decreases the bias on the 25L6 and produces an increase in plate current flow. The increased flow through R_x then raises the cathode voltage, restoring it to its original 150-volt value. An increase in B-plus voltage produces the opposite effect.

The regulated 150-volt bus in this circuit supplies the plate voltage to the front end, video if amplifier, bias to the C-R tube cathode, sync clipper, sync amplifier the sound if amplifier plus one or two other circuits. Therefore, if something happens to the audio tube we may expect any of many symptoms: the sync circuit will be disturbed; there may be no picture due to failure of the 150-volt bus supply to the front end and the video if tubes; if the 25L6 develops a short from plate or screen to cathode, the 150-volt bus would rise to about 260 volts and some components may fail.

The resistors supplying the plates and screens from the 150-volt B bus may overheat if such a short were to develop. The increased voltage increases the current and the heat produced.

It is not practical to test each and every component under such circumstances. Perhaps the best idea is to repair the set and then run it at a high line voltage on the bench. Or, at least, remember that the trouble may not be completely cured merely by replacing a shorted 25L6.

An open-circuited, or nearly so, 25L6 will affect all tubes fed from the 150-volt line. No picture may be due to a bad or weak audio tube!

Troubleshooting

Since the controlled bus (150 volts here) may affect many other sections of the receiver the first test is tube substitution no matter what the symptoms indicate. Even the high voltage may be missing due to supply of the horizontal oscillator by the controlled lower-voltage bus. The circuits supplied vary considerably with different receivers.

The next procedure, if substitution does not help, is voltage readings at the plate, grid and cathode of the audio output tube.

If the audio tube is cut off or does not pass normal current, the high B plus rises and may be 25–50 volts more than normal. Likewise, the voltage at the R2–R3 junction will rise since it is independent of the controlled B bus. The audio tube may have a very high resistance. If so, the 150-volt bus will be lower than normal.

A lower than normal 150-volt bus with a higher than normal supply voltage might be due to a change in value of the resistors controlling the audio grid voltage. These are frequent offenders and can be checked with an ohmmeter. Use at least 5% resistors in any replacements.

An unfortunate combination of excess tolerance of resistors may add so as to throw the circuit out of order even though the individual resistors may be well within tolerance. The bias voltages must be tailored to fit! A high-resistance shunting resistor or a low series resistor will assist in this correction.

A leaky capacitor from the controlled bus to ground may cause trouble. All voltages will be low, the audio tube will become extremely hot and may even burn out. Check the voltage after about 5 minutes' operation following the replacement of a dead audio tube. In one case a shorted audio tube damaged this capacitor. Then it became leaky, and the audio tube "wore out."

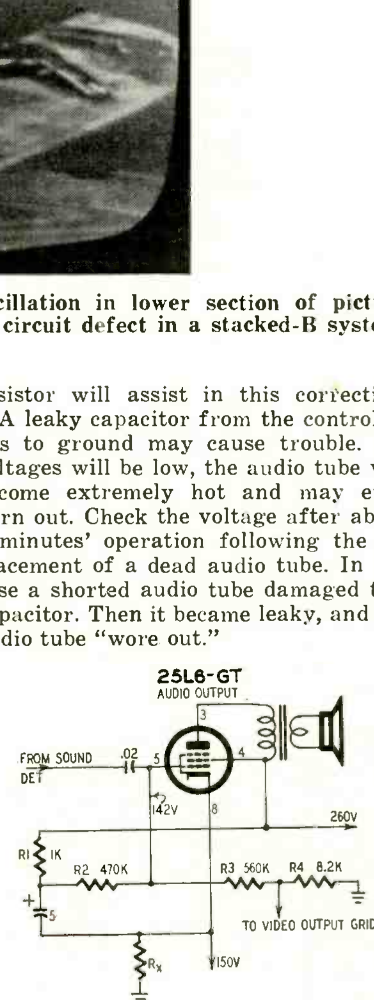

Fig. 1—Schematic shows essential circuitry in a typical stacked-B system.

The tubes on the controlled bus—mixer, if, etc.—must draw about normal current. If the voltage remains persistently high or low on the controlled bus while bias and supply voltages are near normal, then check these tubes by substitution. In one case the current to each had to be measured with a milliammeter before the trouble was discovered.

The photo shows an unusual case of parasitic oscillation due to excess voltage on the vertical oscillator in a stacked-B system. The cause was a defective (changed-value) resistor in the grid circuit of the audio output tube! END

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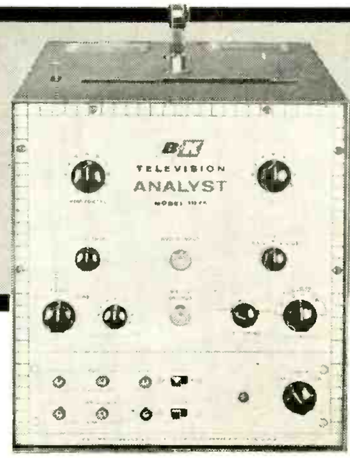
Sectional signal substitution is the secret behind a new TV test instrument that uses signal injection techniques to isolate the trouble.



The Television Analyst

By ROBERT G. MIDDLETON

A NEW concept recently has been introduced into the TV service field with the advent of the Television Analyst.

Basically, it is trouble shooting by *sectional signal substitution.* This is a rapid technique for troubleshooting by driving the various sections of a TV receiver—rf, if, video, sound if, chroma, horizontal output—with a known good signal. Thus the faulty stage in a TV receiver can be easily isolated.

This pioneer instrument, the B & K Television Analyst, model 1075 has built-in vertical and horizontal deflection systems. It also has two high-frequency oscillators for generating frequencies in the rf range covered by TV channels 2–6 and 7–13 and for the if range of 25–45 mc.

A crystal-controlled oscillator which produces a standard rainbow pattern for color servicing and a complete 4.5-mc FM sound system with a 400-cycle tone generator are also included. A flying-spot scanner generates complete video signals, such as a television test pattern, which can be viewed on the receiver being serviced. All of these signals are available at the front panel for rapid signal substitution. Any combination of video, color or sound may be used to modulate the rf or if carriers for high-frequency signal substitution.

Applying the video-frequency signal to the video-output stage provides a test pattern on the screen of the picture tube of either black-and-white or color receivers. This signal gives:

1. Bandwidth of the video amplifier—shown by reproduction of the vertical wedges in the test pattern.
2. Transient response—shown by presence and intensity, or absence of circuit ghosts (repeats in the sharp vertical lines of the test pattern).
3. Low-frequency response—shown by the production of long horizontal lines in the test pattern.
4. Gain of the video amplifier—shown by the level of contrast in the reproduced test pattern.
5. Linearity of video amplification—shown by reproduction of the gray scale in the test pattern.
6. Alignment of the 4.5-mc sound traps—shown by rejection or passage of the 4.5-mc sound sideband.
7. Alignment of sound takeoff transformer or coil—shown by output from the audio channel.
8. Operation of horizontal and vertical sync takeoff circuits—shown by sync stability of the test pattern.
9. Condition of the color subcarrier trap (in a color TV receiver)—shown by rejection (or passage) of the 3.58-mc beat.
10. Condition of the delay line (in a color receiver)—shown by the reproduction of vertical wedges in the test pattern.
11. Operability of the chroma takeoff circuit—shown by reproduction (or lack of reproduction) of a standard rainbow pattern on the screen of the color picture tube (in color sets).
12. Freedom from (or susceptibility to) intercarrier buzz—shown by the level of reproduced buzz in the sound, as the contrast-control setting is varied.

The Television Analyst is shown in the photo. Output cables come with the unit. Top-chassis signal injection can be employed if standard plug adapters are plugged into the tube socket and the tube inserted in the adapter. Various pin connections are provided at the outside of the adapter and signals are injected at these points.

If receiver operation is satisfactory when the video amplifier is driven by the video output of the Television Analyst, we next take if output from the Analyst and inject it at the grid of the last if amplifier. If the picture detector and last if amplifier are working properly, we get a satisfactory pattern. If trouble is present, we will see no pattern or a distorted one. Next, we check the detector diode or tube, and other components until the faulty part is found and replaced. Fig. 1 shows a normal test pattern.

Testing the if's

If trouble in the if amplifier is suspected, tune the Analyst to the receiver's if (this may be 25 or 45 mc). Then, apply the if signal to the grid of the last if stage. If the pattern is satisfactory, we proceed to the grid of the next-to-the-last stage, etc. Should the if strip check good, we go back to the oscillator–mixer stage.

To check for a dead or off-frequency local oscillator, apply an rf signal at (for example) channel 6 to the grid of the mixer tube. If the receiver's local oscillator is working, you will see a video pattern on the receiver under test and get an audio output. If the local oscillator is not working, the converter will not convert channel 6 to the intermediate frequency and no output will be apparent. It is then necessary to inject an if signal of the proper frequency at the mixer's grid, to check that circuit.

An rf signal on any low channel

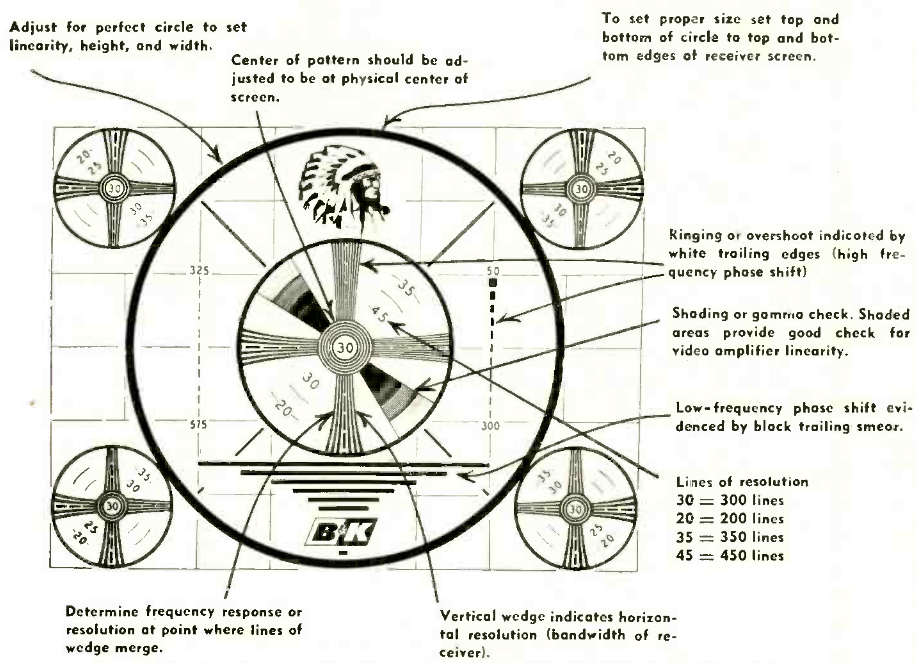


Fig. 1—A perfect test pattern. Points to check are noted.

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Fig. 2—Waveform of the horizontal drive supplied by the Analyst.

(fundamental output) or any high channel (harmonic output) can be applied to the grid of the rf amplifier stage. It can also be applied to the receiver's antenna input terminals.

In a color TV receiver, the foregoing tests also provide a check of chroma circuit operation. This is reserved for a more detailed discussion later.

Sweep tests

The flyback system is tested by applying drive to the horizontal output tube's grid. A normal test pattern shows that the sweep system is working, and that any faults will be found in the horizontal oscillator.

When drive is applied to the horizontal output tube, a voltmeter check quickly isolates trouble to the booster damper circuits or the horizontal oscillator. If normal boost voltage is found, the trouble is in the oscillator circuit. If there is weak or no boost voltage, there is a failure in the booster damper section. Fig. 2 shows the drive waveform used in flyback tests. In color TV receivers, where convergence circuits obtain drive from the horizontal sweep section, this test provides the starting point for troubleshooting the horizontal dynamic convergence circuit independently of associated receiver circuitry.

This type of flyback testing localizes troubles—reduced picture width, nonlinear scanning, raster ringing, excessive width, foldover, vertical lines and bars, raster distortion—to either the sweep or drive circuits. For example, a vertical line in the raster can originate in the horizontal oscillator circuits or the horizontal output system. Applying a known normal drive waveform immediately localizes the fault to one section or the other.

A drive waveform is also provided for the vertical output tube (see Fig. 3). This test localizes vertical sweep trouble to the sweep section or the oscillator and drive section.

When the faults are in the sweep output circuit, the technician substitutes or checks individual components to obtain normal sweep. However, if faults are present in the oscillator and drive section, as shown in the quick-check, he turns his attention to components in these circuits. Thus, waste of time in hit-or-miss approaches is avoided.

You might think that the Analyst has applications only in tests of indi-

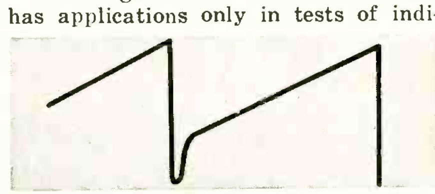

Fig. 3—The Analyst supplies this vertical drive waveform.

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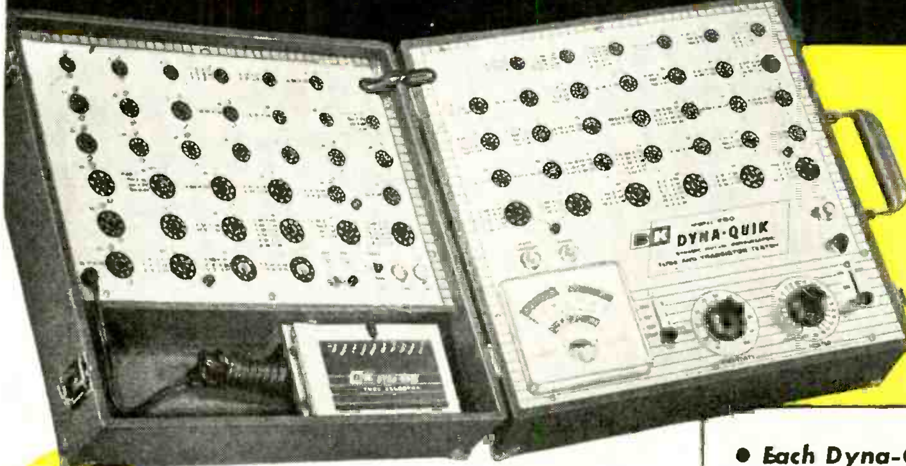

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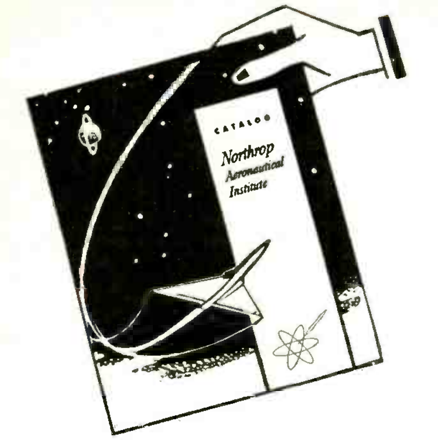

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vidual receiver sections. However, its field of design extends far beyond this limitation. Since many obscure faults which occur in service work result from interaction or crosstalk of reeciver sections, the Analyst is designed to run down this type of faulty operation.

To illustrate this class of test, consider the common complaint of vertical bar interference in the picture. As you know, such bars can result from velocity modulation of the horizontal scan. This type of trouble shows up when the test pattern is switched off and a blank raster is viewed. If the bars appear when the horizontal output tube is driven by the Analyst, you know that trouble is in the horizontal output circuit. Investigate, for example, the R-C network in the yoke circuit.

When the bars do not show up on drive from the Analyst but do appear when the horizontal output tube is driven by the horizontal oscillator, you know that the oscillator is generating a ringing waveform. Circuit corrections must be made in the oscillator to remove the ringing.

Vertical bars also result from ringing voltages in the video signal. Such bars do not appear in a blank raster. They show up only when the test pattern is applied (or when the receiver is tuned to a broadcast signal). Now, where does the ringing voltage come from? How is it getting into the video signal? What must we do to suppress the voltage or to stop its entry?

1. Apply the test-pattern signal to the grid of the video amplifier tube, and horizontal drive voltage to the grid of the horizontal output tube. Observe the test pattern.
   a. If the bars show up in the test pattern, look for crosstalk between the flyback circuit and the video output circuits. Crosstalk can occur between the yoke leads and the grid lead (or cathode lead) to the picture tube. Try separating these leads or temporarily shielding them. Crosstalk can also occur as a result of poor decoupling between the video amplifier and the horizontal sweep circuits. Try bridging the decoupling capacitor (s) with a known good one.
   b. If the bars do not show up in the test pattern, the crosstalk must be entering the signal circuits at a point prior to the video output stage. A further test is required.
2. Apply the test pattern signal to the input of the last if amplifier and horizontal drive voltage to the grid of the horizontal output tube. Observe the test pattern.
   a. If bars now appear in the test pattern, you have localized the point of entry to the if amplifier or detector circuit (input circuit of the video amplifier). Take steps to prevent entry of the interfering voltage or to eliminate it at the source.

You may find that the source of interfering voltage is in the flyback cir-

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Fig. 4—Crystal-controlled full-color rainbow display produced by Analyst.

cuit (this is the most common situation). That is, the interference persists whether we drive the horizontal output tube with the Analyst or the receiver's horizontal oscillator. Sometimes the interference occurs only when the horizontal oscillator is operating, and stops when drive voltage is used from the Analyst—this shows that the interfering voltage originates in the horizontal oscillator circuit.

In other cases, you will find that bar interference is not found in any of the foregoing tests. If so, inject the test-pattern signal earlier in the signal circuits, going step by step back to the tuner. You may even have to go back to the mixer or antenna input circuits before the bars appear in the test pattern. Then, you know where to pin down the trouble because you definitely establish the point of entry of the interfering voltage.

Chroma signal subbing

A rainbow display signal is available from the Analyst in video and modulated rf (or if) forms. This chroma signal can be injected at the input of the bandpass amplifier, at the grid of a low-level chroma demodulator, at the input of the video amplifier, at any point in the if circuits or in the rf section of the receiver.

These tests quickly pin down complaints of *no color*, *weak color* and *distorted color*. They also localize phase errors. Fig. 4 shows the appearance of the rainbow display pattern when receiver phasing is normal. Phase errors appear as a spectrum shift, the sequence of colors appearing incorrectly.

Briefly, phase errors arise in the chroma or if sections. It is possible for the rf or video sections to cause phase errors, but these are less common trouble points. If you inject the chroma signal into the bandpass amplifier and get a normal color pattern, the next step is to inject a modulated if chroma signal at the input of the if amplifier.

When a phase error is found in the later test, it indicates that the if amplifier needs alignment. A phase error in the former test indicates the need for chroma circuit alignment.

The rainbow signal provides a convenient method of checking quadrature, chroma channel gains and chroma matrixing. These are more specialized tests, which may be explained in a future article. END

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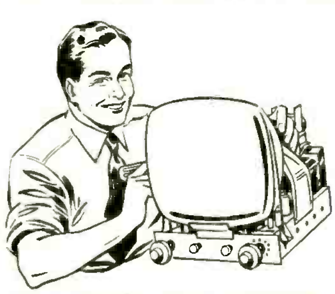

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watch out for these jokers!

An "easy job" can be a heartbreaker

By H. M. LAYDEN

EVERY so often a set comes into the shop with what are apparently simple faults such as raster but no sound or picture. Exploring the trouble, however, turns out to be no simple procedure. We have had our share of these "jokers" and think you might find interest and aid in our story.

One instance we recall most vividly was an Emerson 120134-G. The complaint was raster, no sound or pix. The outside man had tried tubes in the front end, if and video strips to no avail, so he pulled the chassis.

On the bench the first thing we tried was to put through an if signal from converter grid to detector load, but were unsuccessful. Next, we took voltage readings in the if strip and in the process discovered that the third and fourth if stages operate with their plates at ground potential, the cathodes returning to a more negative point in the voltage distribution system. (See Fig. 1.) So far, so good. But there was a fly in the ointment. The more negative point was, for some reason, also grounded. This was what was killing the if and blocking the signal.

At this point we realized we needed additional help. Where was the schematic? Believe me, a large, well-defined schematic diagram is the benchman's best friend. Ours was quickly consulted and after some careful scrutiny the light began to seep through. It revealed the 12AU7 used as the first sync separator and first amplifier operated with one cathode grounded at the chassis while its heater was tied to the 160-volt negative bias bus. (Fig. 1.) Eureka! A cathode-to-heater short here would be just what we were looking for, and it was. A quick substitution and the set was back in action again.

Actually the time taken to locate the defect was much longer than it took you to read this account. Capacitors were lifted and resistors checked to locate the short. You know from experience that sort of thing can take too long!

In sets where the difference of potential between chassis ground and the negative return is considerable, the service technician often has a headache on his bench.

Sync buzz

An annoying case of sync buzz turned up in an RCA 9TW333, KCS 30-1. With the volume control set at minimum a loud buzz was heard. Advancing the control brought up the level of the sound signal, but the buzz remained. After the usual checks to determine if the vertical sweep circuit was the culprit and deciding it was not, we began investigating the audio section. The first audio tube was pulled, but the buzz was still with us. Next, the plate coupling capacitor between audio stages was lifted at the grid end. Wrong again. This left one remaining possibility for investigation, the B-plus feed. For our working hypothesis, it was assumed the buzz was being introduced via the plate-cathode circuit of the audio output tube in some manner. A scope examination showed pix and sync information of high amplitude at the cathode. What manner of beast was this?

We dragged out the diagram, traced the cathode and found it went to the negative supply, −120 volts. Tracing the video signal path showed the video output tube's grid returning to chassis ground (Fig. 2). Now we felt we were getting somewhere for these two points were connected through a section of the voltage divider. It didn't take much imagination to conjure up what would happen should this common impedance be improperly bypassed. The pix information would modulate the dc in the B-supply feed. The designers provided an 80-μf electrolytic section as the bypass agent. We located it on the chassis and found out why this bypass was not serving the purpose for which it was provided. It was not connected! The lead from the positive terminal going to ground was broken off at the capacitor. It had either been clipped or the strain on the short lead was too much for it. A little surgery, and the trouble was licked.

Many RCA sets employ this type of low-voltage power supply. A dried-out

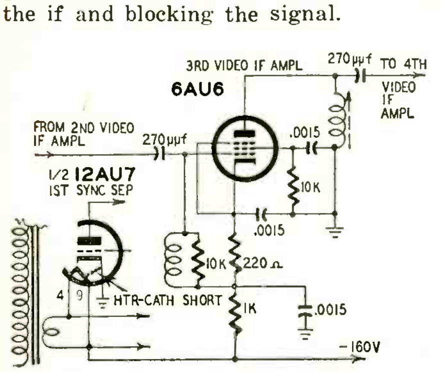

Fig. 1—Emerson 120134-G, cathode-heater short caused no picture or sound.

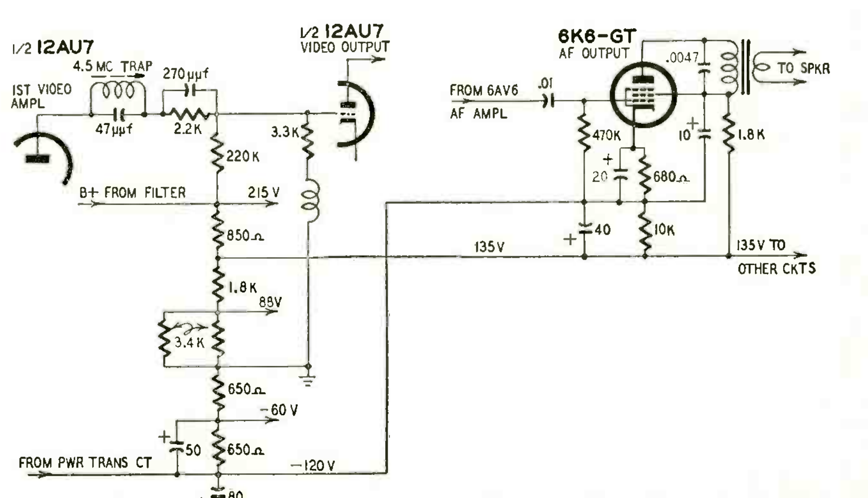

Fig. 2—Sync buzz in RCA KCS 30-1.

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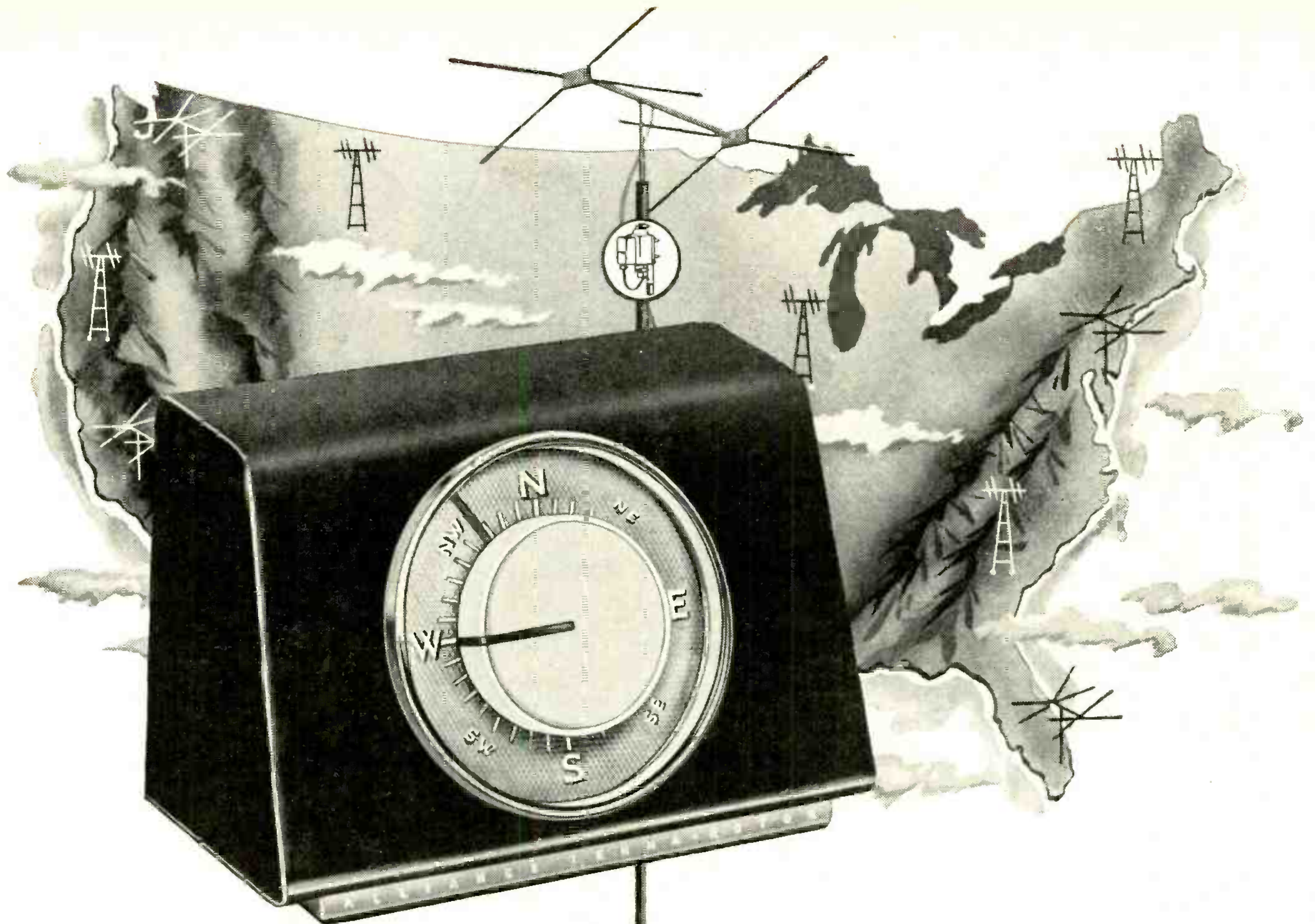

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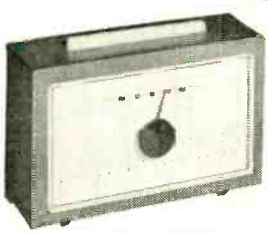

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electrolytic section connected from chassis to the negative return could bring about the same symptom—*annoying buzz.* It might be well to keep this case in mind when confronted with buzz in these sets.

Expanding picture

Another case of what appeared to be a simple, easy-to-locate fault was an Olympic TV-948. The complaint was inadequate height. A vertical spread of 3 inches in the center of the screen was all that could be coaxed out of the vertical controls. Sync, too, was missing, and a new tube did nothing for it. A routine bench check showed an open primary in the blocking oscillator transformer. Evidently the tube was oscillating through capacitive feedback, accounting for the 3-inch spread. A new transformer was installed, the vertical controls adjusted and the set placed on the cooking table to do its stuff. After 20 minutes it showed an expanded picture vertically, overlapping the mask considerably.

Before changing the tube, a 6SN7-GT, the controls were again manipulated for proper height and linearity, and the set again allowed to cook. Once more the very same effect. The picture had expanded, overlapping the mask. To bring it back to normal this time, the linearity control had to be set at the maximum resistance end of its range. A new tube was inserted, the controls properly set and again the set was allowed to cook. Yep, it happened again in exactly the same manner. Back on the bench once more, the vertical output circuit was explored. The plate of this section is fed from the B boost through the primary of the vertical output transformer. The plate measured 325 volts; the boost 410 volts. Here was the cause of our trouble. The tube manual recommends a plate voltage not to exceed 300 for 6SN7's. Here we were working the tube way beyond its ability to dissipate its heat. What to do? We experimented with the drive control, monitoring the boost voltage as we reduced the drive. When the boost reached 375 volts, we inspected the screen to see if we had too much width or too little high voltage. Both were OK. The plate voltage at the vertical output tube now showed 275. We readjusted the controls and let the set cook once more. This time it held up and as far as we know has not acted up since, which was over 6 months ago. Someone evidently had adjusted the drive before the set came to us.

This case serves to bring to mind the fact that modern design often employs the boost voltage to work the vertical output tube. A defect in the boost, while in the horizontal section, can and often does affect the vertical circuit's operation.

The service technician needs to be more than a mere tube puller. He has to be ever on the alert, on the ball all the time, and his best friend is the schematic diagram. Be seeing you. END

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tv dx

By ROBERT B. COOPER, JR.

JUST when we think we have the hobby figured out, it springs another surprise on us. The fan must rely on the oddities of the atmosphere and ionosphere to bring him his much-sought-after long-distance reception. But every so often the line between atmospheric and ionospheric wave propagation becomes nonexistent, and we TV dx experts begin to wonder just how a signal maneuvered from point A to point B.

Such is the problem with three Western loggings made during the month of October, 1957. Dxer Ed Hepp of Portland, Ore., notes the reception of KBOI, channel 2, Boise, Idaho, over a distance of 365 miles on Oct. 14, and again on Oct. 17. Each occasion was near 1630 hours PST. Reception was weak and steady, not unlike long-range tropospheric reception experienced in Eastern states. The terrain covered—hundreds of miles of Cascade mountains and generally impassable ground—makes such tropospheric reception virtually unknown west of the Rockies.

And then on Oct. 30, 1957, in Fresno, Calif., I received KBOI, Boise, for five minutes, at 1130 hours PST. The fact that the same station is involved in all three loggings may be more than a coincidence. The distance from Fresno to Boise is 630 miles, an unheard-of distance for tropospheric reception in Western states. Reception, like that of dxer Hepp, was weak, with slow fading. Perhaps Western dxers are experiencing a new form of dx reception, peculiar to Western terrain problems. Whatever it is, RADIO-ELECTRONICS is very interested in receiving any similar reports involving dx reception in mountainous areas.

F2 from Europe

Our European television dx-pert, Gordon Simkin, formerly of Havre de Grace, Md., now reports European television reception from Loma Linda, Calif. Gordon notes that BBC television on 41.5 mc was first logged on Oct. 9, at 0729 hours PST. BBC video on 45 mc was seen on Oct. 27, from 0810 to 0830 hours PST with better average signals than the best seen in Maryland. This appears to be a result of less ghosting or, in other words, fewer transmission paths. Gordon is working on some BBC identification-call slide photographs, taken in Loma Linda, for a future TV dx column. Other reception of poorer quality has also been noted from Ireland, Germany and France.

I still have no reports of possible transcontinental F2 reception (Maine to California) although I feel certain that such reception was possible on a few peak days in November and early December. This is especially true for a radio path such as Nova Scotia to Oregon and northern California.

By the end of March we will reach the so-called ultimate low in television dxing. Fair-weather dxers have allowed the rotator to rust and knobs to become dusty, but not without fond memories of the winter E-skip season. Although this is being written as the winter E_s is just beginning, all signs point to a very productive session. The period of Dec. 15 to 22 appears to have been very good throughout the Eastern and Central portions of the country, while Dec. 20, 21 hit the West and Southwest with frequent periods of E_s. Double-hop E skip was observed on channels 2 and 3 on the evening of Dec. 20, between central California and western Florida. This was, indeed, very unusual for a wintertime opening. Up to 6 hours of E_s was observed on Dec. 21 in some Western regions.

Predictions

Meteor showers head the prediction department this month. Several minor showers appear in March and April, with a major shower occurring April 17-21. Dxers will find that low-band channels, clear of locals during a meteor shower, will produce burst counts as high as 70 per hour with only an average-sensitivity dxing setup. During periods of test-pattern transmissions, call slides at station breaks and local news shows with the station call letters visibly displayed, station identification out to 1,400 miles is a relatively simple matter.

Tropospheric bending, or extended ground-wave dx, will be exceedingly productive throughout the South and especially along the Gulf Coast, during March and April. Watch for obvious signs of improving ground wave, such as fringe-area stations becoming stronger and dropping their snow. Strong, steady fringe-area stations are a good sign of trops dx; strong, fading fringe-area stations (fading into snow, etc.) are seldom a *good* sign of anything.

Dxers should not pass up the uhf band during such periods of good trops—our present 750-mile uhf record was set in April, 1956, during such a session.

Sporadic E skip in most areas will be very low, although not unheard of. Mexico City, Guatamalan and Cuban stations often appear in the early evening hours from southern California to South Carolina, during March and April. Beginning around April 10, the summer E-skip season will begin to evolve in southern latitudes, from Florida to Texas. After a slow beginning, with E skip in the late afternoon and early evening, the warm months' E_s season will be in high gear. By the 21st of April, E_s should be hitting all corners of the United States and Canada at frequent early morning and early evening intervals. More about this in the May column.

Transequatorial scatter

Dxers in Florida, southern Texas, Cuba and Mexico should be alert for nighttime reception from Venezuela, Brazil, etc., as a result of a form of wave propagation known as TE (*trans*-*e*quatorial) scatter. On the southern end of the path, dxers in Argentina report frequent reception from Venezuela, Brazil, Cuba, Mexico, Guatamala and Puerto Rico in the evening hours, beginning around 1700 local time. Distances vary from 900–5,000 miles, with signals displaying violent fading and much ghosting. The period of March 15–April 21 should be the best for such reception. (This reception appears to be quite dependent on the current high on the sunspot cycle.) Channels 2–6 are affected. Dxers farther north should also be wary of an evening E-skip session occurring to the south during this period, as the E_s session is likely to extend the TE into more northern areas.

FM DX reports?

For some time now, the editors of RADIO-ELECTRONICS have felt that a section devoted to long-range FM reception, and the equipment needed for same, might fill a very definite need in the vhf field. Many television dxers also maintain FM listening posts as a check on improving tropospheric conditions, upper reaches of E skip, etc. And such forms of wave propagation as meteor scatter and forward tropospheric scatter are much easier to work with when you are employing the comparatively narrow-band techniques of FM broadcasting (compared to TV bandwidth). In short, FM provides a way of keeping tabs on vhf conditions in the region lying between TV channels 6 and 7 and tracking 108-mc US satellites.

At this time, we would like to sound out readers' opinions as to the advantages in running an FM (88–108-mc) reception column. If we have sufficient interest in an FM column, one will be established post-haste.

RADIO-ELECTRONICS magazine and the TV dx column editor have already established a policy of providing TV Dx Report Forms free.

If you haven't begun to make regular use of the reporting forms, why not drop a postcard with your name and address to TV Dx Column, RADIO-ELECTRONICS Magazine, 154 West 14 Street, New York 11, N. Y. END

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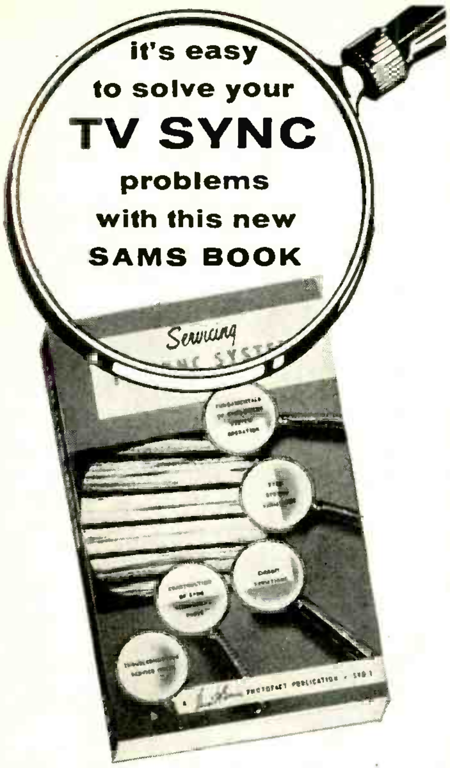

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COLOR picture analysis is a large subject. For example, did you know that if the color subcarrier oscillator gets too far off frequency, a combination rainbow and color bar pattern will lock in color sync?

A normal color bar pattern in color sync is shown in Fig. 1. Likewise, a normal rainbow pattern in color sync is shown in Fig. 2.

The color bar pattern is characterized by sharp transitions of color at the edge of each bar. The rainbow pattern, on the other hand, displays a progressive blending of hues from orange through reds, blues and greens.

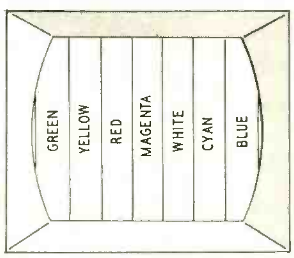

Fig. 1—In a standard color bar pattern individual vertical color bars are locked in color sync.

Now, if we apply a color bar pattern to a color receiver in which the subcarrier oscillator is operating 15,750 cycles off frequency, we obtain a combined color bar and rainbow pattern locked in color sync. The hues of the bar pattern and of the rainbow blend together to make a color pattern which is very confusing when first encountered by the beginner (see Fig. 3).

It might appear odd that a rainbow pattern develops when the subcarrier oscillator is operating 15,750 cycles off frequency. However, this occurs because the only requirement for rainbow generation is that there exists a 15,750-cycle *frequency difference* between the subcarrier oscillator and the applied signal.

Whether the receiver is operating on frequency, and the applied signal is off frequency, or vice versa, makes no difference—a rainbow is generated. Hence, when an off-frequency subcarrier-oscillator heterodynes with a standard color bar signal, we obtain a pattern which is a blend of a color bar and a rainbow display.

Many color receivers cannot drift 15,750 cycles off frequency, so they do not display the discussed characteristic. However, receivers with L-C subcarrier oscillators will display up to 15 or 20 rainbows over a color bar pattern when the oscillator is detuned.

Vertical foldover

A Crosley chassis No. 331-2 has severe vertical fold. The picture appears to be on a drum. I have replaced the sawtooth capacitor, blocking-oscillator transformer, output transformer and yoke. The set worked OK for about a week, when foldover returned.—B. E. R., Perrysburg, Ohio

When the picture appears to be on a drum, the trouble is caused by strong 60-cycle sine-wave voltage entering the sweep circuits. It may start from heater–cathode leakage or from an open return circuit that picks up stray 60-cycle field and feeds it to a grid. This type of trouble can be run down easily with a scope. Check the 100-μf electrolytic off the vertical output tube's cathode and the two series 40-μf capacitors off the arm of the height control. You will unquestionably find 60-cycle sine-wave voltage at the grid, pin 5, of the 6V6 vertical output tube. Check back step by step until you locate the point at which the 60-cycle sine-wave voltage is entering.

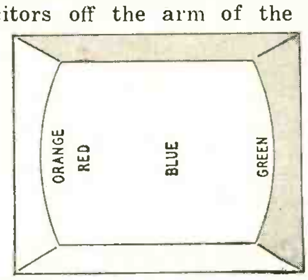

Fig. 2—In a rainbow pattern, a continuous spectrum of color-difference hues are locked in color sync.

Blame the agc

A seemingly unrelated series of breakdowns has occurred in an Admiral 21P1 chassis. Vertical buzz developed about a month ago. I corrected it by replacing the vertical output transformer. Two weeks later, white specks and buzz again appeared for a while *and then disappeared. A couple of weeks later the raster blanked out. Rotation of the channel selector to a blank channel brings the raster back.—R. G., New York, N.Y.*

Difficulties such as these in which reception is affected by channel switching are caused by feedback and internal oscillation of the various receiver sections. The cause of the trouble is an open decoupling capacitor, usually in the agc system. Try a 0.25-μf capacitor shunted from the agc line to the chassis. If this doesn't help, check all capacitors in the agc system for opens.

Bigger screen

An Emerson 701-D, chassis 158B has a bad 17BP4 picture tube. I wish to replace it with a 21EP4. I would like to know how the circuit should be changed, if a change is necessary.—J. F. V., Philadelphia, Pa.

You can use a 21EP4 to replace a 17BP4 in an Emerson 701-D. The sweep circuit and high-voltage system will require no change. This is a rather special situation because there are smaller-screen tubes which you would not be able to sweep satisfactorily without replacing the flyback and yoke. The 21EP4 is fairly easy to sweep and will replace the 17BP4 directly.

Hot oscillator

In an Admiral 19F1 chassis, run 4, the 6J6 runs hot and is soon ruined. When the shield is on the tube, it causes the tube to crack. What causes these failures?—R. S., Sunland, Calif.

Cracking and overheating of the 6J6 are caused by low or positive grid bias. The grid circuit should be checked with a vtvm to find out why bias is not normal. Low bias causes heavy plate current, which overheats and damages the tube.

Pincushion

There is pincushioning of the picture in a Silvertone 528.52001 chassis. I installed antipincushion magnets, but this did not help. Could the trouble be caused by the yoke?—F. L., Fall River, Mass.

From the somewhat limited data available, the only diagnosis that can be made is that the yoke must be at fault. The only possibility of some component other than the yoke causing the trouble would be if the effect is not a true pincushion, but rather a severe vertical nonlinearity. In this case, there are several other courses

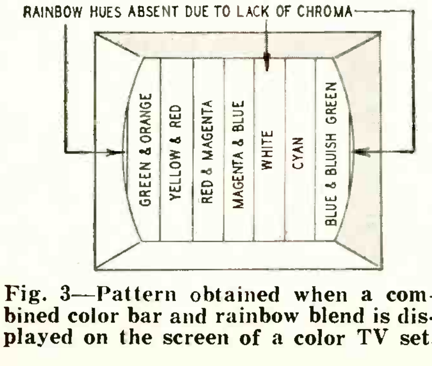

Fig. 3—Pattern obtained when a combined color bar and rainbow blend is displayed on the screen of a color TV set.

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of action which might aid in solution of the problem. If it is a true pincushion, replacing the yoke is the only answer.

Color TV flyback

An RCA color set, No. 21-CT-55, needs a new flyback. It will cost about $60 for a replacement. A black-and-white universal flyback costs about $5.50. Would it be possible to use a couple of these connected in parallel with a voltage-doubling high-voltage circuit? I have saved every issue of RADIO-ELECTRONICS *and* RADIO-CRAFT *since 1939.—H. L. L., Fair Oaks, Calif.*

First of all, I must say that this is something of a record. Every issue since 1939 means a total of over 200 copies! How about that?

In reply to the flyback question, the circuit draws a much heavier current in a color receiver than in a black-and-white set. There are also several pulse windings on the color flyback transformer. It would not be practical to use more than one transformer in parallel because the impedance-matching problem will lead to an impossible situation. The best precaution against flyback burnout is to fuse the circuit.

Drifting horizontal frequency

I have a Crosley model G-17TOMH on the bench. When it is first turned on, there are only horizontal lines on the screen. The picture can be locked in by adjusting the horizontal hold control. After 5 or 10 minutes the control must be readjusted. If room temperature goes above 80°, it becomes almost impossible to lock a picture in.—R. G. C., St. Paul, Minn.

After trying a new 6SN7 (horizontal oscillator), a marginal electrolytic capacitor is the next suspect. Let the set run for a half hour or so. Then touch the electrolytics. If one is much warmer than the others, it is probably at fault. If you check the B-plus lines to the sync and sweep sections, you will probably find a gradual drop in B-plus voltage as the set warms up. If a bad electrolytic is not the trouble, check the ceramics tied to the horizontal frequency transformer and elsewhere in the horizontal circuits. Replacement is the only check. With age these units become sensitive to temperature and change in value with changes in temperature.

Install casode tuner

I have a Sentinel model 1U420 and would like to change the tuner to a cascode type.—H. D., Sherman Oaks, Calif.

It is quite practical to change the tuner to a cascode type. This receiver uses a 23-mc if and hence the replacement tuner must provide this output frequency. Probably the trickiest part of the job is a slight modification of the tuner's output circuit.

The tuner conventionally used in this chassis does not have the input if coil mounted in the tuner section. Instead, the mixer plate (called the modulator) is connected to a 23.4-mc if coil located at the beginning of the if strip.

The if output coil supplied with the cascode tuner should be removed, and a lead is run directly from the plate of the mixer in the cascode tuner to the junction of C24 and T2 in the if strip. In this way, the original alignment and response of the if amplifier will be disturbed the least. The lead from the mixer to the first if coil is a high-impedance lead and should be suspended freely in the air, not running close to metallic surfaces or other components.

The heater lead from the tuner is black and can be connected to the same source as in the original tuner. The agc lead from the tuner is white and can be connected to R47, as in the case of the original tuner. The blue B-plus lead can be returned to a suitable source of 220 volts. You can use the original B-plus lead from R39 if you insert a 3,300-ohm 2-watt resistor in series with the lead. This resistor drops the 250 volts somewhat, and also helps to keep rf signal out of the B-supply line.

The red B-plus lead can be returned to the same voltage source (R39) if you place a 15,000-ohm 2-watt resistor in series with the red lead. This resistor drops the supply voltage to a suitable value for the mixer and oscillator tubes and helps to provide high-frequency isolation.

To be certain of obtaining the desired results from the new tuner, it is advisable to check the if response curve with a good sweep and marker generator and scope. The tuner itself will probably be shipped with accurate alignment adjustments.

If you have difficulty in obtaining the specified response curve, shunt a 100-$\mu\mu$f disc capacitor from each of the input terminals of the tuner to chassis.

Yoke resistor burns

I have a Motorola TS-95 which burns out the 100,000-ohm resistor in the yoke every few months. All voltages check OK. Is this a common trouble with this receiver?—R. O., Oleum, N. Y.

Burnout of the 100,000-ohm resistor in the yoke (R98) is not a common occurrence. The most likely cause is an intermittent open in the yoke winding L240. If you cannot locate the fault, the best procedure will be to replace the yoke and this will doubtlessly clear up the trouble. END

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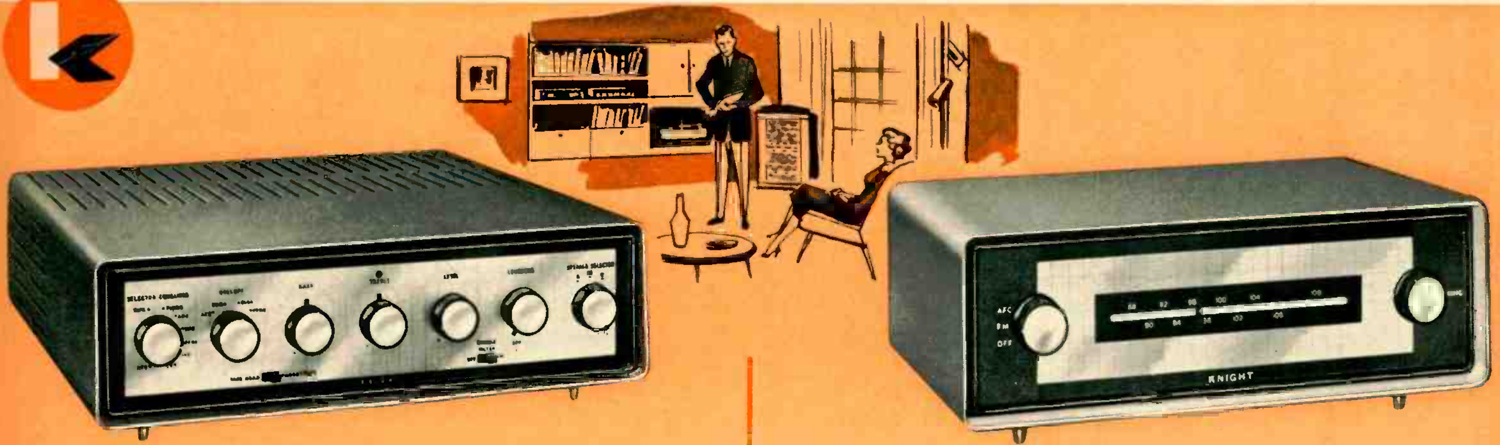

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- Printed Circuit • Pre-Adjusted Coils and IF's
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Here is top value in creative engineering, impressive hi-fi performance and distinctive design—a tuner you'll be proud to build and own. Covers the full FM band, 88 to 108 mc. Features Automatic Frequency Control (with disabling feature) to "lock-in" stations and prevent drift; Inertia Flywheel Tuning for velvet-smooth, accurate station selection; pre-adjusted RF coils; pre-aligned IF's; cascode broad-band RF amplifier; drift-compensated oscillator; neon bulb pointer. All critical wiring is already done for you in the form of a printed circuit board—assembly is simple. Sensitivity is 4 microvolts for 20 db of quieting across entire band; output, 2 volts at 1000 microvolts input; IF bandwidth, 200 kc; response, 20-20,000 cps. with only 0.6% distortion. Output jacks for amplifier and tape recorder; cathode follower output. Ideal for use with the KNIGHT-KIT amplifiers, or any amplifier with phono-tuner switch. Features custom-styled case in French-gray, with tapered chrome-finished feet, 4 x 13 x 8". Includes all parts, tubes and step-by-step instructions for easy assembly. Shpg. wt., 12 lbs.

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- Klipsch Designed and Licensed
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- Easy to Assemble—Top Hi-Fi Quality
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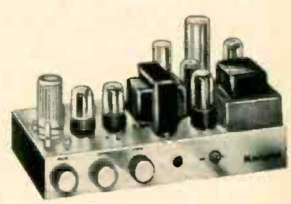

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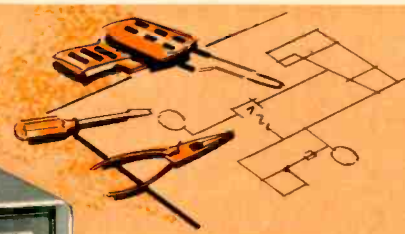

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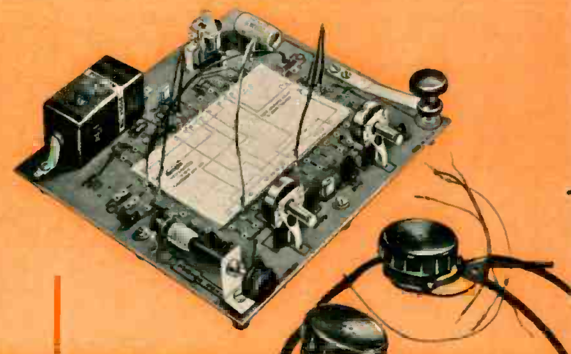

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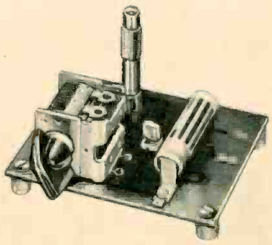

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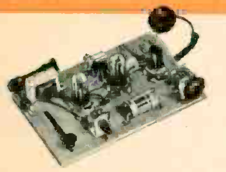
$3.95 Offers excellent AM local broadcast headphone reception. Printed circuit board for easy assembly. Operates from single penlight cell for months. Complete with all parts, transistor and penlight cell. (Antenna and headphones required.) Shpg. wt., 1 lb.

Model Y-765. Net only **$3.95**



"10-In-One" Electronic Lab Kit

$12.65 Famous experimenters' kit. Builds any of 10 fascinating projects, including broadcast receiver, wireless phono oscillator, code practice oscillator, signal tracer, relays, etc. Shpg. wt., 5 lbs.

Model Y-265. Net only **$12.65**

"6-In-One" Electronic Lab Kit

$8.45 A favorite with beginners. After basic wiring is completed, you make circuit changes without soldering. Builds any of six favorite projects, including radio, wireless broadcaster, etc. Shpg. wt., 3 lbs.

Model Y-770. Net only **$8.45**

Crystal Set Hobby Kit

$2.15 Entertaining, educational. Delivers clear headphone reception of local broadcast stations. With all parts, ready for easy assembly. (Antenna and headphones required.) Shpg. wt., 1 lb.

Model Y-261. Net only **$2.15**

Wireless Broadcaster Kit

$9.50 Play music or make announcements through your radio set—no connection to set required! Loads of fun—easy to build. Works up to 50 feet from set. Shpg. wt., 3 lbs.

Model Y-705. Net only **$9.50**

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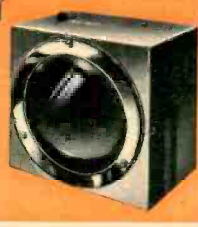


Interruption of light beam triggers relay, which in turn sounds chime or bell, turns on lights, etc.

knight-kit Photoelectronic Relay Kit

Model Y-702

$13.50

Advanced-design, ultra-sensitive photoelectronic relay—build it yourself and save! Dozens of uses: for automatic control of lights, door announcer, burglar alarm, counting devices, etc. Provides dependable operation up to 250 feet with white light, up to 125 feet with "unseen" light (red filter) from Light Source Kit listed below. Selectable operation, with "trip" for burglar alarm to provide continuous ringing of alarm; and "auto" if relay is to operate each time beam is broken (for chimes, counting devices, turning on lights at darkness). Has SPST relay operated from thyratron; 6.3 v. terminals provide power for accessories. For 105-120 v. 50-60 cy. AC use. 6 lbs.

Model Y-702. Relay Kit. Net only . . **$13.50**

Model Y-703. Light Source Kit. With bulb and red filter. Shpg. wt., 3½ lbs. Net. **$6.75**

knight-kit "Ocean Hopper" All-Wave Radio Kit

Model Y-740

$11.95

This top-performing regenerative receiver puts a world of listening pleasure at your finger-tips. Tuning range (using coils listed below) is virtually world-wide; covers 155 kc to 35 mc. including every type of radio transmission: AM broadcast, marine, aircraft, distress channels, direction-finding, Amateur, frequency standard, foreign broadcast, and police. With band-spread tuning. For use with headphones or 3-4 ohm PM speaker. Kit is supplied with standard broadcast band coil and all tubes and parts. (Less extra coils, headphones, speaker and cabinet.) Shpg. wt., 5 lbs.

Model Y-740. Net only **$11.95**

Y-746. Cabinet for above. 1½ lbs. Net **$2.90**

Extra coils available: Long Wave Coil (155-470 kc). Net 79c. Short Wave (1.65—4.1 mc; 2.9—7.3 mc; 7—17.5 mc and 15.5—35 mc), Each 65c.

knight-kit "Space-Spanner" Bandswitching World-Wide Radio Kit

Model Y-243

$15.95

- Broadcast or Short Wave Reception
- Sensitive Regenerative Circuit
- Convenient Bandspread Tuning
- Built-In Loudspeaker

Imagine the thrill of hearing overseas broadcasts on a precision receiver you've built yourself—and then, at the flip of a switch, being able to tune to your favorite local broadcast station! Bandswitch selects exciting short wave, including foreign broadcasts, amateur calls, aircraft, police and marine radio on the 6.5 to 17 mc range, as well as standard 540-1700 kc broadcasts. Features highly sensitive regenerative circuit. Includes built-in 4" PM speaker and beam-power tube for strong volume and clear tone. Headphone connectors are available for private listening; switch cuts out speaker. Controls: Bandspread, Main Tuning, Antenna Trimmer, Bandswitch, Regeneration, Volume. 7x10x6". Easy to build from step-by-step instruction manual. For 110-120 v., 50-60 cy. AC or DC. (Less cabinet.) Shpg. wt., 5 lbs.

Model Y-243. Net only **$15.95**

Y-247. Cabinet for above. Shpg. wt. 2 lbs. Net. **$2.90**

"Ranger II" Superhet Receiver Kit

$17.25

Popular Broadcast band receiver built and enjoyed by thousands. Features built-in antenna, automatic volume control, ball-bearing tuning condenser, PM dynamic speaker. Handsome plastic cabinet. Easy to assemble. AC or DC operation. Shpg. wt., 8 lbs.

Model Y-735. Net only **$17.25**

knight-kit 2-Way Intercom System Kit

Model Y-295

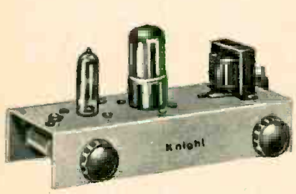
$14.75

- Low Cost—Easy to Assemble
- High Gain—Clear Tone
- Handsome Metal Cabinets
- Includes 50-Foot Cable

Easy to build at lowest cost—ideal for home, office, shop or school. Consists of Master unit and Remote unit. Remote unit may be left "open" for answering calls from a distance, for "baby sitting", etc. Remote also may be set for "private" operation—cannot be "listened-in" on, but it can be called and can originate calls. Master unit includes high-gain 2-stage amplifier, combination volume control and on-off switch, plus pilot light. Each unit has 4" PM dynamic speaker. System responds to even a whisper. Handsome Antique white cabinets, each 4¾x6½x4⅜". With all parts, tubes and 50-ft. cable (up to 200-ft. may be added). For 110-120 v., AC or DC. 8 lbs.

Model Y-295. Master and one Remote. Net only . . **$14.75**

Y-296. Extra Remote Station Kit. 3 lbs. **$3.75**



Phono Amplifier Kit

$9.45

Build it yourself—and save! Ideal for use in a portable phonograph—just add record player and 3-4 ohm speaker. 1½ watts output. Inverse feedback circuit. Easy to assemble. Shpg. wt., 3 lbs.

Model Y-790. Net only **$9.45**

Electronic Photoflash Kit

$28.50

Ideal for color or black and white photography. 1/700th-of-a-second flash; 50 watt/second output. Synchronizes with any camera with X or O shutter. (Less battery.) Shpg. wt., 4 lbs.

Model Y-244. Net only **$28.50**

Code Practice Oscillator Kit

$3.95

Ideal for beginners learning the code. Transistorized circuit. Operates for months from single penlight cell supplied. Clear, crisp 500 cycle tone. Jacks for headphones; screw terminals for key. 1 lb.

Model Y-239. Net only **$3.95**

Phono Oscillator Kit

$5.85

"Broadcasts" recorded music through any standard radio set up to 50 feet away. No direct connection to set required. Easy to build—fun to use. Shpg. wt., 2 lbs.

Model Y-760. Net only **$5.85**

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Model Y-143

$29^{75}

- With 16 Filament Voltages
- 600 Latest Tube Types Listed
- Easy-to-Read 4½" Meter
- Tests Series-String TV Tubes

Expertly designed for complete, up-to-date coverage of tube types. Tests *series-string TV tubes;* tests 4, 5, 6 and 7 pin large, regular and miniature types, octals, loctals, 9-pin miniatures and pilot lamps. Tests for open, short, leakage, heater continuity and performance (by amount of cathode emission). Big 4½" square meter has clear "GOOD-?-REPLACE" scale. With line-voltage indicator and line-adjust control. Choice of 16 filament voltages from 0.63 to 117 volts to check virtually all receiving tubes; blank socket for future type tubes. Universal-type selector switches permit selection of any combination of pin connections. Single-unit, pre-assembled 10-lever function switch simplifies and speeds assembly. Up-to-date illuminated roll chart lists over 600 tube types. Counter model case, 5 x 14 x 10". Easy to build. 14 lbs.

Model Y-143. Net only **$29.75**
Y-142. Portable Case model. 15 lbs. Net **$34.75**
Y-141. Picture Tube Adapter. 1 lb. Net ...... **$ 4.25**

knight-kit RF Signal Generator Kit

Model Y-145

$19^{75}

Build this wide-range, extremely stable RF signal generator—save two-thirds the cost of a comparable wired instrument! Large, semi-circular dial is clearly calibrated; range is covered in 5 separate bands for close accuracy in setting individual frequencies. Ideal for aligning RF and IF stages in radio and TV sets and for troubleshooting audio equipment. Delivers output on fundamentals from 160 kc all the way out to 112 mc; useful harmonics to 224 mc. Has built-in 400-cycle sine-wave audio oscillator for modulating RF; audio is also available externally. Features high-stability Colpitts circuit. Convenient jack for external modulation. Maximum audio output 10 volts; RF output over 0.1 volt on all ranges. Step and continuous-type attenuator controls. Supplied with precision-wound coils that require no adjustment. 7 x 10 x 5". Shpg. wt., 11 lbs.

Model Y-145. Net only **$19.75**

knight-kit 1000 Ohms/Volt VOM Kit

Model Y-128

$16^{95}

Exceptional accuracy and versatility at amazing low cost. Ideal for service shop, lab or Amateur use. Large 4½", 400 microamp meter with separate scales for AC and DC voltage and current, decibels and resistance. *Uses 1% precision resistors;* has 3-position function switch and 12-position range switch. *38 ranges* include: AC, DC and output volts, 0-1-5-10-50-500-5000 (1000 ohms/volt sensitivity); Resistance, 0-1000-100,000 ohms and 0-1 meg (center scale readings of 60, 150 and 1500 ohms); Current, AC or DC, 0-1-10-100 ma and 0-1 amp; Decibels, −20 to +69 in 6 ranges. Precision resistors are used as shunts and multipliers to assure exceptional accuracy of measurements. With all parts, battery, test leads and black bakelite case with convenient carrying handle, 6¾ x 5¼ x 3¾". A great value in an easy-to-build quality instrument. Shpg. wt., 2½ lbs.

Model Y-128. Net only **$16.95**

knight-kit Vacuum Tube Voltmeter Kit

Model Y-125

$24^{95}

- 200 μa Movement, 4½" Meter
- Includes AC, Peak-to-Peak
- Balanced-Bridge, Push-Pull Circuit
- 1% Film-Type Resistors

Top buy in an extremely stable, highly accurate VTVM. Easy to assemble—entire chassis is printed circuit board. Perfect for radio-TV service work, lab and Amateur use. Features low-leakage type switches; 1% film-type precision resistors; balanced-bridge, push-pull circuit (switch to any range without readjusting zero set); zero center scale and direct-reading db scale; polarity reversing switch. Ranges: Input Resistance, 11 megs; DC and AC rms, 0-1.5-5-15-50-150-500-1500; AC Peak-to-Peak, 0-4-14-40-140-1400-4000; Response, 30 cycles to 3 mc; Ohms, 0-1000-10K-100K and 0-1-10-100-1000 megs; db, −10 to +5. Includes all parts, tubes, battery, test leads and portable case, 7¾ x 5¼ x 4-3/4". Easy to assemble. Shpg. wt., 6 lbs.

Model Y-125. Net only **$24.95**
Y-126. Hi Voltage Probe; extends DC to 50,000 v. .... **$ 4.75**
Y-127. Hi-Frequency Probe; extends AC to 250 mc. .... **$ 3.45**

6V-12V Battery Eliminator Kit

$32^{95}

High current rating; continuously variable filtered output; delivers 15 amps at 6 volts, 10 amps at 12 volts. May be used as battery charger. Two meters provide simultaneous current and voltage readings. Shpg. wt., 18 lbs.

Model Y-129. Net only **$32.95**

Transistor Checker Kit

$8^{50}

Checks gain ratio of all types of transistors; checks germanium and silicon diodes; checks for continuity and shorts. A valuable instrument at very low cost. Easy to assemble. Shpg. wt., 2½ lbs.

Model Y-149. Net only **$8.50**

Flyback Checker Kit

$19^{50}

Checks condition of all types of horizontal output transformers and deflection yokes, as well as TV linearity and width coils. 4½" meter; widest range in its field. Shpg. wt., 6 lbs.

Model Y-118. Net only **$19.50**

Sweep Generator Kit

$43^{75}

Extreme linearity on a par with costly lab instruments; fundamentals to 250 mc; output flat within 1 db; electronic blanking. Easy, money-saving assembly. Shpg. wt., 16 lbs.

Model Y-123. Net only **$43.75**

Capacitor Checker Kit

$12^{50}

Tests capacitors while in the circuit! Has widest range—20 mmf to 2000 mfd. Exclusive circuit for cancelling lead capacity. "Magic Eye" indicator. Save 60% over factory-wired units. 5 lbs.

Model Y-119. Net only **$12.50**

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knight-kit 20,000 Ohms/Volt VOM Kit

Model Y-140

$29.50

Outstanding quality and performance at money-saving low price. Features 1% precision multipliers; 4½" meter accurate within 2% of full scale deflection; 50 microamp sensitivity for 20,000 ohms/volt input resistance on DC; front panel "Zero adjust"; single switch to select function and range. 32 ranges: AC, DC and output volts, 0-2.5-10-50-250-1000-5000; Resistance, 0-2000-200,000 ohms and 0-20 meg.; DC ma, 0-0.1-10-100; DC amps, 0-1-10; Decibels, −30 to +63 in six ranges. Moisture-resistant film-type resistors for extreme accuracy. Carefully engineered circuit design achieves high sensitivity and extremely versatile application. Kit includes all parts, battery, test leads and black bakelite case with highly legible white markings; size 6¾ x 5¼ x 3¾". Easy to assemble. Shpg. wt., 5 lbs.

Model Y-140. Net only **$29.50**

knight-kit High-Gain Signal Tracer Kit

Model Y-135

$26.50

A remarkable value in an easy-to-build instrument which permits visual and aural signal tracing of RF, IF, video and audio circuits. Has *highest gain in its price class.* Traces signal from antenna to speaker. Reproduces signal at plate or grid connection of any stage. Identifies and isolates "dead" stages. Features: usable gain of *91,000;* "magic eye" with calibrated attenuators for signal presence indication and stage-by-stage gain measurements; built-in 4" PM speaker; combination 2-position probe, one for RF (6 mmf. input), the other for audio. Provides noise test; built-in watt-meter calibrated from 25 to *1000 watts;* provision for external scope or VTVM. Binding posts provide output transformer and speaker substitution test, plus external 280 volts B+. With all parts, tubes and probe. 7x10x5". 12 lbs.

Model Y-135. Net only **$26.50**

knight-kit 5" Wide-Band Oscilloscope Kit

Model Y-144

$69.00

Only $6.90 down

- 5 mc Width for Color TV
- Horizontal Sweep to 600 kc
- 25 mv/inch Sensitivity
- Z-Axis Input
- Printed Circuit Construction

Equals or betters the performance of commercially wired scopes costing far more. Two printed circuit boards and laced wiring harness assure wiring accuracy and cut assembly time. Ideal for lab use, color TV servicing and high frequency applications. Wide sweep range—*15 to 600,000 cps.* Vertical response, ± 3 db, 5 cps to 5 mc; only 1 db down at 3.58 mc color burst. High vertical sensitivity of .025 rms v/inch. Input capacity, 20 mmf. Outstanding features: cathode follower inputs; 2nd anode provides 1400 volts high-intensity trace; push-pull amplifiers; positive and negative locking; frequency-compensated attenuator; Z-axis input; one volt P-P calibrating voltage; astigmatism control; retrace blanking circuit; DC positioning control. Includes CRT. 14½ x 9½ x 16". 40 lbs.

Model Y-144. Net only **$69.00**
Y-148. Demodulator Probe. Net .... **$ 3.45**
Y-147. Low Capacity Probe. 12 mmf. Net .... **$ 3.45**

Voltage Calibrator Kit

$12.75

Permits use of any scope as precision peak-to-peak AC voltmeter. Puts a true square-wave voltage on scope screen. Selects any voltage between .01 and 100 volts; feeds external signal direct to scope for instant comparison. Shpg. wt., 5 lbs.

Model Y-136. Net only **$12.75**

knight-kit 5" General-Purpose Scope Kit

Model Y-146

$42.00

Only $4.20 down

- Phantastron Linear Sweep
- 25 mv/inch Sensitivity
- Printed Circuit Board
- Retrace Blanking Circuit

Feature for feature the world's best oscilloscope kit value. A standout in its class with all these fine features: *Printed Circuit* wiring board and laced harness for quick, error-free assembly. *Phantastron Sweep Circuit* for high linearity of sweep from 15 to 150,000 cps. *25 Millivolts Per Inch Sensitivity*—3 times that of similarly priced scope kits. *Calibration Voltage*—1 volt peak-to-peak square wave, fully regulated. *Vertical Amplifier*—frequency response ± 3 db, 3 cps to 1.5 mc (± 6 db to 2.5 mc). Includes: Directly coupled positioning controls; retrace blanking circuit; frequency-compensated vertical input attenuator; positive and negative internal sync; high 2nd-anode voltage for high-intensity trace; input capacity, 45 mmf. Kit includes CRT. 9½ x 13¾ x 17¾". 26 lbs.

Model Y-146. Net only **$42.00**

Resistance Substitution Box

$5.95

Easily determines resistor values required in a circuit. Makes available 36 standard 1-watt resistance values in 2 ranges between 15 ohms and 10 megohms, with 10% accuracy. Slide switch selects range; 18-position switch for value selection. Shpg. wt., 2 lbs.

Model Y-139. Net only .... **$ 5.95**

Capacitance Substitution Box

$5.95

Makes it easy to find capacitor values needed in a circuit. Provides 18 standard values from .0001 mfd to .22 mfd, ± 20%. All values are 600 volt, except .15 and .22, which are 400 volt. 18-position selector switch. Shpg. wt., 2 lbs.

Model Y-138. Net only .... **$ 5.95**

Audio Generator Kit

$31.50

Excellent design; range, 20 cps to 1 mc; less than .25% distortion; 600 ohm output. Ideal for hi-fi testing; offers the flat response of a lab standard. Shpg. wt., 16 lbs.

Model Y-137. Net only **$31.50**

R/C Tester Kit

$19.50

Measures capacitance and resistance. Balanced-bridge circuit; indicates power factor; tests capacitors at rated voltage. Large, easy-to-read dial and "magic eye." Shpg. wt., 10 lbs.

Model Y-124. Net only **$19.50**

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knight-kit All-Band Amateur Receiver Kit

Model Y-726
$104.50
Only $10.45 down

- Tunes 540 kc to 31 mc
- Built-In Q-Multiplier
- Constant Running HF Oscillator
- Worthy of the Advanced Ham Operator
- Printed Circuit Bandswitch
- Printed Circuit Board • 1.5 μv Sensitivity

A sensational communications receiver value with all the selectivity, sensitivity and features of high-priced commercial units. Uses printed circuitry throughout, including the exclusive new KNIGHT-KIT printed circuit bandswitch, for remarkably easy assembly. Covers 540 kc to 31 mc in 4 ranges; calibrated, electrical bandspread on 80-10 meter Ham bands; slug-tuned Hi-Q coils; continuous, VR tube-regulated B+ applied to HF oscillator lets you switch from standby to receive with no drift; built-in Q-multiplier peaks desired signal or nulls interference; delayed AVC; provision for crystal calibrator (below). Sensitivity, 1.5 microvolts for 10 db signal-to-noise ratio. Selectivity: variable from 300 cps to 4.5 kc at 6 db down. Exalted BFO injection. Controls: Main tuning, bandspread, band selector, Q-multiplier selectivity, Q-multiplier tune, null-off-peak, BFO pitch, RF gain, AF gain, BFO-MVC-AVC-ANL, off-stby-rec-cal, antenna trimmer, and phone jack. Cold-rolled 1/16" steel chassis. Handsome metal cabinet, 10 x 10 x 16½". (Less phones, 8-ohm loudspeaker and S-meter.) 23 lbs.

Model Y-726. Amateur Receiver Kit. Net **$104.50**
Y-727. S-Meter Kit for above. 1 lb. Net **$9.50**

knight-kit 50-Watt CW Transmitter Kit

Model Y-255
$38.95
Only $3.89 down

- Ideal for the Novice
- Pi Antenna Coupler
- Bandswitching—80 to 10 Meters

There's exceptional value in this very popular bandswitching transmitter kit. Compact and versatile, it's the perfect low-power rig for the beginning novice as well as the seasoned veteran. Has bandswitching coverage of 80, 40, 20, 15 and 10 meters. Rated at 50 watts—actually operates at up to 60 watts on 80 and 40 meters. Oscillator is efficient 6AG7; final is reliable 807. Crisp, clean, cathode keying of oscillator and final. Built-in pi coupler permits use with random length antennas. Has highly effective TVI suppression. Other features not usually found in transmitter kits at this low price include: Ceramic-insulated final tank capacitor; pre-assembled switches; pre-wound parasitic chokes; ceramic coil forms; coax connector; crystal and VFO socket on front panel; power take-off jack for accessory equipment. Meter reads either plate or grid current of final. Takes crystal or VFO without circuit changes. Cabinet interior and chassis are copper-finished. Size, 8½ x 10½ x 8¼". With tubes and all parts for easy assembly. (Less crystal and key.) Shpg. wt., 19 lbs.

Model Y-255. 50-Watt Transmitter Kit. Net only **$38.95**

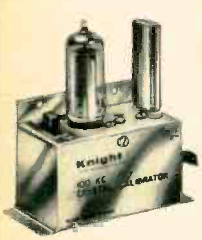
knight-kit Self-Powered VFO Kit

Model Y-725
$28.50
Only $2.85 down

Complete with built-in power supply! Careful design and voltage regulation assure high stability. Excellent oscillator keying characteristics for fast break-in without clicks or chirps. Full TVI suppression. Has plenty of bandspread; separate calibrated scales for 80, 40, 20, 15, 11 and 10 meters; vernier drive mechanism. 2-chassis construction keeps heat from frequency determining circuits. Output cable plugs into crystal socket of transmitter. Output: 40v on 80, 20v on 40. With Spot-Off-Transmit switch for spot frequency tuning. Extra switch contacts for operating relays and other equipment. Attractive metal cabinet, 8¾ x 6 x 6". Ready for easy assembly. Shpg. wt., 8 lbs.

Model Y-725. VFO Kit. Net only **$28.50**

knight-kit 100 Kc Crystal Calibrator Kit



Model Y-256
$10.50

Crystal frequency standard at very low cost. Gives marker every 100 kc up to 32 mc. A "must" for marking band edges. Mounting flanges for installation in or back of receiver cabinet. Size only 1½x 1½x3". Requires 6.3 v. at 0.15 amp and 150-300 v. DC at 3-6 ma. Trimmer for zero-beating with WWV; On-Off switch. Complete with tube, crystal, all parts and easy-to-follow instructions. Shpg. wt., 1 lb.

Model Y-256. 100 Kc Crystal Calibrator Kit. Net only **$10.50**

knight-kit Amateur RF "Z" Bridge Kit

Model Y-253
$5.85

Measures standing wave ratio (SWR) and impedance of antenna systems; ideal for adjusting antenna systems for optimum results. Measures impedances from 20 to 400 ohms up to 100 mc; SWR to 150 mc. Any VOM may be used for null indicator. With coax input and output connectors. Meters both input and bridge voltage. Calibrated dial gives direct impedance reading; includes 1% precision resistor for precise calibration adjustment. With all parts and handy plasticized SWR chart (less meter). 2½ x 3 x 4½". Shpg. wt., 1½ lbs.

Model Y-253. "Z" Bridge Kit. Net only **$5.85**

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Quantity	Description	Model No.	Price

$.......... enclosed. (For parcel post, include postage—express is shipped collect).
☐ My Down Payment in the amount of $.......... is enclosed. Send Time Payment form.

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Address ....

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

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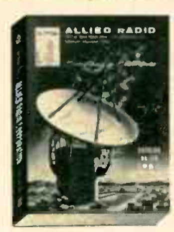

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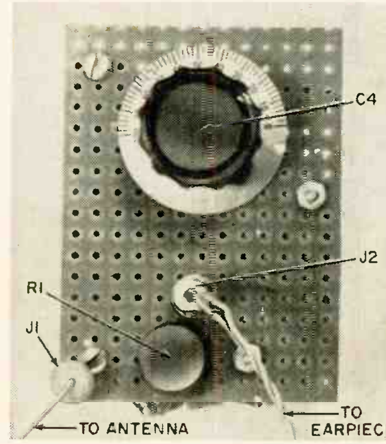
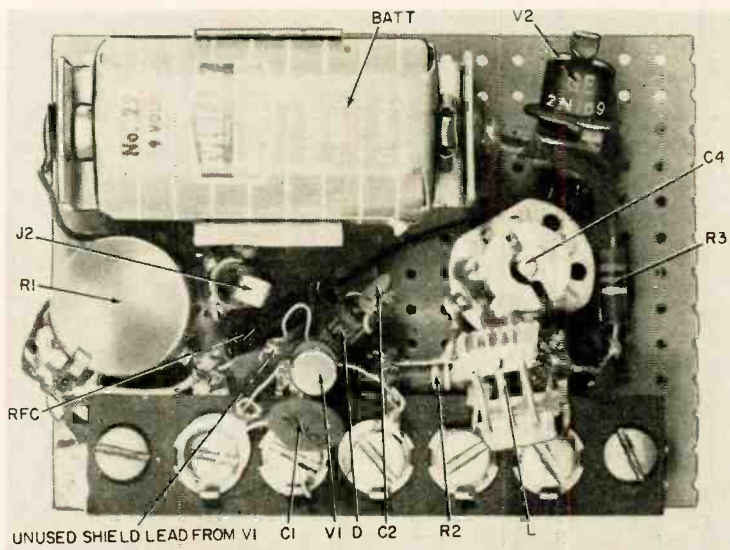
2 Transistor Superregenerator for FM and HAM bands

Palm-of-the-hand receiver covers AM and FM up to and past 108 mc.



Front panel of the miniature unit.

By I. QUEEN
EDITORIAL ASSOCIATE



Rear view shows how components are mounted.

TRANSISTOR superregenerators are not news any more. For example, Bohr's 30-mc set was shown and described in the May 1956 issue of RADIO-ELECTRONICS. But here is a superregenerator that does have *new features*. It can do several things not possible with previous receivers of this type.

It extends the frequency range up into the vhf band with the aid of RCA's new 2N384 transistor which easily breaks the 100-mc barrier. This set picks up all local FM broadcasters on a 2-foot antenna! With other coils you can hear the 10- and 6-meter ham bands, cover the satellite frequencies and other interesting services. It responds to both FM and AM.

The circuit is designed for easy assembly and operation. It uses a *single battery* to supply all needs of the superregenerative detector and the audio stage. The tank coil is *untapped*. You will know what a help this is when you decide to add additional coils for other bands.

A special *diode* network makes for greater audio gain. It appears that this rectifier feeds back energy so that the superregenerator also amplifies at *audio* frequencies. If you are skeptical about the gain due to the diode, just try removing it (readjusting the circuit if necessary to retain superregeneration). Actually, the volume from this two-transistor set is better than that from a four-transistor broadcast tuner. Sensitivity is high, as it should be from this type of circuit.

In Fig. 1, transistor V1 is the superregenerative detector. It oscillates due to feedback through C3. Since a single battery supply is desired, it is shunted by voltage-dividing network R2, R3. Thus correct potentials are applied to emitter and collector. R1 is the superregeneration control. It should be adjusted for the usual hiss that indicates superregeneration. For greatest gain, R1 may be backed off slightly but the hiss must remain.

When V1 oscillates, a negative voltage charges C2 and in time the transistor is blocked. As this capacitor discharges, conduction is resumed. The blocking frequency is not critical and may be about 100 kc. The periodic blocking is a necessary feature of superregeneration and results in the hiss background. When a signal appears, the hiss is reduced. A very strong station will nearly eliminate the hiss entirely. Diode D must be polarized as shown, otherwise volume will be considerably reduced.

The rf choke in the emitter lead blocks the vhf signal. It is wound with No. 26 enameled wire on a ⅛-inch form (which is then removed). A total of 24 turns is used.

Tuning is taken care of by a tiny capacitor made by E. F. Johnson. It has a maximum capacitance of 14.2 $\mu\mu$f. This unit produces no noise during rotation. Coil L is three turns of heavy wire on a ½-inch diameter. It is wound eight turns to the inch (cut from a B & W Miniductor 3002). Note from the photo that this coil is held in place by screws on a terminal strip. The other three terminals of the strip are for the active elements of V1.

The detector output appears across R4 and is fed across the input of V2. Note that this must be an *n-p-n* transistor. Amplified output is present at J2 for an earpiece. This jack is a normally closed-circuit type modified as shown in Fig. 2. The change makes it normally *open-circuited*. Inserting an

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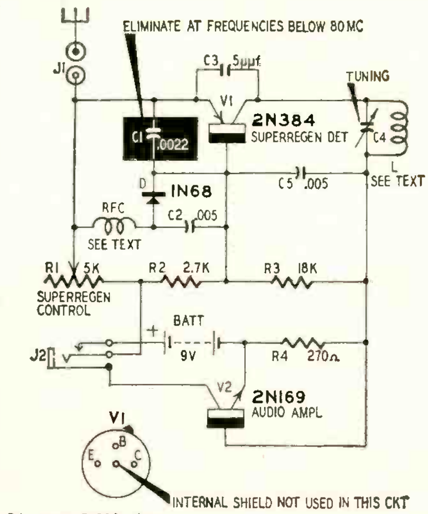

R1—pot, 5,000 ohms
R2—2,700 ohms
R3—18,000 ohms
R4—270 ohms
All resistors 1/2-watt 10% unless noted
BATT—9 volts (Eveready 226 or equivalent)
C1—.0022 μf (see text)
C2—.005 μf
C3—5 μμf
C4—air variable, 2.3–14.2 μμf (E. F. Johnson 15M11, or equivalent)
D—1N68
J1—antenna jack and plug (Lafayette MS303)
J2—miniature jack (modified, see text)
L—see text
RFC—see text
V1—2N384
V2—2N169
Plastic base, 2 1/2 x 3 3/8 inches
Battery holder
Knobs
Miscellaneous hardware

Fig. 1—Circuit of 2-transistor receiver.

earpiece plug closes the battery circuit for reception.

Collector voltage is 9, far below the maximum allowed for the 2N384. It is supplied by a 9-volt battery which fits into a battery holder meant for a size-C dry cell. V1's three leads are held by screws of the terminal strip. Its fourth lead (to the metal envelope) is not used in this circuit. See Fig. 1 for basing diagram.

With the parts and values described, the tank should cover from about 80 to 110 mc. In cutting down L from the complete Miniductor, trim it gradually so you won't take off too many turns. You may have to experiment with values of C1 and C3 to assure superregeneration (hiss) throughout the FM band. The longer the antenna, the more difficult it is for superregeneration to take place; so don't use too long an antenna (at least not on these very high frequencies). I find that 2 feet of wire is ample.

Using the receiver

After you have located the band and have the set operating properly, connect the 2-foot antenna and listen. As you tune across an FM station, hiss will drop down (even during intervals when the station does not modulate). If you don't have sufficient superregeneration the station may sound distorted and garbled. On the other hand, with too much some gain and volume will be lost. While the 2N384 works well at 110 mc, this frequency is quite high and it is possible that the superregenerative hiss may not be obtained throughout the entire band with a single adjustment of R1.

Of course this receiver is also satisfactory for receiving the *sound* channel of a TV transmitter. It is only necessary to wind the proper coil for the desired channel. The *video* channel sounds like a rough buzz.

Since tank coil L is held by the screw terminals of a bakelite terminal strip, it is easy to change coils. You don't have to worry about center taps either. For any frequency below 80 mc, *remove C1*. For easy removal of this capacitor, I tie down its leads by screws of the terminal strip. Also, at these lower frequencies it becomes easier for V1 to superregenerate.

The 10-meter band coil requires 10 turns cut down from a Miniductor 3003. They have a ½-inch diameter and are wound 16 turns to the inch. This particular tank also requires a 10-μμf capacitor which is soldered directly across the coil leads. Results on this band are amazing except perhaps for those who have worked a superregen set before. Coast-to-coast coverage is easy when conditions are right. The antenna should be 2 or 3 feet long.

A 6-meter coil requires five turns made from the same Miniductor mentioned in the previous paragraph. Results on this band have been less spectacular, but this is probably due to poor conditions during tests because my big communications set also showed poor results on this band. The 6-meter coil has no shunting capacitor. Incidentally, this same coil also brings in the sound channel of TV channel 2, which is just above the ham band.

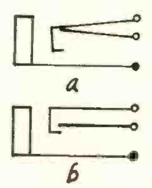

Fig. 2—Modifying normally closed miniature phone jack for use with superregenerator: a—unmodified jack, upper two contacts touch; b—after slight bending, upper contacts do not touch. Upon inserting jack, they make contact.

The satellite frequency (40 mc) is between the mentioned ham bands. At the time of writing, there was no radio transmission from any satellite and no tests were made. However, don't dismiss this simple receiver as useless for the purpose. The superregenerator, when properly adjusted and operated, is actually a high-gain receiver. West Coast hams are picked up daily here in the East on 30 mc. The other satellite frequency, 108 mc, is also within reach of this set.

In assembling this superregenerator, I recommend that you first try one of the lower-frequency bands like 10 meters. Once you get it going here, then wind the higher-frequency coils like the FM unit. Don't forget that C1 is not needed for any band below the FM region. When inserting the battery, watch the polarity to avoid transistor damage. Don't solder near the transistors or their leads. It is safer to remove them until you are finished. END

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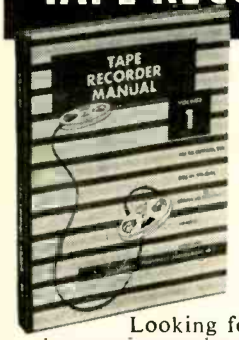

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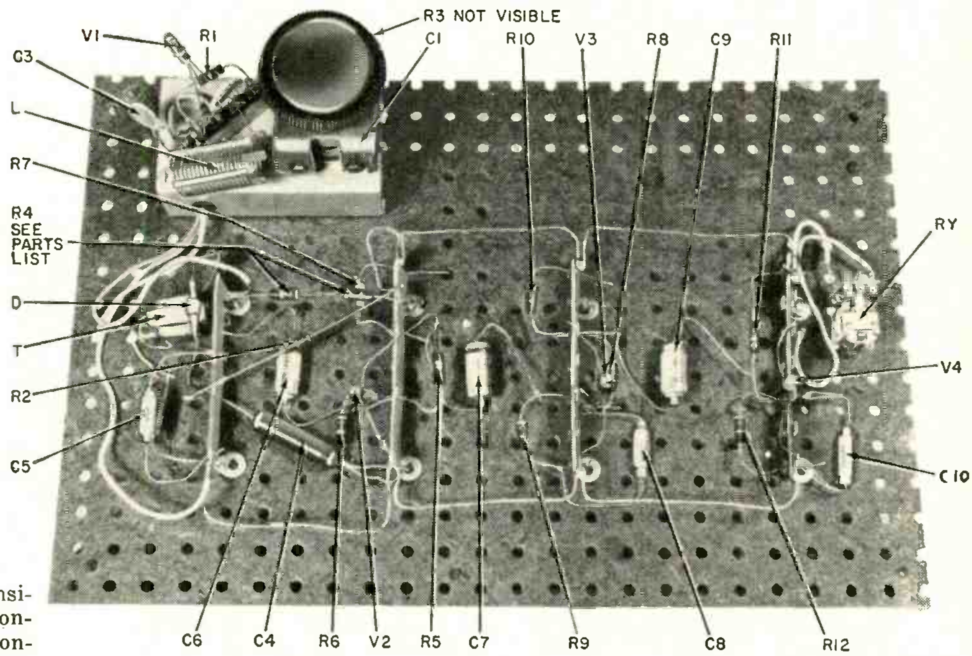
4-TRANSISTOR RADIO-CONTROL RECEIVER

Extremely sensitive, this superregenerative unit operates on the 27.255-mc Citizens band

By CHARLES DEWEY



The experimental breadboard layout. Components can be fitted into a much smaller space.

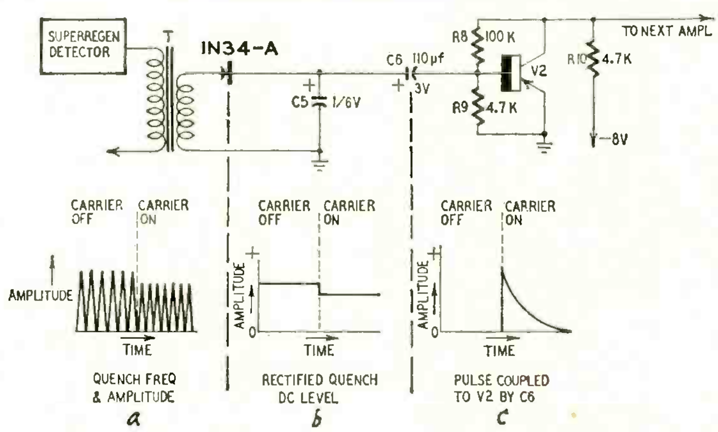


Fig. 1—Here's how the carrier causes a pulse to key the relay.

HERE is a practical, highly sensitive, all-transistor remote-control receiver that a non-engineer can build and adjust. Reliability and sensitivity are excellent and the entire circuit is powered by a single 8-volt mercury battery.

Initially, this receiver may be considered expensive, but in the long run it is more economical than a vacuum-tube receiver. Contrasted to the A-batteries, high-voltage B-batteries and short-lived gas triodes, transistors do not wear out or break. To illustrate this point, I know one fellow who buys gas triodes for his radio-control receivers 12 at a time from the local electronics store.

This is a four-transistor receiver. Three transistors comprise an audio type pulse amplifier that operates the control relay. Pulses to operate the relay originate by simply pushing the carrier on-off button of a conventional radio-control transmitter. The mode of operation, which I will explain, is very simple; yet, as far as I know, this is the first time it has been applied to radio control.

The fourth transistor is a high-frequency surface-barrier type in a superregenerative signal-detecting circuit. This transistor is the most expensive item in the receiver.

The circuit

A superregenerative detector goes in and out of carrier-frequency oscillation over 10,000 times a second. This rate of carrier-frequency oscillation and decay is called quench frequency.

When a carrier is received, the quench *frequency* increases but, at the same time, the quench amplitude *decreases*. Fig. 1-a shows this more clearly. Of course, the percentage change is exaggerated.

In conventional vacuum-tube circuits, the slight change of quench-frequency conditions is further amplified by the trigger action of the gas triode. But even then, the relay-operating signal is rather small. The relay must operate with an approximate 30% change in coil current. Normally, a reliable high-quality relay requires a 2-to-1 current change. However, by reducing the armature movement and increasing the armature-to-coil air gap, relatively satisfactory operation has been achieved with the vacuum-tube circuit.

My transistor radio-control receiver operates on a somewhat different principle. Referring to Fig. 1 again, we see

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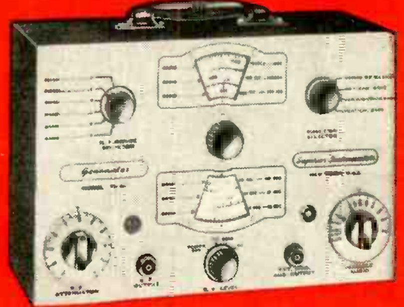

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that the quench frequency is rectified and converted to a positive-to-ground dc signal. (The cathode of the diode goes to the junction of C5 and C6.) When a carrier signal is received, the amplitude of the quench decreases and so does the amplitude of the positive dc signal output from the 1N34-A diode. The dc output remains at a decreased level as long as the carrier is received.

However, coupling capacitor C6 passes a signal to the following stage only during the time it is charging or discharging as a result of a change in the rectifier output. When a carrier is received, the positive level decreases, passing a *negative* pulse to the following amplifier. (An electrode going less positive is equivalent to a negative-going signal in its effect on a coupling capacitor.)

This negative pulse is amplified by three stages of transistor amplification, producing a pulse across the relay almost equal to the entire battery voltage. The change in coil current amounts to *several hundred percent* with even an exceedingly weak carrier signal.

However, *relay action is only momentary*. If the transmitter is held in the on position, the relay will remain closed only for several tenths of a second and then will return to its open position. Each time the carrier control button is pushed to on, the relay closes as long as the button is pushed up to about 1/3 second, depending to some extent upon the signal strength.

The majority of model control operations actuate from pulses, rather than continuous signals, anyway. This circuit, therefore, is compatible with most radio-control equipment.

Circuit details

Fig. 2 is the complete circuit of this unit. The detector is very simple and oscillates easily at 27.255 mc, since the SB103/2N346 has a minimum-rated oscillating frequency of 60 mc. The SB103/2N346, incidentally, is now manufactured by both Philco and Sprague.

L1 is a Barker-Williamson Miniductor section with a feedback tap to the emitter. The emitter coupling capacitor value of .01 μf is necessary for proper superregenerative operation. Superregeneration is controlled and varied by changing the base bias of transistor V1.

Temperature and frequency stability are very good and the setting of R3 seems to produce no noticeable detuning. effect. Once the receiver is tuned to the carrier, we have never had to retune or readjust the circuit. Changing the antenna, however, will necessitate readjustment of C1. Short antennas may be connected directly to V1's collector. Progressively longer antennas must be connected to points on the coil closer to the end, forming the junction with C3.


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An Argonne AR-109 transformer couples the quench voltage to a 1N34-A diode. Any changes in the dc output level are coupled to V2 by capacitor C6. All the coupling capacitors have as large a value as possible to preserve adequate low-frequency response. Although the coupling capacitors are operated somewhat past their voltage rating, I have had no trouble with them.

Low-frequency response is further improved by omitting emitter bias resistors and the necessary bypass capacitors. The bias circuit used provides good stabilization with very few components. The values specified will hold good for transistors with reasonably low values of I_{co}. Philco 2N47 transistors, the type used, are no longer available. However, Philco is now producing a 2N207 which is a direct replacement for the 2N47. I have also used CK721 transistors with good results.

The collector-to-ground voltage should be −3 to −6 for the first two stages and −7 volts minimum for the last stage. These voltages are measured with no signal being received. If any readings are outside of these tolerances, change the value of R5, R8 or R11 until the collector voltage is correct. Increasing the value of any of these resistors will increase the collector voltage of its associated transistor, or vice versa.

The relay may be any unit with at least a 4,000-ohm coil that will pull in reliably with 7 volts applied *across the coil*. The one I used is the Jewel relay sold by Lafayette. It has a 5,000-ohm coil. Another suitable relay is the tiny Advance type SO1C 4,000D.

Capacitor C5 filters the rectified quench-frequency ripple at the 1N34-A output. Additional capacitors C8 and C10 further suppress any quench frequency from the pulse signal. Otherwise, the quench signal would overload the amplifier stages. Using three capacitors distributed among the stages gives a sharper attenuation characteristic than would using one large capacitor.

Construction

Two receivers of this type have been built. Unfortunately, the one with compact packaging was not available for photographs. The photograph shows my pegboard model which was used for checking experimental changes and modifications.

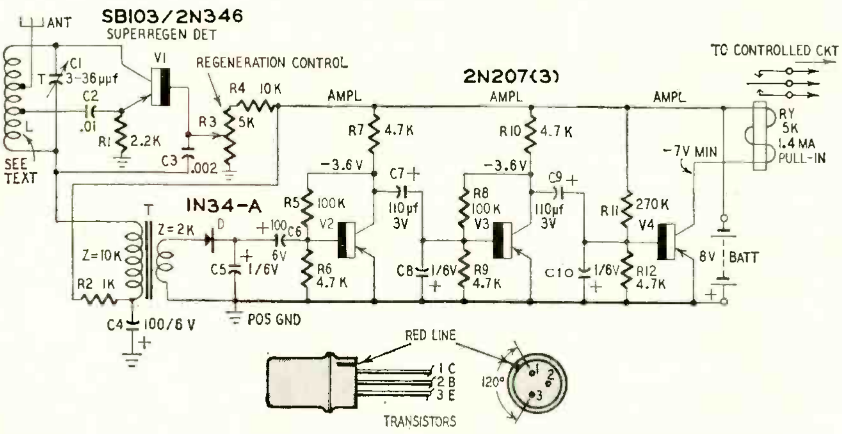
Nevertheless, the photograph does show the type and size of some of the components used. The experimental model used a variable, air-dielectric tuning capacitor. A compact receiver, of course, must use a midget trimmer. A 3–36-μμf Bud MT-833 trimmer (or its equivalent) is satisfactory.

All components should be solidly mounted, particularly where the super-regenerative detector is concerned. A perforated bakelite board makes a good chassis. Printed-circuit eyelets can be riveted into the holes and the leads pulled through and soldered to the eyelets for a very sturdy assembly.

The regeneration control is mounted by drilling a large hole in the bakelite board. Insert the control and let the shaft stick straight up for its full length and attach a small knob. This method reduces hand-capacitance effects to a minimum.

Connect the battery and check the voltages against those shown on the diagram. *Be sure battery polarity is correct.* A wrong connection could damage the transistors.

Next, connect phones across the secondary of transformer T. These leads are coded green and yellow. Now



R1—2,200 ohms
R2—1,000 ohms
R3—pot, 5,000 ohms (Lafayette VC-28 or equivalent)
R4—10,000 ohms (two 4,700-ohm resistors in series)
R5, 8—100,000 ohms
R6, 7, 9, 10, 12—4,700 ohms
R11—270,000 ohms
All resistors ½ watt, 10%
C1—3-36 μμf, trimmer (Bud MT-833 or equivalent)
C2—.01 μf, subminiature ceramic (Lafayette C-612 or equivalent)
C3—.002 μf, ceramic
C4, 6—100 μf, 6 volts, electrolytic
C5, 8, 10—1 μf, 6 volts, electrolytic
C7, 9—110 μf, 3 volts, electrolytic
D—1N34-A
L—11 turns, tape at 5 turns (Barker & Williamson No. 3003 Miniductor or equivalent)
RY—relay, 5,000-ohm coil (Lafayette F-260 or equivalent)
T—driver transformer: primary, 10,000 ohms; secondary, 2,000 ohms (Argonne AR-109 or equivalent)
V1—SB103/2N346
V2, 3, 4—2N207
Chassis, perforated board (Lafayette MS-305 cut as required)
Knob for regeneration control
Miscellaneous hardware

Fig. 2—Circuit of the miniature unit.

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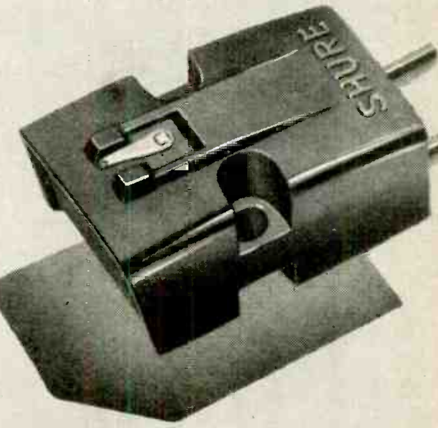

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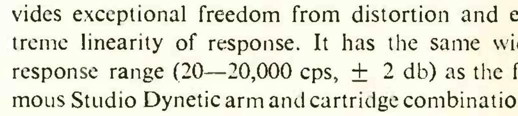

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rotate the REGENERATION CONTROL R3 until a typical superregeneration hissing or frying sound is heard. The sound will not be very loud. Bring a signal generator lead near the coil or place a remote-control transmitter nearby and tune the receiver to 27.255 mc. Listen for the modulated tone from the generator or turn the transmitter carrier on and off. When the receiver is tuned to the carrier, the superregenerative sound will stop when the carrier is on. Adjust regeneration until the tuning is sharpest.

During this procedure, the relay can be expected to do quite a bit of erratic operating. Just disregard it at this phase and listen to the phones. Any fast operation of the regeneration control will actuate the relay. The earphones act as microphones and just bumping them against the table can induce a pulse that will also operate the relay.

Next, attach a length of flexible insulated antenna lead–1 or 2 feet should do. Attach it to coil L1 as close to the collector end as possible and still secure good superregeneration. In all likelihood, this will result in a direct connection to the collector end.

Readjust tuning and regeneration for optimum performance. C1's capacitance will have to be decreased somewhat to compensate for the additional loading of the antenna.

Remove the phones and the receiver is ready for operation. When the transmitter is close by, the relay may operate both when the carrier is turned on and when it is interrupted. This is because the R-C-coupled circuits and overloaded amplifiers pull a trick called double differentiation. This will not occur, even when the transmitter and receiver are side by side, if the transmit button is held down for only about 1/10 or 2/10 second. This is plenty of time to operate any solenoids or escapements. It takes approximately 1/10 second to say the word one.

To give some idea of this receiver's sensitivity, we can trigger the receiver when it is inside a concrete building at a distance of 1/5 mile *with the transmitter's antenna collapsed* to its shortest length. I tested the receiver under these conditions for two days without a single failure to operate or any necessity for touching up the adjustments. There was every indication it would keep this up until the batteries ran down.

Incidentally, the battery I use is a Mallory TR-136-R, good for 1,000 milliamp hours. However, it weighs 3 ounces, which may be too much for the model-airplane folk. These people can try using six RM-400-R cells in series for a really small power pack.

During the last year and a half I have built five types of all-transistor remote-control receivers, including a superhet. If there is sufficient reader interest, possibly we can describe some of these other receivers in future issues. END

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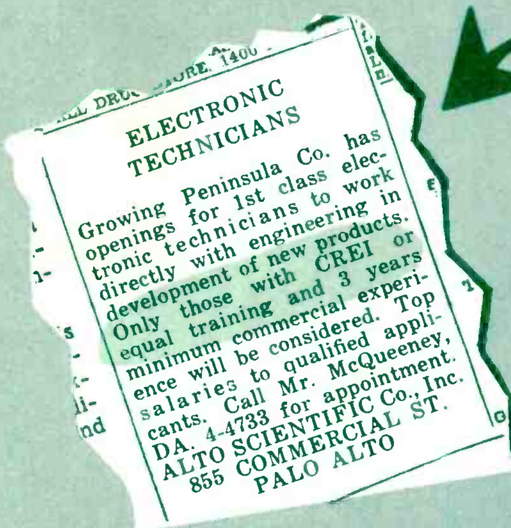
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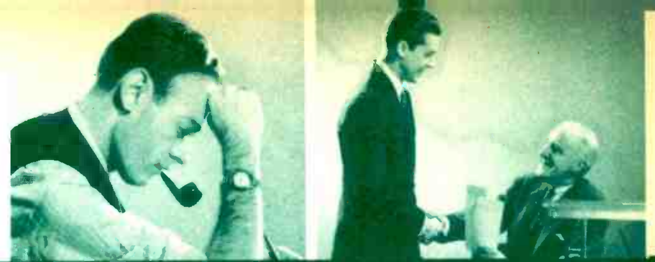

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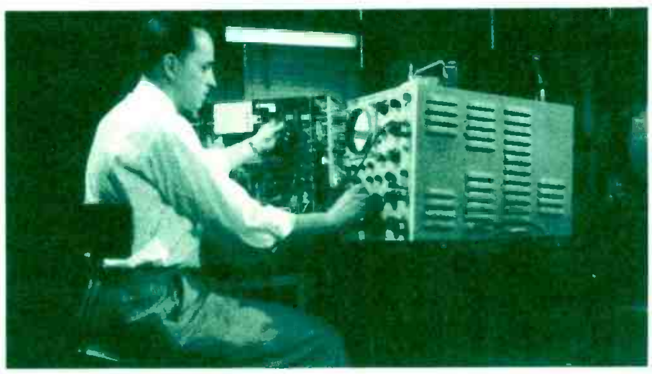

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Ac heater supply operates at 150,000 cycles

By LEONARD E. GEISLER, AES*

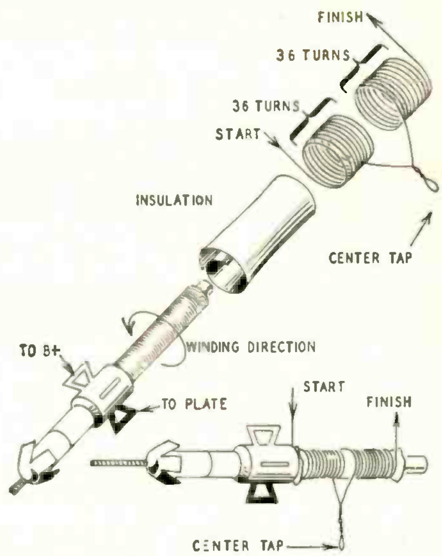
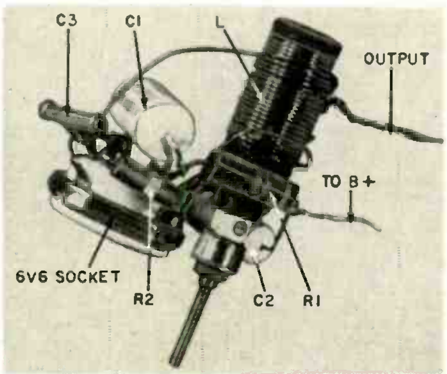
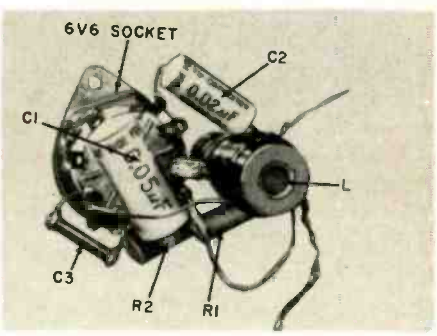


Fig. 2—Coil winding details. Note that *outside* end of primary is connected to B plus.



Side view of supply. Short direct wiring prevents parasitic oscillations.



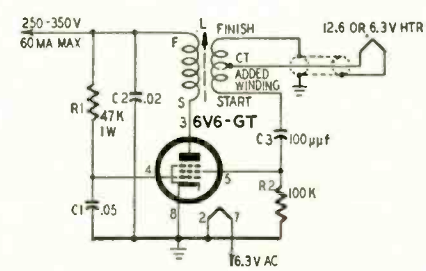
Bottom view showing general parts placement.

THE majority of hi-fi preamps have dc heater supplies to avoid the problems created by hum. This heater supply is humless, inexpensive and easy to build. It does not require the usual extra-high-voltage filament winding normally found with bridge rectifiers, but obtains its power from the amplifier's B-plus line. This feature makes it a snap for the man who has more hum than he wants, but little cash to lay out for a rectifier and filter network.

A good close look at the circuit (Fig. 1) shows its simplicity. It is a modification of one of the high-frequency exciter-lamp bias oscillators used in 16-mm movie projectors. It is quite capable of putting out 6.3 volts of 150,000-cycle ac at over 300 ma, with an input power demand of about 60–35 ma at 250–350 volts.

How it works

When the power is turned on, the rush of voltage to the tube causes magnetic fluctuations in the windings and dust core of the oscillator coil. Due to the heavily distributed capacitance of the windings in the primary, a condition of resonance is set up at a frequency around 150,000 cycles. The secondary winding picks up these fluctuations and since the number of secondary turns is far less than the primary turns, they are transformed from high to low voltage—high-current versions of the primary fluctuations or alternations. A portion of the developed voltage is fed back, in the proper phase, to the tube's grid to sustain oscillation which continues until the power is turned off. As the B supply is usually pretty well filtered, no ac modulation appears in the high-frequency output of the heater oscillator. Since the vacuum tube is operating class C, efficiency is approximately 70%. This compares more than favorably with the large internal losses of a bridge rectifier in heater supply service, not counting losses in the filter network.



R1—47,000 ohms, 1 watt
R2—100,000 ohms, ½ watt
C1—.05 μf, paper
C2—.02 μf, paper
C3—100 μμf, ceramic
L—linearity or width coil, 0.5–5 mh or 0.2–3 mh (J. W. Miller 6313, 6318 or equivalent)
V—6V6-GT
Tube socket, octal
Shielded wire
No. 20 enameled wire (15 feet)
Spaghetti

Fig. 1—Circuit of the humless heater supply.

Construction details

Start construction by obtaining a TV width or linearity coil; suitable types are indicated in the parts list. Wrap a strip of heavy paper or electrical cambric, about 3 inches long, over the coil winding. (See Fig. 2.) Secure this insulation with Duco cement or coil dope. While this is drying, wire the tube socket. Do not permanently solder in the 47,000-ohm screen resistor, but tack it in lightly as you may want to change it later.

After checking your wiring for errors, wind the oscillator coil's secondary. Start by securing one end of the No. 20 wire to the lug from the *outer* end of the primary winding. Wind the secondary in the same direction as the primary winding. Count your turns and form a hairpin loop, several inches long, when you get to the 36th turn. Twist the pigtail firmly and wind 36 additional turns. Secure the last turn with Scotch electrical tape and cover the whole coil with tape. Be sure to allow plenty of pigtail length as you can always trim off any excess later. Wire the coil into the circuit as shown

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in the diagram. Tack in the secondary ends lightly before you finish the oscillator. You may wind the coil the wrong way and have to reverse the leads to make the circuit oscillate properly.

Now connect the completed oscillator to a reasonably well filtered point on the B-plus line from the power supply. Be sure the power supply can carry the extra current without going up in a cloud of smoke! Use a 300-ma pilot lamp or a wornout 300-ma 6-volt tube as a dummy load for testing. Fire up the rig and see if your oscillator puts out. If nothing happens, try twiddling the tuning slug in and out of the coil for a peak. If it still doesn't perk, reverse the secondary's leads. Check the voltage output with a vom, or preferably a vtvm. Tune the slug for maximum output. If you can't wring 6.3 volts ac out of the oscillator, shunt a 500,000-ohm potentiometer across the screen resistor and gradually increase the screen voltage until you get about 7 to 7.5 volts output. Check the screen resistance value and insert a permanent resistor with a value within 10% of the ohmmeter reading. If you are a little on the low side and the screen voltage is a little too high, you can tune out the excess voltage with the coil slug and set the voltage right on the nose.

Solder all connections and wire the output of the oscillator to your preamp's heater leads. Retune the oscillator, if necessary, to correct for any losses which may occur. You will not necessarily need shielded wire to prevent radiation from the heater leads but it would be a good idea. If by chance you have a 12.6-volt 150-ma tube in the preamp, don't worry. You can tune the oscillator to the required voltage with the greatest of ease. I'd suggest you mount the oscillator on your main power supply chassis. No particular rf shielding is necessary, if you exercise a reasonable amount of care in making good grounds when wiring. However, to insure peace of mind you can shield the thing with a few scraps of aluminum or copper screening. If more than 12 volts output is desired, wind on about one-third to one-half more turns on the secondary. Remember that your power supply can take only so much drain! If it won't take it, use almost any power supply—one from an old receiver will be excellent. To those of you who are worried about rf pickup from the heaters: this unit oscillates at such a high frequency that any pickup will fall considerably above the normal hearing range. The same is true of heterodynes with those 20,000-cycle ultrasonics which most people can't hear but claim add so much something-or-other to their hi-fi records. I have yet to find an amplifier of commercial design that will pass these frequencies (over 50,000 cycles). If you can't sleep nights anyway, shunt the plate of the preamp tube with a 50–200-$\mu\mu$f capacitor and rest assured you've done your duty. END

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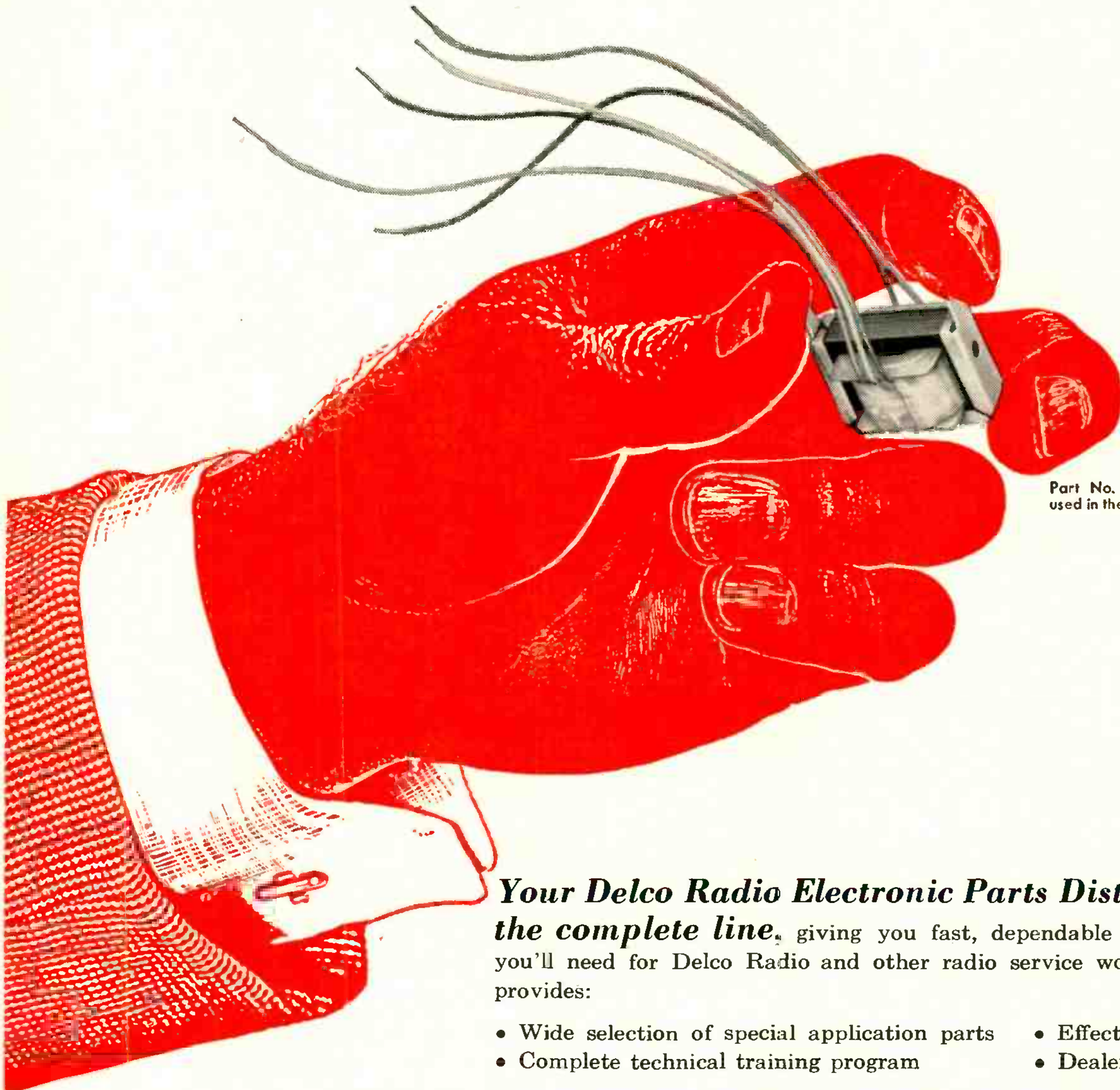

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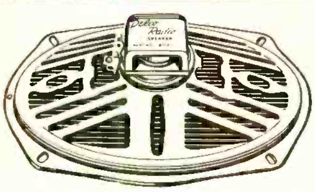

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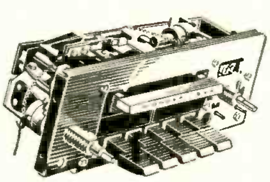

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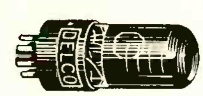

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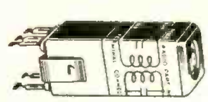

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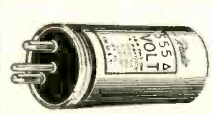

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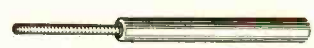

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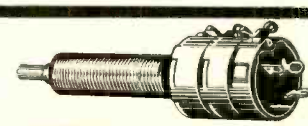
CAPACITORS



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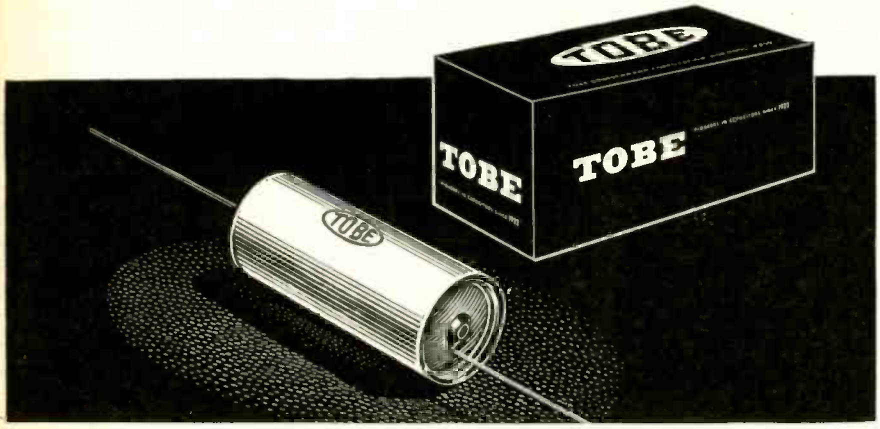

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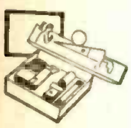


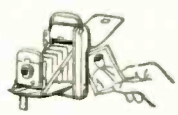


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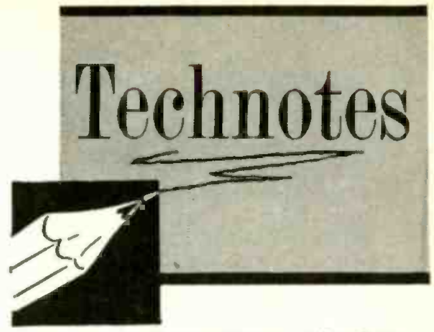


Technotes

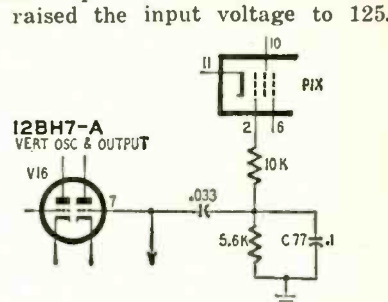
TAPE RECORDER WHINE

A high-pitched whine, resembling flyback transformer singing, in tape recorders is often due to the recording- or erase-head pressure pad vibrating on its holder because of friction with the moving tape. To eliminate or minimize this condition, first determine which pad is at fault by applying a little pressure with some small object to each pad in turn while the recorder is running. Then carefully dope the back of the offending pad with service cement or a quick-drying thermoplastic adhesive and press lightly in place until the cement has set.—*Warren J. Smith*

SENTINEL 1U-1101

The set came in with a complaint of intermittent appearance of retrace lines. The owner said the picture and raster shrank a little at the top and bottom whenever this happened.

During the first day's monitoring at the shop the set acted normally. I then hooked it up to a variable transformer and raised the input voltage to 125.



The retrace line appeared. Lowering the input to about 115 volts returned the set to normal.

Parts replacement revealed that capacitor C77 (0.1 μf) as the offender. It broke down under higher voltage pulses due to higher line voltage. The capacitor was replaced with a molded unit rated at 1.6 kv. A little exaggerated—but it worked! The partial schematic shows C77's position in the retrace blanking circuit.—*James A. McRoberts*

FAST REPAIR JOB

This service call involved one of those "fix-it-immediately" customers you run across now and then. I followed the signal right up to the grid of the 6V6 audio output tube but there was no signal on the plate. The tube checked good in the checker and a new tube substituted for the suspected one also failed to work. That left only one possibility: a bad tube socket. And I don't carry spare sockets in my toolbox. What a situation!

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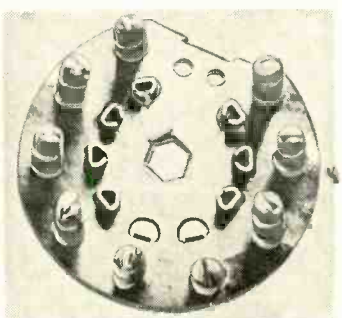
Playing one last, desperate hunch, I asked the customer for a piece of household aluminum foil. I wadded up a small piece, pushed it in the grid socket hole, put the tube back in, sat back holding my breath and waited. As the filament came up to brightness, sound blasted from the speaker. Sometime later, when the set came in for a major repair, I replaced the defective socket just to be on the safe side.
—*John A. Comstock*

TOO MUCH PUSH

When his Emerson TV, model 1176, stopped playing late one night, the owner decided to have a go at repairing it. Peeking through the perforated Masonite back he could see five or six tubes that were not lighted. Removing the back, he pulled the tubes and hurried over to the nearest drugstore, where he found the 12BY7 burned out.



To his great disappointment, however, when he replaced the tubes and turned the set on, he saw the new 12BY7 flare up like a flash bulb.

I was called to look at the set the next day. I put a new 12BY7 in, watched carefully and, as soon as I saw all of the tubes light up with their characteristic glow, I cleaned up, presented my bill and left.

Three weeks later I received another call from the same customer. This time I found a dead 12AX4. Replacing the damper tube failed to complete the circuit. All of the tubes checked normally. I then substituted tube for tube and, when that failed to produce the desired result, I put all new tubes in. Still this string of tubes remained dead and disgustingly cold. With a small vom, I checked from the ground through each tube socket, removing one tube at a time. There was a cheerful continuity until I came to the 12BY7 socket. I got the same reading on both sides whether the tube was in or out! Of course, the resistance reading was a little different—12 ohms on one side, 2.5 on the other.

Removing the cabinet (after a dozen or so screws are removed, speaker unsoldered, and the controls loosened from their supports, the cabinet can be juggled off the chassis by one man), I checked the printed circuitry very carefully. Everything seemed fine and I was beginning to look like a dunce before the lady of the house and her two friendly little boys.

Finally I sat back on my heels and stared fixedly at the chassis. This al-

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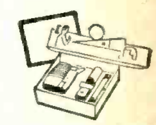
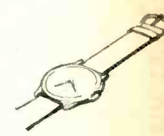
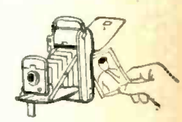
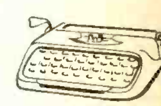

Here's all you do . . . In 25 words or less, tell us why you prefer TOBE SERVICE CAPACITORS.

Then, send your entry to us with the top from any TOBE capacitor carton, or the plastic box some TOBE capacitors are packed in.

That's all there is to it. Enter as many times as you wish, providing each entry is accompanied by a TOBE carton top or the plastic box. Use entry blank below. Additional entry blanks can be obtained from your TOBE DISTRIBUTOR.

Contest Closes May 30

Contest is open to all service-men over 21 years of age residing in the continental United States. Employees of the TOBE DEUTSCHMANN CORPORATION and their advertising agency are excluded. All entries become the property of TOBE DEUTSCHMANN CORPORATION. Decisions of the judges are final. In case of ties, duplicate prizes will be awarded. Contest closes May 30, 1958. Winners will be announced June 30th.

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Old Hands at Dependability

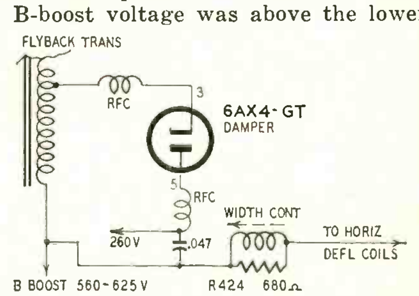
ways helps. I concentrated on the 12-BY7 socket and my glare turned to a worried, inquisitive look. Something was wrong with that socket. The tube happened to be out and all of the nine little holes seemed to twinkle at me, that is, all but two. I crawled closer. Sure enough, two of the holes were plumb empty! I didn't have to check—they were the holes that received the No. 4 and No. 5 pins of the 12BY7. The small tabs of metal that had held the grippers were still in place and I could see that occasionally a tube with its pins bent a little outward might just touch enough to cause the tube to light. Of course, if contact was made by pin 4 or pin 5 alone, the tube would flare up and burn out.

Apparently the first time someone changed the 12BY7, the small grippers were pushed right down out of the socket. I wonder who did this.—*Eugene W. Klemm*

SYLVANIA 21T201

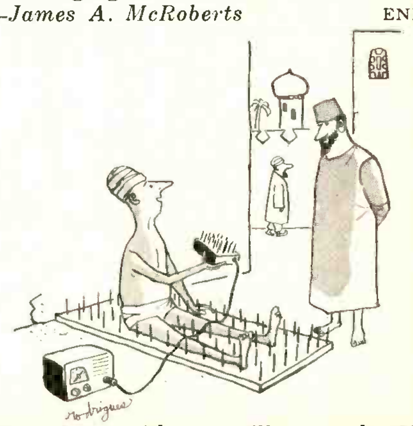
This set had distortion on the right-hand side of the raster, typified by waves (on both picture and raster) with some lack of height and width. The right-hand side was also compressed in comparison with the left side of the picture and raster.

B-boost voltage was above the lower



limit quoted by the manufacturer—570 volts for the nominal low of 560. Resistance checks did not disclose any trouble until the resistor (R424) across the width coil was disconnected and tested. It had increased from its normal value of 680 ohms to about 1,100 ohms. Replacing the resistor cured the trouble.

The symptom caused by the increased value of the resistor was due to self-excited oscillation of the width coil during the last quarter of the horizontal sweep. The energy extracted by this ringing also lowered the B-boost. —*James A. McRoberts* END



"How do you like my pillow-speaker?"

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Technicians' News

PAY TV PROTECTS TECHS

Teleglobe Inc. of New York City has proposed a new system of toll TV, which, the company claims, is the only one which will not jeopardize the free access of technicians to TV sets for servicing. All other systems, they point out, call for attachments to the receiver proper. This would tend to put servicing into the hands of the installing companies, since neither a service organization nor the toll TV company would care to guarantee a set worked on by others.

The Teleglobe system would broadcast the picture in the usual manner. Sound, however, would be sent over lines leased from the telephone companies, and would be reproduced with a small amplifier–speaker unit entirely independent from the set and leased to subscribers to the system. Music would be piped over the system when no pay programs were being broadcast. Thus the subscriber's TV set would not be interfered with in any way and could be serviced by the local technician in the usual manner.

MORE SERVICING BUSINESS

Total TV–radio production dipped in 1957. With other trends in the nation, it would appear, that the total volume in the coming year will again be below last year's. Since fewer sets are being sold, the older sets will be kept in operation. From this standpoint, more tubes and other replacement components will be needed to keep these sets running, according to a release from the National Alliance of Television & Electronic Service Associations (NATESA). And of course, there will be more service calls.

On the dark side, the release continued, the professional service industry can expect an increasing invasion by incompetents who have been laid off from factory and other nonservice jobs. This invasion is being encouraged by many marginal trade schools and certain book publishers who use any means to sell texts and courses.

Overall, NATESA feels that a great opportunity is being presented by existing conditions, and a realistic attitude toward the professional service industry on the part of other elements of the electronics industry could result in mutual benefits. The big question in the minds of the professional service people is whether they or the unethical and unequipped opportunists with whom they cannot compete will render the actual service. Support by set and

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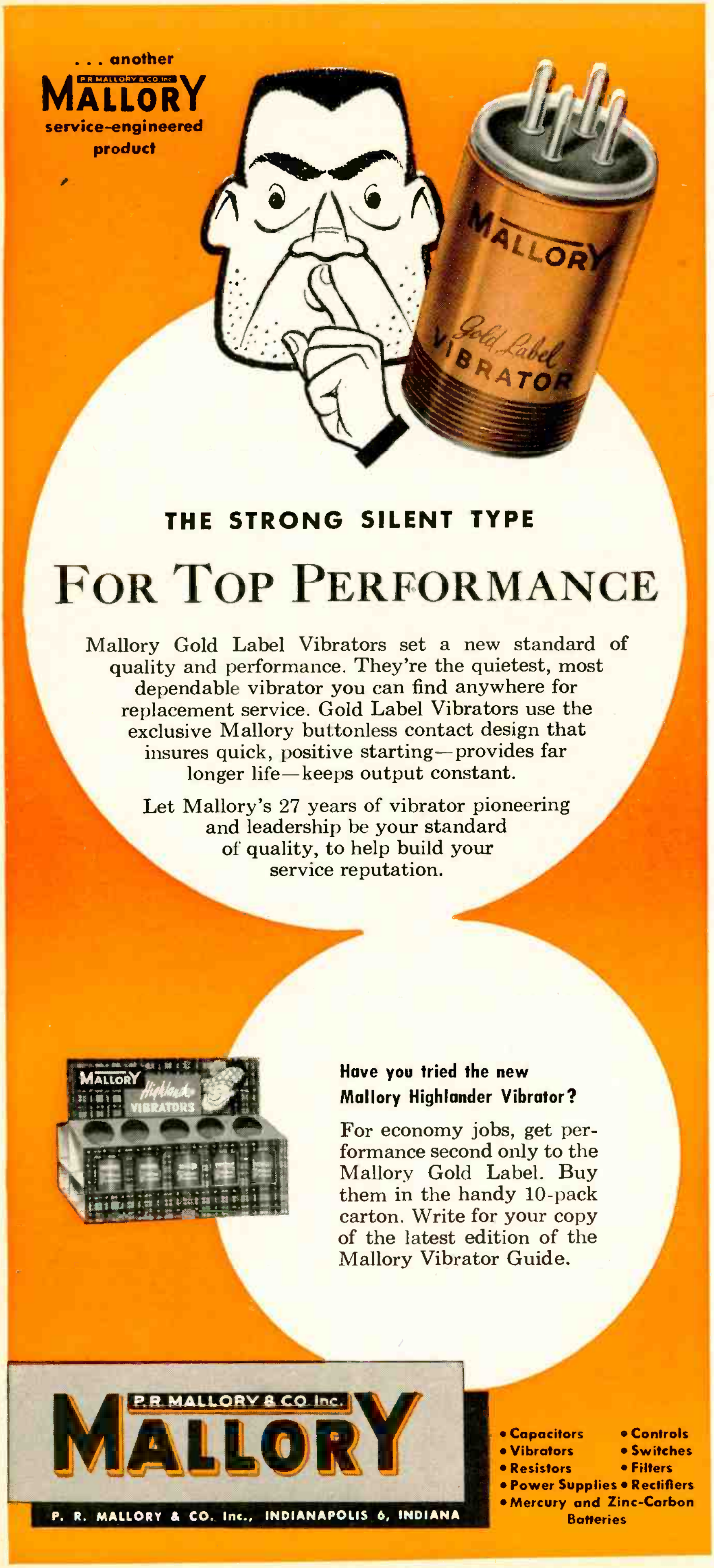

component manufacturers and parts jobbers of the professional service people will pay dividends for all.

HELP WANTED

The Director of Communications of the Trust Territory of the Pacific Islands is looking for three radio operators and one technician. If interested in duty on tropical islands, write to the Director of Communications, Trust Territory Government, Truk, Eastern Caroline Islands. Include a Standard Form 57 obtained from your local Civil Service office.

In his letter, the director says: "For your information, we have fairly modern conveniences, weekly mail service and a freighter that brings supplies and surface mail about once every six or eight weeks. Communities of Americans vary in size. I have begun my sixth year here . . . other communications people have been here four and five years."

There are no tropical Dorothy Lamours, but grass skirts or lavalavas are worn outside the district centers. Fishing is the best. Some islands have deer and dove for hunting. No snakes, but the Palaus do have crocodiles. No TV and only one broadcast station, located on Majuro, Marshall Islands and operated by the Government.

LETTER TO TIME

The Associated Radio & Television Servicemen's, (ARTS) chairman, Howard J. Wolfson, in a letter to the managing editor of *Time Magazine* said: "Since the 'U. S. Repairman' article appeared in your October issue you have no doubt received many accolades and a few 'brickbats.' This letter carries neither. It is written to suggest to you that there are two sides of a coin and that your writer see both.

"To do this, I enclose a reprint of an article which appeared in the May, 1957, issue of RADIO-ELECTRONICS, entitled 'Customers We Could Do Without.' These are but samples. Were you to sit in a meeting of servicemen and listen to their experiences with the public, you might be a little surprised if not amazed at what you would hear."

Among the types of customers discussed in the article Mr. Wolfson referred to is the one who calls six service dealers and gives the job to the first to arrive. Then there's the one who doesn't want to pay for the job after it's finished. The ones who want a lifetime guarantee are also featured, with a few lesser varieties well known to the TV technician.

TV TECHS SPEND MILLIONS

The independent television service industry, according to a statement from NATESA, spent more than \$2 million last year for service data alone. This does not include other literature, test equipment, tools or replacement parts.

The \$2 million figure is an intentionally conservative estimate, being based on the report of a single publisher

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of electronic books and service data who grossed over $4 million during the past year.

The National Alliance of Television & Electronic Service Associations (NATESA) compares this sum—spent on service data alone in a single year—to the $150,000 the EIA (Electronic Industries Association, formerly RETMA) has spent in five years.

NATESA points out that the independent service industry is also a big buyer of replacement components, test instruments and tools. They consider the service industry a highly indispensable adjunct to other phases and a good customer besides.

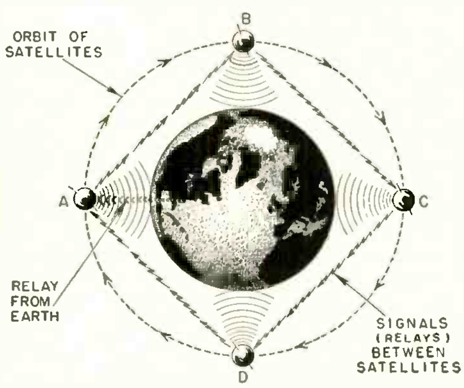
ELECTION IN NEW YORK

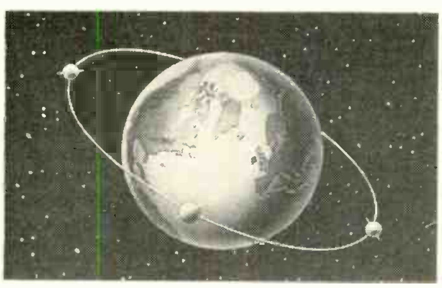
The Western New York Electronics Guild has elected its officers for 1958. They took office at an installation dinner held at McVan's in Buffalo, N. Y.

William Harrington was re-elected president. Fred Ditondo became vice president. Other new officers are Clarence Thielke, treasurer; Elmore L. Bement, secretary, and Michael Squitieri, sergeant-at-arms.

Lester Marschall and James Archibald were elected to the executive committee. END

WORLD-WIDE TELEVISION





The above two diagrams refer to Hugo Gernsback's editorial on page 33. The top diagram shows how signals originating from earth are transmitted to a system of four earth satellities orbiting equidistance from each other. In such a system, television programs originating from a point in the US can be seen simultaneously at practically any point on earth 24 hours a day. The upper illustration shows a plan view looking down on the earth from space. The bottom view, a perspective of the four satellites as they gravitate around the earth about 1,000 miles up.

. . . another
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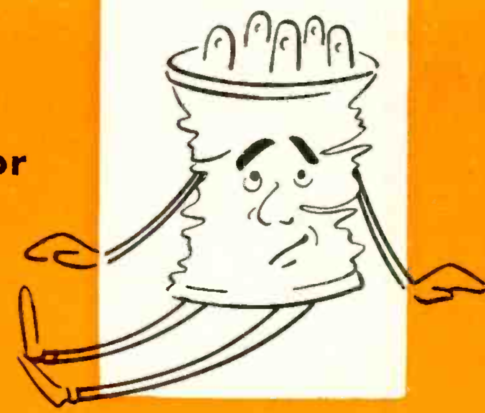
watch out for shrinking capacitance



—insist on

Etched Cathode

Ever notice how some capacitors fail before their time? In just a few weeks, especially in a high ripple circuit, they begin to develop hum.

This is due to loss of capacitance, and it's a common ailment of capacitors with plain foil cathodes.

You'll never have this trouble with Mallory FP's and popular Mallory tubular electrolytics . . . because they have *etched cathode* construction. It's a standard feature of Mallory electrolytics that insures against "missing microfarads."

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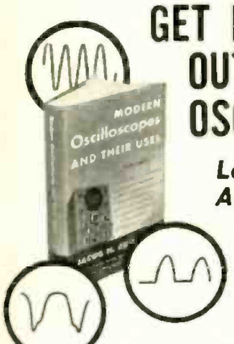

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Stereo actually requires still higher fidelity than single channel systems due to the highly critical timing sequences which must be maintained until the separate signals reach each of the listeners' ears. Probably the most difficult problem in this regard is in the speaker system which now must reproduce and radiate these signals in the exact sequence required.

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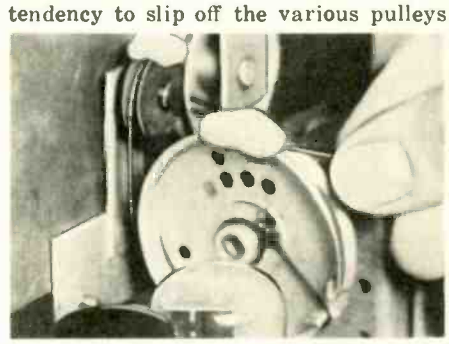
HANDY IRON TIP

I find that a small notch filed in the tip of my soldering iron makes it easier to use. For instance, when soldering wires, the tip hooks over the wire and the iron can be held steadier. And since part of the tip surrounds the wire, the larger surface area imparts more heat to the work.

If your hand is a little unsteady, you will find the notched tip handy for all sorts of delicate soldering jobs.—*John A. Comstock*

DIAL-CORD RESTRINGING

It's no cinch to restring a dial mechanism because the dial cord has a tendency to slip off the various pulleys



as restringing progresses. This can be prevented by tacking the cord in place on each pulley with a small gob of modeling clay until the tension spring has been fastened. This holds the cord securely and is easy to remove once the dial has been restrung.—*John A. Comstock*

SERIES-CONNECTING VOLTAGE-REGULATING TRANSFORMERS

In some electronic work, we need unusually constant line-voltage regulation. A constant-voltage transformer will hold the secondary voltage within ±1% when the primary voltage varies as much as 30%. This is adequate for most applications.

However, when still better regulation is required, one constant-voltage transformer can be used to drive a *second* constant-voltage transformer. With this arrangement, the voltage is held to a small fraction of 1% for line-voltage variations as great as 30%.

The waveform from a simple regulating transformer is not a true sine wave. It is a sine wave with a flattened top. For power applications this makes no difference. However, if this nonsinusoidal wave is used for scope line sweep, the horizontal deflection becomes nonlinear. To obtain a linear sweep from a regulated source voltage, an auto type

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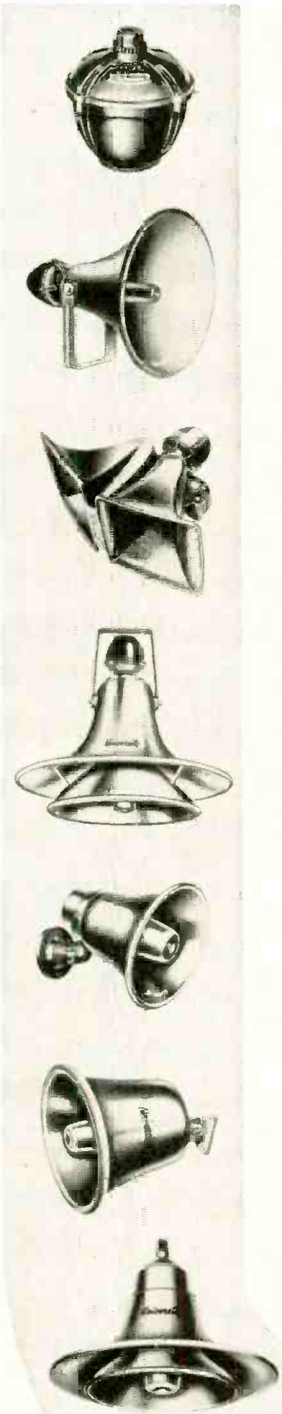

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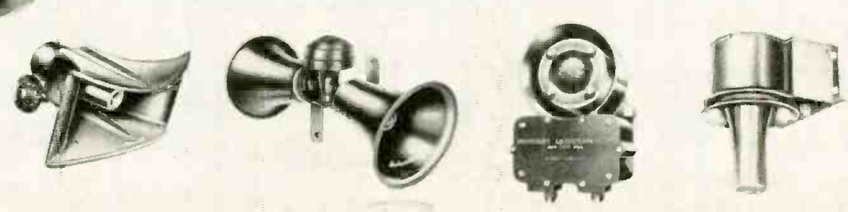
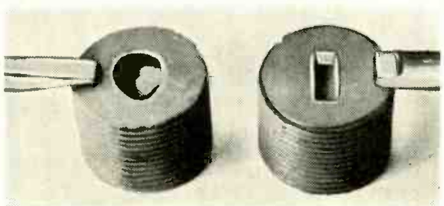


constant-voltage transformer should be used. This type of transformer has a primary, a resonant-circuit winding, and a compensating coil with a harmonic neutralizer. This holds the output waveform to less than 3% harmonic distortion.

When two transformers are used in series, the first may be a simple regulating transformer, followed by an auto type regulating transformer. This arrangement is suitable for the most exacting applications—the line voltage is held very constant and the waveform is also very good.—*Robert G. Middleton*

PROTECT IF SLUGS

Radio experimenters and radio service technicians would be lost without their screwdrivers, but there are times when screwdrivers should never be used. We technicians sometimes run across radios having badly out-of-line



if transformers, and when an alignment job is under way it is sometimes found that one or more of the slugs have such gouged-out slots that it is difficult, or impossible, to turn the slugs. What has happened is that someone not familiar with if transformers has used a small steel-bladed screwdriver instead of the correct fiber or plastic alignment tool, and the ill-fitting steel screwdriver blade has gradually gouged out the apertures in the tops of the powdered-iron slugs so that an alignment tool will no longer fit. It doesn't take long for an ill-fitting steel screwdriver to ruin the slot in an if slug, especially when the slug doesn't turn easily!

Referring to the photo, the slug at the left had to be removed and replaced with a new one because the correct alignment tool would not budge it. Close to the slug is the steel screwdriver that did the damage. The slug at the right is brand-new, and the correct alignment tool is shown near it.—*Art Trauffer*

FASTER INSTALLATION

To facilitate chassis deliveries, when the picture tube is carried separately from the chassis, spray a light coat of some nonmetallic paint over the ion trap before pulling the set off the bench. This makes relocating the ion trap much quicker when replacing the set in its cabinet.—*Frank A. Salerno*

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Since the war there have been many rf ammeters on the surplus market at relatively low cost. Most of these excellent meters have scale values beyond the range usable with the average amateur transmitter. The thermocouples can be removed, leaving movements which need only new scales and proper shunts or series resistors to become

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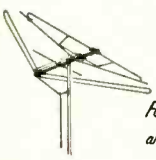

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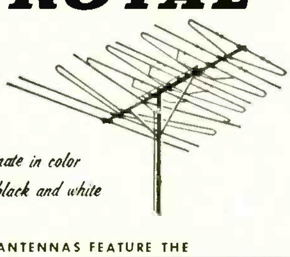

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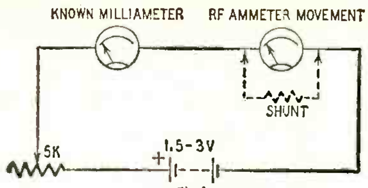


Fig.1

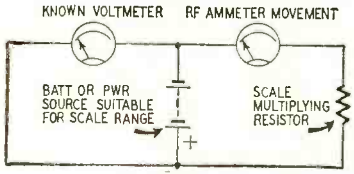


Fig.2

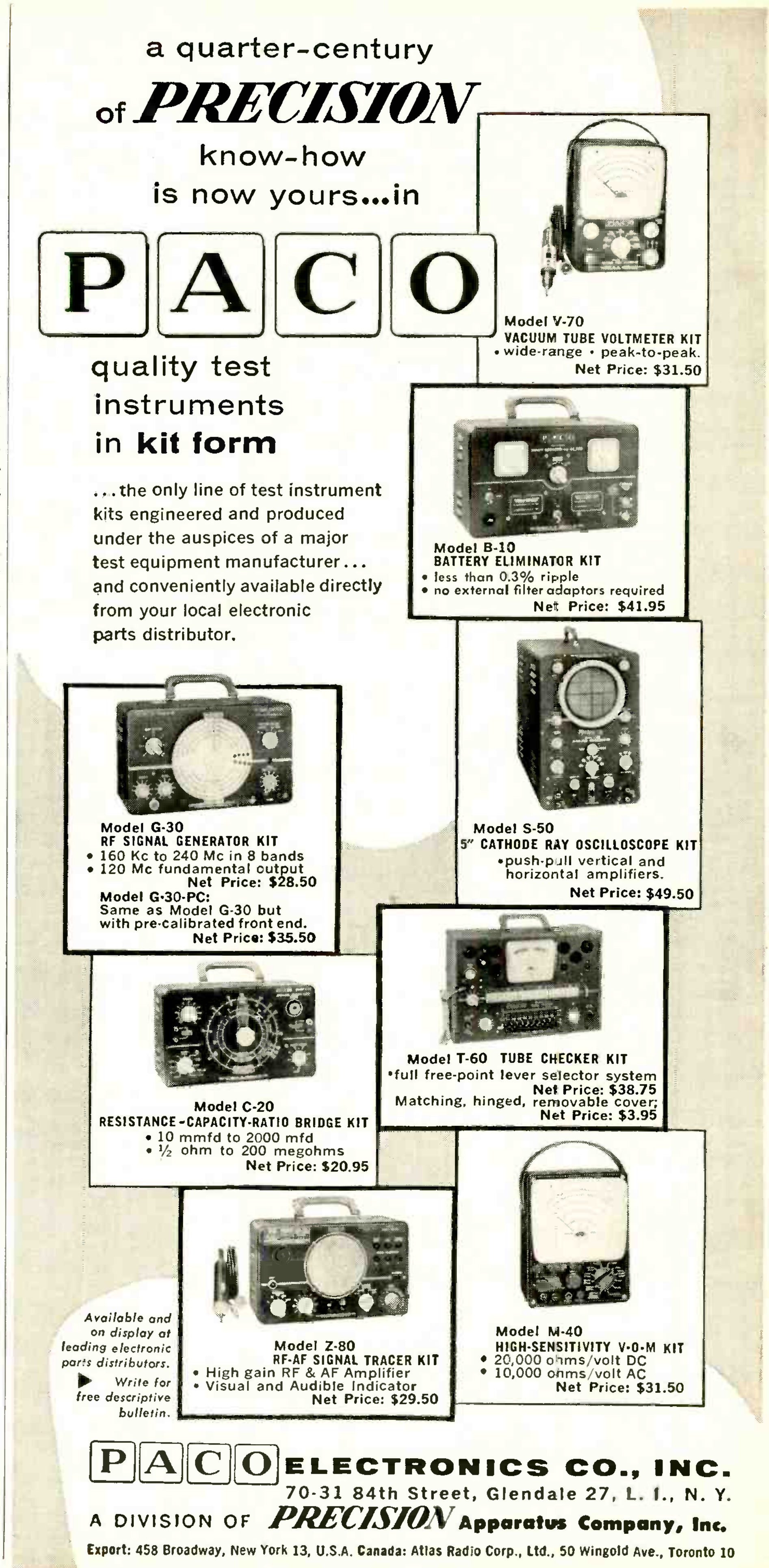
useful as milliameters or voltmeters. The movements are usually fairly sensitive (0–1 ma) and the basic range can easily be determined by putting them in series with the shop multimeter or a low-range milliameter and running a small current through them. In most cases, a dry cell in series with a 5,000-ohm variable resistor will provide a satisfactory current range. See Fig. 1. The same circuit can be used to calibrate the meter to read currents, finding the proper shunt resistance by cut-and-try.

Fig. 2 shows the proper hookup for calibrating the movement as a voltmeter. While the value of the series resistance can be computed once the internal resistance of the movement is known, it is easier to find it empirically as shown. Suitable scales for both voltage and current meters can be purchased from some parts supply house, or may be made. A good material for home-made scales is the white enameled aluminum house-siding widely used today. If it is washed to remove grease, it takes both pencil and India ink well and can give a real commercial look to the meters.—*Wm. Bruce Cameron, W8IVJ*

PROTECTING FIXED-BIAS TUBES

Many recent hi-fi power amplifiers use fixed bias. Should the bias supply fail, the expensive output tubes will be damaged. A slow-blow fuse placed in series with the B-plus lead to the output tubes will save those imported low-distortion types. For 50- or 60-watt amplifiers a ¼-amp unit is satisfactory. For lower-power amplifiers try ⅛ amp. —*Joseph A. Fiederer* END

"I don't have a 76 tube, Al. How about two 38's?"



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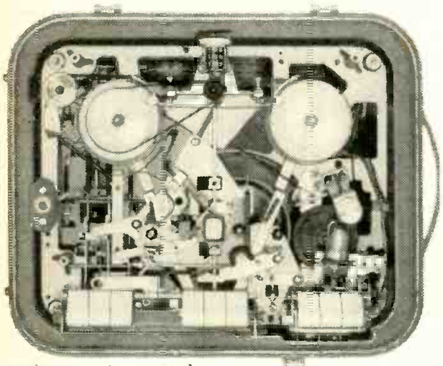

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Patents

DC TRANSISTOR INVERTER

Patent No. 2,798,160

George Bruck, William R. Harter and Irvin M. Wilbur, Cincinnati, Ohio (Assigned to Avco Mfg. Corp., Cincinnati)

Fig. 1 is a block diagram of two similar transistor amplifiers. Either channel conducts when fed with a positive signal and blocks if its signal is negative. In each amplifier the output is *in phase* with the input. Thus when either amplifier 1 or amplifier 2 begins to conduct, regeneration (through the respective capacitor) soon brings it to full conduction. Since points A and B are out of phase, a positive signal to one channel corresponds to a negative signal to the other.

When power is switched on, one channel (say amplifier 1) starts to conduct before the other. Also, C1 and C2 charge. In a short time, therefore, A goes positive and amplifier 1 is conducting fully. B, being negative, keeps amplifier 2 blocked. C1 discharges through amplifier 1 to maintain conduction, but as the charge falls the amplifier begins to pass less current. A goes more negative, while B grows more positive. Soon amplifier 1 is blocked and 2 conducts fully. It is clear that a square wave is being generated and fed to the transformer T.

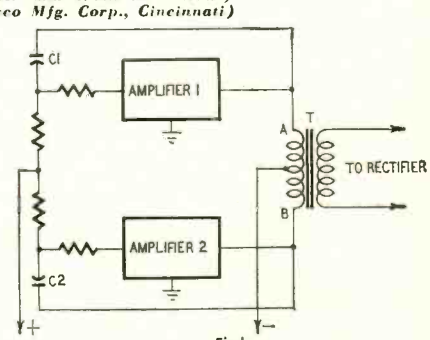


Fig. 1

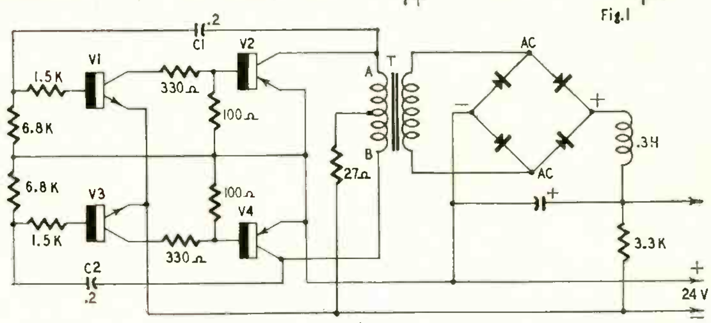


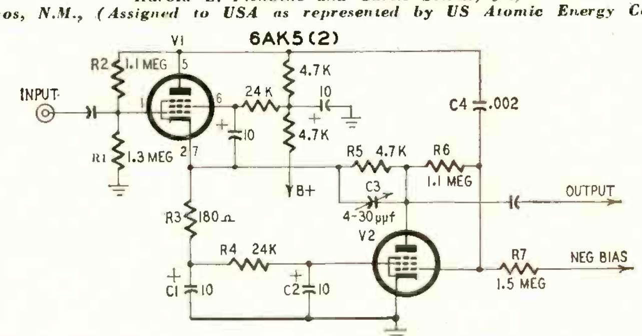
Fig. 2

A practical circuit is drawn in Fig. 2. Each channel uses a pair of transistors, directly coupled. The square wave is rectified by a network of rectifiers, then filtered. Up to 97% efficiency is claimed for a circuit like this.

2-STAGE AUDIO AMPLIFIER

Patent No. 2,802,070

Harold L. Fishbine and Curtis Sewell, Jr., Los Alamos, N.M., (Assigned to USA as represented by US Atomic Energy Commission)



This amplifier uses two tubes in series to conserve plate current. The total B-voltage need not be unduly high since each 6AK5 tube requires only 120 plate volts for a mu of 5,000. V1, the input tube, is coupled through C4 to the second stage V2. A portion of the output is then fed back to the cathode of V1 as negative feedback.

Both control grids are stabilized by voltage dividers; R1, R2 for V1; and R6, R7 for V2. The V2 screen is fed via filter network C1, C2, R4.

The overall gain of the amplifier is given approximately by $\frac{R3 + R5}{R3}$. C3 is a compensating capacitor for high-frequency feedback. It is adjusted for maximum bandwidth.

VOLTAGE-DIVIDER CALIBRATOR

Henry Siegel and Herbert H. Adise, Great Neck, N.Y.

This is a convenient setup for determining the *total* required resistance as well as the correct *tapping points* for accurate voltage dividers. A standard resistor (R1) and a standard voltage divider (R3) are needed. The power sources are I, a constant current, and E, a constant voltage.

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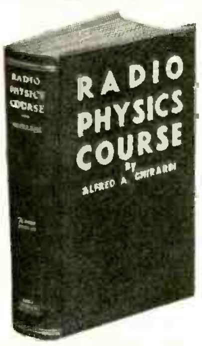

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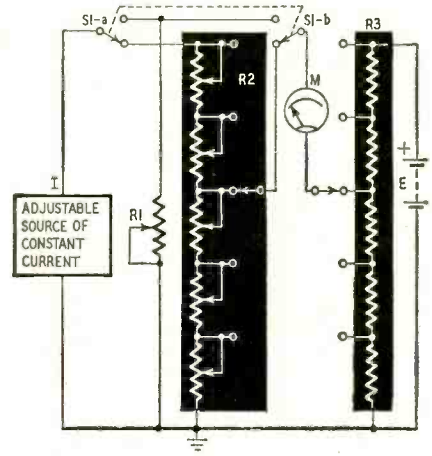
justed for null reading at M, at which time the voltages across R1 and R3 are equal to E.

Now throw S1 to the position shown and R3 to its lowest tap. Also set R2 to the lowest tap and adjust its resistance (between the tap and ground) for null. Repeat the same process for each of the other taps on both R2 and



R3. The final step is to switch R2, R3 to their *upper taps* (the first variable resistance section from the top) and adjust the upper resistance section of R2 for null.

When complete, each tap of R2 delivers the correct voltage percentage of the total E. I, being a constant current, does not vary with changes in R2. Voltage output from R3 is correct at each tap since there is no loading, which might change the voltage, at the null setting.

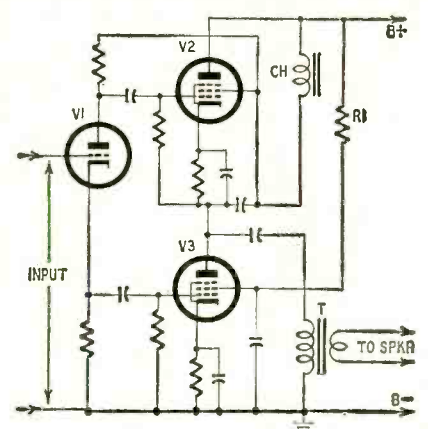
The total resistance of R2 must equal R1 since both have been compared with R3 with the *same* current I flowing through each.

SERIES-CONNECTED PUSH-PULL STAGE

Patent No. 2,802,907

Arnold P. G. Peterson, Newton, and Donald B. Sinclair, Concord, Mass. (Assigned to General Radio Co., Cambridge, Mass.)

The push-pull output transformer of an audio amplifier is usually very expensive. The halves of its center-tapped primary must be tightly coupled and this requires special design such as bifilar winding. This circuit requires no special transformer yet is capable of hi-fi



reproduction. The transformer primary has a *single* winding for both output tubes and is connected across the plate and cathode of V3.

V1, the inverter, feeds out-of-phase signals to V2 and V3. These output tubes are in series so they divide the total B-voltage. Note that the screen of V3 must have a dropping resistor (R1) because the B-potential is so high. However, the screen of V2 may be supplied through choke CH which acts as a dropping resistor.

The audio outputs from V2 and V3 are out of phase. At a given instant, when current through V2 is *increasing* (upward through the primary of T), the current through V3 must be *decreasing* (downward through T). These are additive effects similar to those present in a conventional push-pull stage used in audio amplifiers. END

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You suddenly find yourself manipulating the various controls and filters to see "how she handles." You hear the wide range . . . the flexibility and ease of operation. You examine the unit closely and see the many inputs, outputs, and the well-engineered chassis design.

You ask for a "spec" sheet which you read carefully. You notice response curves, power output, balance controls, etc. They meet the most critical standards of the perfectionist.

"It's wonderful" you remark, "but too rich for my blood!" The expert shows you the price tag which somehow brings the color back to your cheeks. "Here, look at these step-by-step instructions and these clear pictorials . . . it's a cinch to BUILD one of these units in your spare time . . . parts and performance are guaranteed. What's more should you have any difficulty the company has a complete factory service to help you."

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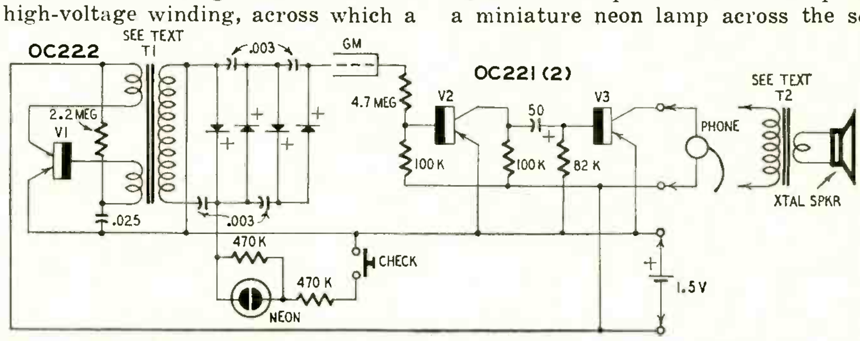
RADIATION COUNTER

Several hundred volts are required to operate Geiger-Muller tubes. The diagram shows a circuit that delivers 500 volts from a 1.5-volt battery.

Transistor V1 (most p-n-p amplifier transistors can be used) is used as a grounded-emitter blocking oscillator. Its base and collector are transformer-coupled. The blocking transformer has a high-voltage winding, across which a 100-volt potential appears. This voltage is applied to a multiplier-rectifier, which delivers 500 volts dc to the Geiger-Muller tube and uses ordinary 100-volt rectifiers.

Pulses from the G-M tube are applied to a two-transistor amplifier. Any p-n-p audio output transistor can be used. The positive-pulse output of the tube is connected to the base of the first transistor through a 4.7-megohm limiting resistor. Negative pulses appear at the collector and are applied to the base of the following transistor.

The indicator is an earphone of a few hundred ohms connected between the collector and −1.5 volts. A crystal speaker or phones may be used by coupling to the output through transformer T2. A pushbutton switch places a miniature neon lamp across the secondary of transformer T1 to check the battery discharge. T1 can be wound on a ferrite pot or core of small dimensions. The collector winding has 100 turns; the base winding 40 turns and the high-voltage winding 1,000 turns. T2 is wound on a similar core, with 200 turns in the collector winding and 1,500 turns in the speaker winding. This circuit originally appeared in *Funkschau*, Munich.—*A. V. J. Martin.*

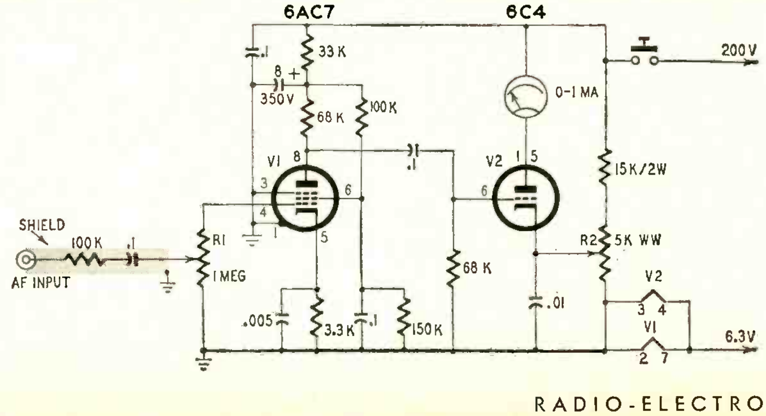


MODULATION METER

When connected to your receiver, this modulation meter lets you give accurate reports when asked for comments on modulation percentage. The meter was described originally by M. W. Kirby in *The Short Wave Magazine* (London, England).

The 6AC7 is a linear audio amplifier feeding the 6C4 meter amplifier, which is normally biased close to cutoff. The input to the 6AC7 is taken from the receiver's detector output. The 6AC7 drives the 6C4 out of cutoff and its plate current, as shown on the meter, is an indication of audio power on an incoming carrier.

Connect the modulation meter to 200 volts B-plus from the receiver or other convenient source. Connect the audio input lead immediately after the set's detector and ahead of tone controls, limiters or other circuits that may distort the signal. If the highs are lost, the meter will read falsely on signals



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where modulation power is concentrated in the lower audio frequencies. Shield the audio input circuit and the 100,000-ohm isolating resistor to prevent hum pickup in meter and receiver circuits.

Tune in a station of known modulation depth. Carefully center the carrier and adjust the receiver's rf gain control so the S-meter reads S8 or some value that will be used as a reference when measuring modulation percentage. Adjust R2 so the meter reads full scale when R1 is set for minimum resistance. Set the meter pointer to zero with its adjustment screw. Advance R1 until the meter pointer just kicks to full scale on a 100% modulated signal.

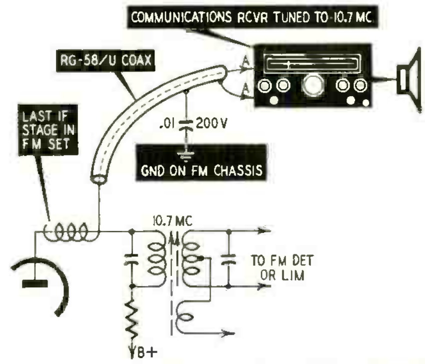
Now, the meter reading is in direct proportion to the percentage of modulation. A reading of 0.5 ma indicates 50%, 0.75 ma is 75% and so on. These measurements are accurate only when the receiver's rf gain is adjusted so the signal is S8 on its S-meter.

The normally open pushbutton switch disables the circuit so the meter won't be damaged by tuning in a station that would drive the S-meter above the predetermined reference level.

RECEIVING US SATELLITES

The diagram illustrates a simple and economical system that many technicians here in Southern Florida will use to track soon-to-be-launched US satellites. It uses a conventional FM tuner or receiver and a communications receiver tunable to 10.7 mc.

Wrap a five- or six-turn gimmick of insulated hookup wire around the plate lead of the last if amplifier or limiter in the FM set and connect it to the center conductor of a length of RG-59/U or RG-58/U coaxial cable. Ground



the cable shield to the FM chassis through a .01-μf capacitor. Connect the other end of the coax to the antenna terminals of the communications receiver. Carefully tune the FM set to 108 mc and the communications receiver to 10.7 mc and you are in business. The gain of the 10.7-mc if strip plus that of the communications receiver make this a very sensitive system.

In closing, let me add that Mr. G. Graham's Vanguard 108 (RADIO-ELECTRONICS, January, 1958) offers the constructor a fine plan for a Minitrack station. He is to be congratulated for the effort he put into the design of the converter.—*Frank J. Lutz, Jr.* END

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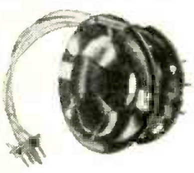
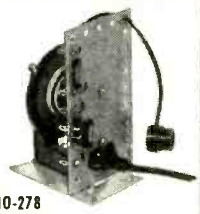


Exact replacements for RCA in chassis KCS-107, 108F, 109 113 series

Exact Replacement Flybacks for PHILCO



HO-276
HO-277, HO-278
used in 171 models—with resistors and capacitors attached.

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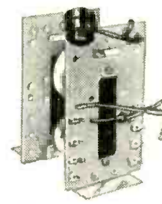
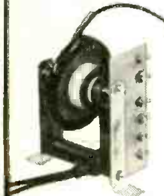


HO-273 used in 19 models

Exact Replacement for MAGNAVOX



HO-279
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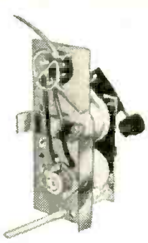
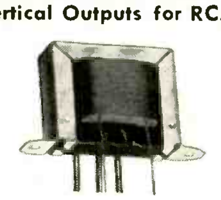


HO-281
used in 154 models

Exact Replacement Vertical Outputs for RCA



VO-103 replaces 103093, 972151-1
VO-106 replaces 102146, 972725-1
VO-107 replaces 103266, 972725-2

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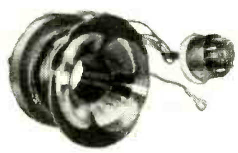

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technical Literature

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ANTENNA CATALOG *No. A-58.* More than 100 styles of vhf, uhf, color and do-it-yourself antennas are described in the pamphlet's 28 illustrated pages. Horizontal directivity patterns are shown for the most of the antennas.—**Telco Electronics Mfg. Co.**, Div. of G. C.-Textron Inc., 400 S. Wyman St., Rockford, Ill.

AR-2 SPEAKER SYSTEM is presented in a 4-page illustrated folder. Technical data, including frequency response and harmonic distortion charts, are offered. —**Acoustic Research Inc.**, 24 Thorndike St., Cambridge 41, Mass.

LINE-VOLTAGE REGULATOR *1570-A* is detailed in a 4-page descriptive catalog. The unit automatically keeps its output voltage constant within an accuracy of 0.25%.—**General Radio Co.**, 275 Massachusetts Ave., Cambridge 39, Mass.

AUDIO ACCESSORIES, including molded cable assembles, right-angle and straight phone and phono plugs, are described in *Catalog S-580.* Specifications and illustrations are given with each type.—**Switchcraft Inc.**, 1328 N. Halsted St., Chicago 22, Ill.

USE OF CHEMICALS in electronics is outlined in a 28-page technical bulletin. Oxide cleaners, cements, resin sprays and varnishes are among the items discussed in the bulletin entitled *Electronic Chemicals*—**General Cement Mfg. Co.**, Div. of Textron Inc., 400 S. Wyman St., Rockford, Ill. $1.

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MOTEL TV BULLETINS. *MP-97* is comprised of system layouts, TV outlet connections and a list of this manufacturer's installations. *SF-97* shows a complete system layout which can be used in 90% of the motels in the United States.—**Blonder-Tongue Laboratories Inc.**, 9-25 Alling St., Newark 2, N. J.

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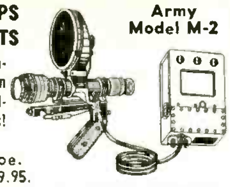

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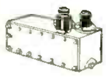

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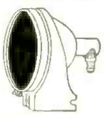

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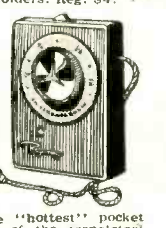

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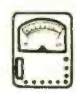

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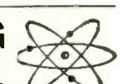

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EIA STANDARDS. *RS-199, Solid Dielectric Transmission Lines,* a revision of *TR-143*; *RS-202, EIA-NEMA Standards for Recommended Practice for Preparation of Outline Drawings of Electron Tubes and Bases,* a revision of *ET-102-B*.—EIA, Engineering Dept. 650 Salmon Tower, 11 W. 42 St., New York 36, N. Y. *RS-199*, $1.20; *RS-202*, $1.20. END

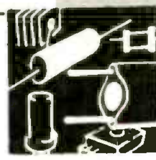
CORRECTIONS

There is an error in the article "Transistors Sensitize Relay Circuits," by Edwin Bohr. In the last paragraph of page 112 the text states, "It should be no more than 50 or 75 ma." This should have been 50 or 75 μa.

Our thanks to Mr. Larry Seligman of Rockville Centre, N. Y., for reporting the error.

In the article "3-Transistor Regenerative Receiver," which appeared on page 100 of the February, 1958, issue the polarity of the battery is incorrect. The positive end should go to the transistors' emitters and the negative end to switch S1.

new Devices



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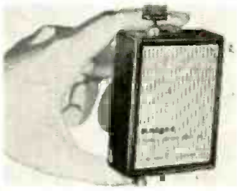

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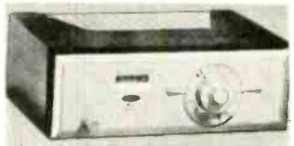

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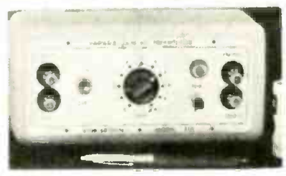

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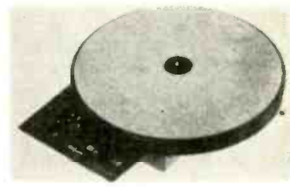

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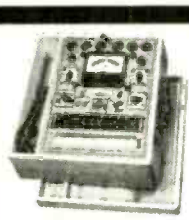

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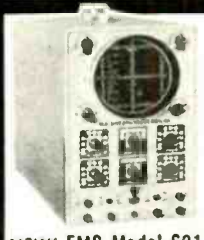

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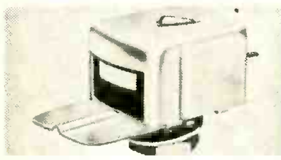

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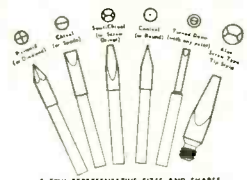
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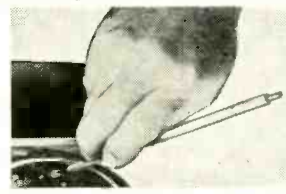

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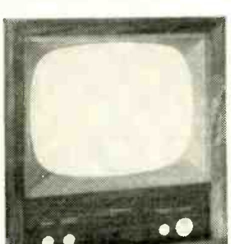

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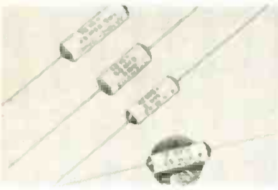
736488, 24K739283, 24K739284, 24K741937 and 24K741938; *FLY-126* replaces Admiral 79D65-1, 2.—**Thordarson-Meissner Mfg. Co.**, 7th & Belmont Aves., Mt. Carmel, Ill.

SUBMINIATURE ELECTROLYTICS, *type EC.* Aluminum-foil types for transistor and



low-B applications. Ratings from 3–75 volts and capacitances from 1.0–250 μf.—**Cornell-Dubilier Electric Co.**, S. Plainfield, N. J.

SILICON RECTIFIERS handle 200-amp rectified dc output with peak inverse ratings of 100–400 volts. Designed to withstand

severe shock and vibration. Has aluminum airfoil type heat exchanger. — **International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif.

VTVM KIT, *model V-70.* Has 7 dc and rms ac ranges up to 1,500

volts; 7 peak-to-peak ranges up to 4,000 volts; 7 ohmmeter ranges up to 1,000 megohms. 5-inch meter.—**Paco Electronics Co. Inc.**, Div. of Precision Apparatus Co. Inc., 70-31 84th St., Glendale 27, N. Y.

PRINTED-CIRCUIT VTVM, *model 904.* 7 dc scales to 1,500 volts. 7 ac rms scales to 1,500

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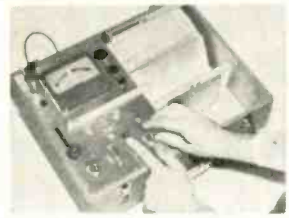

condition.—**RCA**, Electronic Tube Div., Harrison, N. J.

MINIATURE SIGNAL INJECTOR, the *Mosquito.* Transistor

unit for direct and inductive coupling to all magnetic sensitive pickups without direct connection with leads. Produces signals from 2,000 cycles to high radio frequencies in harmonics.—**Don Bosco Electronics Co.**, 1099 S. Orange Ave., Newark 6, N. J.

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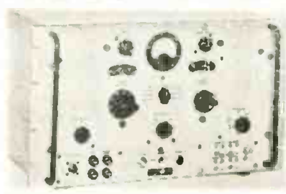
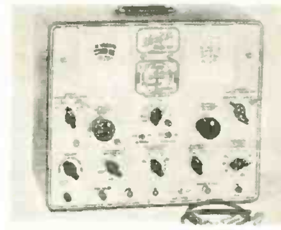


TV SWEEP AND MARKER GENERATOR, *model 615.* Delivers .025-volt rms marker. Fre-



quency ranges: 2.5–5.5 mc; 19–50 mc; 54–108 mc and strong harmonic 108–216 mc. Variable sweep width: 0–15 mc. Built-in 4-5-mc crystal provides simultaneous sound and picture markers.—**Hickok Electrical Instrument Co.**, 10531 Dupont Ave., Cleveland 8, Ohio.

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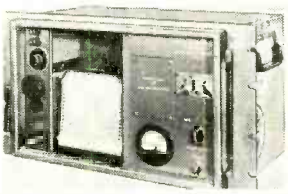
MARINE LEVEL RECORDER, *model SL-4M*. For making frequency response, sound, noise and vibration measurements.



Moistureproof, anodized metal case. Plexiglass hinged door on front panel protects recording mechanism.—**Sound Apparatus Co.**, Stirling, N. J.

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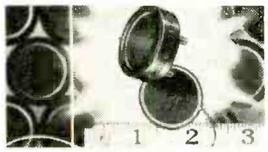

mounted. Mounted cells have black phenolic housings with glass window. Mounting studs serve as electrical output terminals. Unmounted cells have 6-inch color-coded leads.—**International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif.

MUSIC MINDER SWITCH automatically shuts off entire hi-fi system after last record. At end of last record, relay is

triggered and system cuts off. Manual position is also present. At this setting, automatic feature is inoperative. — **C-B-C Electronics Co., Inc.**, 2601 N. Howard St., Philadelphia 33, Pa.

EXTENDED-RANGE SPEAKER, *Ultra 12*. 12-inch unit covers 20–25,000 cycles. Cone resonance is at 20 cycles. Flux

density, 18,000 gauss.—*Bradford Audio Corp.*, 27 E. 38th St., New York 16, N. Y.

EXTENDED-RANGE HI-FI SPEAKER, *Wigo ER85*. 8½-inch unit. Response: 40–15,000 cycles.

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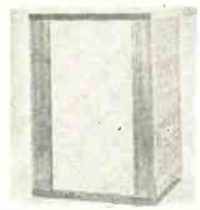

100-cycle low-end limit. For use as the second or third channel of a stereophonic system.—**Klipsch & Assoc.**, Hope, Ark.

CRT CHECKER, *Check N' Tell*. Tests picture tubes for heater continuity, low emission, open control grid, control-grid-to-cathode short, heater–cathode

short, open cathode and focus grid leakage.—**Circuit Manufacturing Co. Inc.**, 923 Shadeland Ave., Drexel Hill, Pa.

VOLT-OHM-MILLIAMMETER, *model 630-PL*. 6 voltage scales, 0–5,000 volts ac and dc. 4 resistance ranges, 0–100 megohms. Ac response, 5–500,000

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All specifications given on these pages are from manufacturers' data.

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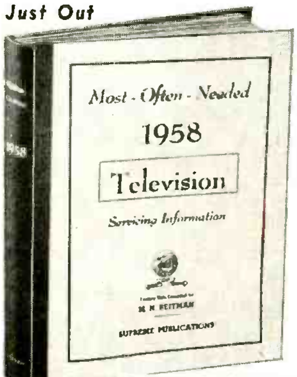

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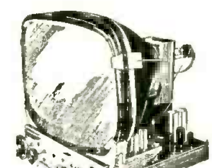

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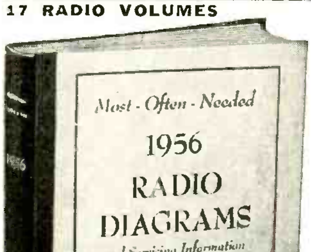

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6 – SPIN TIGHT SOCKET SET 3/16" to 7/16".... $1
3 – TV ALIGNMENT TOOLS 5", 7", 12" $1

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted, enclose with money order or check. You will receive a new copy of this ad for re-orders.

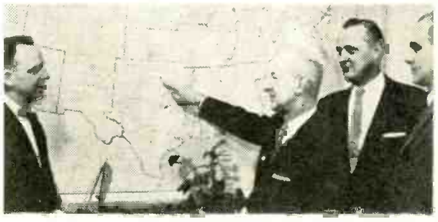
ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

BROOKS RADIO & TV CORP.
84 Vesey St. Dept. A, New York 7 N.Y.

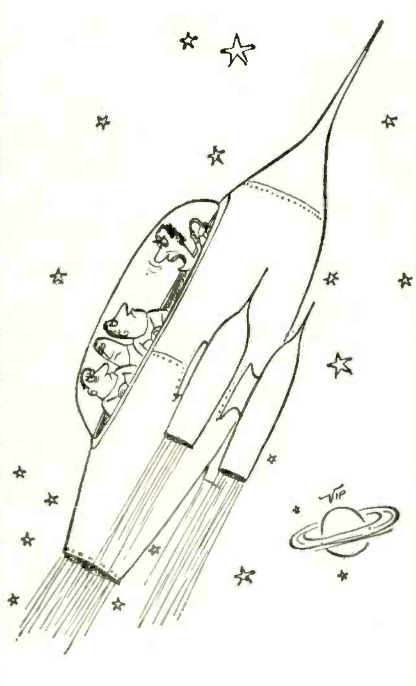
Business and People

Thomas Allinson was appointed president and chief operating executive of the new Daystrom-Weston Co. The new group comprises the Weston Instruments Div., Newark, N. J.; Daystrom Systems Div., La Jolla, Calif., and Daystrom-Weston Industrial Div., Poughkeepsie, N. Y. Allinson will continue as vice president of Daystrom, Inc., Murray, Hill, N. J. Earl R. Mellen, former president of Weston, will be chairman of the new group. Other executives include: Wilbert H. Steinkamp, vice president, sales and marketing; Roswell W. Gilbert, vice president, research and development; Henry W. Strong, comptroller, and John H. Miller, vice president and technical advisor to the president.

Douglas Thatcher was appointed sales manager of the newly organized International Div. of Centralab, Milwaukee, Wis., in a reorganization of sales structure announced by Walter Peek, general sales manager. **Bruce Vinkemulder**, former Distributor Div. sales manager, was promoted to assistant general sales manager. **Gerry Mills**, assistant distributor sales manager, now assumes responsibility for the division's sales. **John Prutton** becomes sales manager of the Ceramic Capacitor Div., and **John LeFeber** continues in charge of piezoelectric ceramics sales and assumes new responsibility for semiconductor product sales. **Joe Fothergill** continues as sales assistant for semiconductor products and will assist LeFeber in the sale of piezoelectric ceramics and special capacitors. Photo shows LeFeber, Thatcher, Vinkemulder and Prutton (left to right) discussing the national sales picture.



A. A. Ward, executive vice president and director of Altec Companies, Anaheim, Calif., was elected president of the firm.



"O.K! O.K! We'll *turn* back to earth and *get* your *JENSEN NEEDLES."*

Dave Rice's
OFFICIAL ORDER BOOK
for every TV-Radio service call

CONVENIENT! EASY TO USE!

Simplify your record-keeping with these convenient triplicate forms. They serve as order form, invoice and office record, with spaces for complete information on every job. Separate listings for receiving tubes, picture tubes, parts, serial numbers, labor and tax charges, etc. 75c a book, $6.50 for money-saving dust-proof box of 10.

In stock at your distributor

ELECTRONIC PUBLISHING CO. INC.
180 North Wacker Drive Chicago 6, Illinois

www.americanradiohistory.com

W. D. Renner was appointed vice president in charge of special services for Howard W. Sams & Co., Inc., Indianapolis, Ind. One of the original 12 who formed the nucleus of the company when it was established in 1946, Renner has since served in executive sales and engineering positions.

Percy L. Spencer was elected senior vice president of Raytheon Manufacturing Co., Waltham, Mass. He headed the company's Microwave and Power Tube Div. since World War II and was elected a director in 1955.

Charles Golenpaul, vice president heading the Distributor Div. of Aerovox Corp., New Bedford, Mass., has been elected an honorary life member of the New England Chapter of The Representatives.

Joseph B. Cejka (left) joined Gabriel Co., Cleveland, Ohio, as general sales manager for Electronics. He had been a vice president of Brach Manufacturing Co. for 8 years prior to joining

Gabriel. **Robert T. Hood** (right) was elected treasurer and controller of Gabriel. Formerly treasurer of the company, he joined the firm in 1955 as plant manager of the Ward Products Div.

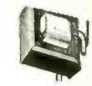
Joshua Ginsparg, (left) superintendent of Assembly Dept. for Shure Bros., Evanston, Ill., was promoted to chief

industrial engineer. **Fabian Fornall** was appointed factory superintendent of the company. He has been with Shure Bros. for 17 years, most recently as superintendent of shops and toolroom.

Edward Wagoner, named sales assistant of the Variable Resistor Div. of Centralab, Milwaukee, Wis., comes from NBC in Detroit.

RAD-TEL TUBE CO.

Transformer PRICE Spectacular!



All Power Transformers 117V 60C 5V Rect. & 6.3V Fil.

Part No.	H.V. Sec. All C.T.	Price
454	696	$3.20
488	440	$2.20
490	156 No C.T.	$2.20
508	686	$4.20
509	640	$3.00
451	700/412	$3.20

#451 has 2-5V Sec. only

Lots of 3 DEDUCT 5%

Lots of 10 DEDUCT 10%

Lots may be assorted!

E.M. SPEAKERS E.M.

Part No.	Dia.	Field	V.C.	Price
345	5″	600	3.2	79¢
330	5″	1300	3.2	79¢
331	5″ x 7″	600	3.2	89¢
346	6″	1700	3	98¢
343	6″ x 9″	1100	5.3	$1.09
344	7″	1075	3	99¢
333	12″	700	10	$1.99
332	12″	800	3.2	$1.99
334	12″	1100	5.1	$2.05

SPECIAL WITH THIS AD ASST. OF 3 DEDUCT 1/3

MARCH SPECIAL!

FILTER CHOKES

RAD-TEL ASSORTMENT
1 to 65 Henrys
300 to 10 MA.
Our Asst. of 6............ $3.00

ALL RAD-TEL TUBES Guaranteed 1 Full Year!

Not Affil. With Any Other Tube Mail Order Co.

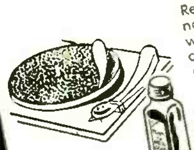
Rad-Tel TUBE CO.

Write Dept. RE-3 for FREE Catalog of Tubes & Parts. Subject to prior sale. No C.O.D.'s, please, on this sale. Allow for postage.

55 CHAMBERS STREET NEWARK 5, N.J.

COLMAN Electronic Products

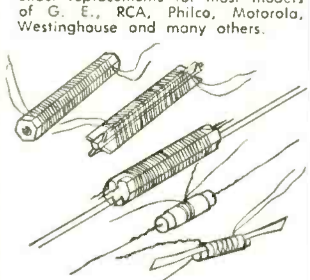
NEW FLOCK



Re-cover worn phonograph turntables with this new flock-coated disc. Simply glue on to the turntable. Fastest, easiest, best method of re-flocking—8" to 16" sizes. Plastic-to-metal cement available in 2 oz. bottle.

Antenna Matching Coils

Exact replacements for most models of G. E., RCA, Philco, Motorola, Westinghouse and many others.



In stock at leading parts jobbers everywhere.

COLMAN TOOL & MACHINE CO.
P. O. Box 7026—Amarillo, Texas

Canadian Representative:
Wm. Cohen Ltd., 7000 Park Ave., Montreal, Canada

NEW! IMPROVED! SENCORE TRC4 TRANSISTOR CHECKER

Another Sencore Time-Saver

America's newest, most popular test instruments

NOW CHECKS:

★ **Transistors** for opens, shorts, leakage and current gain. Includes new gain test on power transistors.

★ **Crystal Diodes** checks forward to reverse current ratio on all diodes.

★ **Selenium Rectifiers** checks forward and reverse currents.

SIMPLE TO OPERATE

ONLY $17.95 Dealer Net

Cannot become obsolete. Approved by leading manufacturers.

Controls are accurately set for each transistor by referring to replaceable set-up chart on rear. Test leads or socket provides for fast hook-up.

See your parts distributor.

SENCORE Mfg by SERVICE INSTRUMENTS CORP.
171 OFFICIAL RD., ADDISON, ILL.

Cut out this ad now for further information

James D. Grady, Jr. (left) has been named manager of the newly formed Instrumentation Tape Div. of ORRadio Industries, Opelike, Ala. **Robert D.**

Browning is manager of the Audio Products Div., also recently established by the company. Grady had been assistant production manager, and Browning comes to the firm from RCA Victor.

Obituary

Basil M. Goldsmith, material control manager of the Industrial Tube Div. of Allen B. Du Mont Labs., Clifton, N. J., recently at the age of 49.

Business

TV and radio retail sales for the first 11 months of 1957 reached 5,636,881 TV sets and 7,689,841 radios (exclusive of automobile sets). This compares with 5,847,590 TV sets and 6,680,127 radios sold in the 1956 period.

TV set production for the first 11 months of 1957 was 5,825,804 compared with 6,760,045 in 1956. **Total radio production** for the 1957 period was 13,634,-402 compared to 12,266,591 in January through November, 1956.

Manufacturers' sales of TV picture tubes for January through November, 1957, totaled 9,076,982 units and receiving **tube sales** equaled 428,688,000 units. During the first 11 months of 1956 10,191,545 picture tubes and 429,846,000 receiving tubes were sold.

Factory sales of transistors jumped to 29,965,000 units during the first 11 months of 1957 from 11,232,000 sold during the 1956 period.

Military electronics spending during the first quarter of the fiscal year 1958 increased to $926,000,000 compared to $637,000,000 for the similar quarter in fiscal 1957. This was the highest first quarter to date. However, it was below the $1,055,000 spent by the military for electronics in the fourth quarter of 1957.

David Bogen Co., Paramus, N. J., recently produced its one-millionth ampli-

fier, a DB130. Photo shows Irving Olson (left), president, Olson Radio Warehouse Inc., Akron, Ohio, congratulating Lester H. Bogen, president of David Bogen Co. as Mortimer Sumberg, dis-

STAN-BURN

CATHODE RAY TUBE SPECIALS

ONE YEAR GUARANTEE

G.E.	Type	STAN BURN	G.E.	Type	STAN BURN
$15.80	10BP4	$10.00	24.75	17LP4	$18.00
19.10	12LP4A	13.95	37.00	19AP4A	24.00
	12QP4	11.50	28.35	20CP4A	18.95
20.35	12UP4	15.00	33.60	20CP4B*	21.95
20.75	14CP4	13.75	36.00	21AP4	25.00
	15DP4	14.50	29.75	21EP4A	20.15
33.75	16AP4	18.50	34.85	21EP4B*	23.25
32.20	16DP4A	15.25	30.90	21FP4	21.15
33.75	16GP4	18.75	37.00	21MP4	26.25
23.50	16KP4	15.75	29.75	21YP4	22.00
28.40	16KP4A*	18.75	34.85	21YP4A*	25.00
31.50	16LP4A	16.25	28.30	21ZP4	21.00
31.50	16WP4	16.25	33.60	21ZP4B*	24.00
23.50	17BP4	15.75	100.00	24AP4 (6 mos. guar.)	56.00
28.40	17BP4B*	18.75			
30.75	17CP4	20.50	48.40	24CP4A*	38.00
33.90	17GP4	21.50	50.00	24DP4A*	39.00

*ALUMINIZED—INQUIRE FOR ANY TUBE TYPE NOT LISTED. STAN-BURN CRT TUBES RCA LICENSED—MFD. BY LINCOLN. All orders of 6 or more STAN-BURN CRT are subject to additional 10% discount. PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

WHY PAY MORE? HI-FI COMPONENTS • KITS • RECORD PLAYERS • TAPE RECORDERS • TUNERS • AMPLIFIERS • SPEAKERS • ELECTRONIC PARTS & TUBES • Etc.

Top brand nationally adv. merchandise in this and other Radio & TV mags. is yours at low. low cost. Send us your list. Give Mfr's name and Model No. of item. Write for "57" catalogs to Dept. RE-3 today.

NOW YOU CAN HAVE QUALITY HIGH FIDELITY AT THE LOW STAN-BURN PRICE

Here is top value combined with superb HI-FI performance. The new STAN-BURN MARK VIII High Fidelity Phono System featuring the DeWald 12 watt amplifier with a frequency response of 30-20,000 cps and distortion less than 1½% at full rated output. Included also in this excellent system is the Collaro 4 speed record changer supplied complete with the new GE VRII series magnetic variable reluctance cartridge with dual sapphire styli, a bass reflex speaker cabinet finished in either blonde or mahogany with luxurious grille cloth to match. Cabinet measures 20" wide x 16" deep x 23" high footed base included. Completing the system is the new STAN-BURN SELECTRONIC 12" coaxial speaker to give you live performance realism right in your own living room.

Only $97.49—F.O.B.—N.Y.

ABOVE WITH AM/FM TUNER ADD $47.50
ABOVE WITH DIAMOND LP NEEDLE ADD $8.00
TUNER ONLY $47.50
AMPLIFIER ONLY $32.50

HI-FI DIAMOND NEEDLES—1 Yr. Guar.

Diamond needles reduce record wear and needle noise thus retaining full frequency response and tonal qualities of your records for a longer period of time.

SINGLE DIAMOND needle............$7.95
DIAMOND SAPP dual needle.......... 8.95
Shipment PPD. (specify cartridge make)

RECORD CHANGERS

COLLARO RC-456 4 speed changer....$33.81
GARRARD RC-88 4 speed changer.... 53.41
GARRARD RC-98 4 speed changer.... 66.15

FREE wood mounting base, record wiping cloth and 45 RPM spindle with all orders for Collaro and Garrard changers, with this ad.

VM 4 SPEED HI-FI CHANGER—Model 1210 with Ronette or Astatic flip-over cartridge $22.95
MONARCH Model UA8U 4 SPEED AUTO. INTERMIX CHANGER less crystal cartridge $19.95
RONETTE (phono fluid) cartridge flip-over type $2.98
SONOTONE cartridge, flip-over........$2.98
45 RPM SPINDLE for V.M. or Monarch..$1.98
WOOD MOUNTING BASE for V.M. or Monarch $3.95
MOUNTING BOARD unfinished for V.M. or Monarch $1.50

NEW GENERAL ELECTRIC HI-FI VARIABLE RELUCTANCE CARTRIDGE. Replaces discontinued RPX050 type. Full range reproduction 20-20,000 cycles. Four gram tracking force for minimum record and stylus wear.

4G050—Dual Sapphire needles.........$8.77
4G052—Diamond, Sapphire needles...$18.99

KITS!

We stock the following manufacturers complete line of kits—see reference pages.

EICO see pages 31-32
QUALITY see page 146
PRECISE
BOGEN
GROMMES
DYNACO
ARKAY see page 132
ELECTRO-VOICE Inside Back Cover
CABINART
TECHMASTER

All domestic orders will be shipped prepaid. Send us your list. Order by Mfr. and Model No. of item.

$20 WORTH OF ELECTRONIC PARTS IN GRAB-BAG consisting of: Porcelain sockets, coils, speaker, transf. resis, cond. ONLY..............$1.98 (plus 50c postage)

YOU NAME IT—WE HAVE IT

Complete line of T.V. & Radio receiving tubes, coils, transf., controls, antennas & accessories—No Minimum Order—DEALER DISCOUNTS! Thousands of satisfied Hi-Fi enthusiasts and dealers will vouch that STAN-BURN GIVES THE BEST DEAL POSSIBLE!

EXPORT INQUIRIES AND OFFERS INVITED.

Terms: 20% with order. Balance C.O.D. All prices F.O.B. NEW YORK Warehouse.

Write for our latest price list and Hi-Fi Catalog RE-3. All Prices Subject to Change Without Notice.

STAN-BURN RADIO and ELECTRONICS CO.
558 CONEY ISLAND AVE. • B'KLYN 18, N. Y.

CATALOG OF *Professional Quality Kits* "DIRECT FROM FACTORY"

FREE

- TV KITS
- INSTRUMENT KITS
- HI-FI KITS, SPEAKERS
- HI-FI CABINETS (Largest Selection)
- Electronic PHOTOFLASH Kits

PAY AS YOU WIRE with Transvision "SPLIT-KITS." A few dollars gets you started. Each Kit is split into a few packages. You can order one at a time as you wire.

Also RECORDS RCA CBS All Labels at BIGGEST DISCOUNT!

TRANSVISION, INC., New Rochelle, N.Y. E

Rush FREE Catalog of KITS, HI-FI Equipment Cabinets, Records, etc

Name____________________
Address____________________
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SPRAY it or DROP it

the NEW QUIETROLE Spray-Pack

or the QUIETROLE Bottle with the Eye Dropper Cap

Now *QUIETROLE* offers you both types of containers. Either way assures you of the same unfailing results that *QUIETROLE* is known for.

Make your next purchase *QUIETROLE*, get both and learn the difference between quality and poor substitutes. *QUIETROLE* is the original product of its kind, it is a FIRST of the Industry and you can depend on it to end your noisy control and switch troubles.

manufactured by
QUIETROLE COMPANY
Spartanburg, South Carolina

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tributor sales manager looks on. The company also announced the largest advertising campaign in its history to celebrate its 25th anniversary. Consumer, hi-fi and trade publications, including RADIO-ELECTRONICS, will be used.

Tobe Deutschmann Corp., Indianapolis, Ind., designed a self-service capacitor display rack for distributors.

Oxford Components Inc., Chicago, is now packaging its rear-seat hi-fi speak-

er kits in multicolored display cartons.

JFD Electronics Corp., Brooklyn, N.Y., is now merchandising its Fireball

Junior-Helix and Super-Helix Colortennas as complete installation kits in colorful cartons.

Amperex Electronics Corp., Hicksville, N.Y., is offering its distributors a

3-dimensional, 4-color, battery operated, Tube-In-Hand motion display. END

Thirty-Five Years Ago

In Gernsback Publications

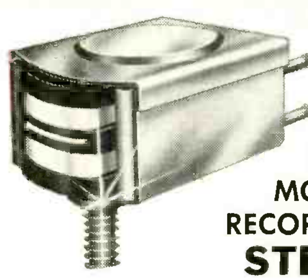
HUGO GERNSBACK, *Founder*	
Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In March, 1924, *Science and Invention* (formerly *Electrical Experimenter*)

New Radio Developments, by H. Gernsback.
Radio Waves Penetrate Tunnel, by L. Port.
Trans-Continental Radio Control.
Novel Detector, by L. Fournier.
Small Portable Receiver, by S. R. Winters.
How I Would Speak To Mars, by H. Gernsback.
European Radio Ideas.
Practical Loop Antenna Construction, by Jack Milligram.
Methods to Stop Regenerative Radiation, by A. P. Peck.
Long Wave Receiver, by Paul Oard.
What Are Kilocycles?

STEREOPHONIC TAPE HEAD



CONVERT MONAURAL RECORDERS TO STEREO

The model TLD-S is easily compensated to provide flat response from 30 to over 10,000 cycles. Unique construction assures precise gap alignment, negligible tape oxide accumulation, and 50 db crosstalk rejection. High quality—ideal for new equipment. Write for information and circuits. Net price $19.50

THE NORTRONICS COMPANY
1017 South 6th Street Minneapolis 4, Minnesota

SPECIALS!
LM FREQUENCY METER

Heterodyne, crystal calibrated, modulated less calibration book 125KC to 20,000KC
Exc. $24.95

1-208 A standard of voltage freq. and freq. deviation for testing, alignment, calibration and sensitivity measurement of FM receivers. Freq. range 1.9 to 4.5 Mc. and 19 to 45 Mc. Operates from either 12 VDC or 110 VAC.
GOVT. ACQ. COST $1800.00.
Exc. $59.50

J-38 HIGH SPEED HAND TELEGRAPH KEY, with on off switch, adjustable spring tension and contact spacing, mounted on Bakelite base.
Brand new $1.69

DM-65 HIGH VOLTAGE HIGH CURRENT 12 volt DC input dynamotor, 440 volt 400 MA output, complete with base and Jones Plug.
Brand New $19.95
Used Exc. $14.95

WRITE FOR NEW BULLETIN
25% Deposit required with order

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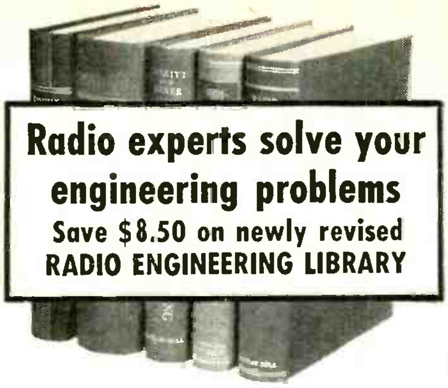
2430 So. Michigan Ave., Chicago 16, Ill.
Dept. E Phone: CAlumet 5-1281-2-3



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At your fingertips in one convenient source—facts, standards, practices, data for the whole field of radio engineering. Highlights current developments in transistors, other semi-conductors, microwave tubes, pulse techniques, color TV, and more. Covers everything from tube and circuit fundamentals through essentials of major fields of application.

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Send for 10 days' FREE trial, the Radio Engineering Library. In 10 days I will send (check one) ☐ $49.50; or ☐ $7.50 in 10 days and $7.00 a month until $49.50 is paid—a savings of $8.50 over regular price of $58. Otherwise I will return books postpaid.

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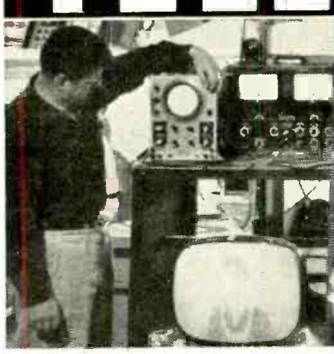
For price and terms outside USA, write McGraw-Hill Int'l., N.Y.C. RE-3

TELEVISION



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Established 1863
Van Ness at Post, RE
San Francisco, Calif.

Never before in American history has the need been so great for Trained Engineers and Technicians. No other type of training can compare with actual shop practice you get at Healds under expert instructors.

Bachelor of Science Degree, 27 Months

☐ Television Technician including Color TV (12 Months)
☐ Electronics Technician (12 Months)
☐ Industrial Electronics Technician (12 Months)
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Heald College ranks FIRST West of the Mississippi in "Who's Who in America"

Approved for Veterans
DAY AND EVENING CLASSES
Write for Catalog and Registration Application.
New Term Starting Soon.

Your Name ....
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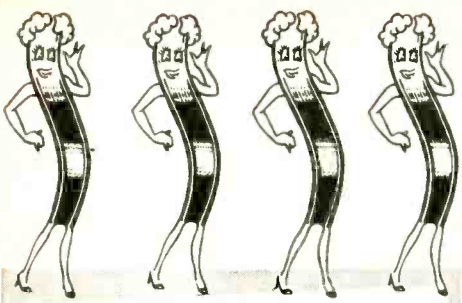


Which one can prove her **QUALITY?**

Most brands of twin lead look alike! Also, the price brands make the same claims of quality and performance as the top quality brands.

What Reason . . . What Proof

Can you give your customer that he is getting something better when he pays a little more for twin lead?

WITH *Columbia* **PERMALINE**

Your Customer has the reason

So GOOD that it's GUARANTEED up to 25 YEARS!

DISTINCTIVE APPEARANCE

HIGH MOLECULAR WT. POLYETHELENE

DEVELOPED AFTER YEARS OF RESEARCH

See your Jobber . . .

Ask him about Permaline — and ask to see the Laboratory Report on weathering studies of Polyethelene.

Once you "Try" COLUMBIA . . . you'll want to always "Buy" Columbia . . . Because *only*, but *only* COLUMBIA gives you a complete guarantee for *25 YEARS*.

AVAILABLE AT ALL LEADING DISTRIBUTORS

Columbia **WIRE & SUPPLY CO.**

2850 IRVING PK. RD., CHICAGO 18

JOIN SERVE

LMB "SAL-MET"

LMB Presents The New

FREE 1957 CATALOG covering the full precision engineered line of original box chassis as manufactured by LMB including new Miniature, new Jiffy, new T.F., new Utility Boxes. Eleven different types, 160 different shapes and sizes. A ready reference for engineers, experimenters or anyone using metal boxes. Send for your FREE CATALOG now! "SAL-MET" Non-corrosive Flux—solders copper to aluminum, aluminum to aluminum, any metal to any metal using conventional solder and regular soldering methods. Send for both LMB and "SAL-MET" Catalogs.

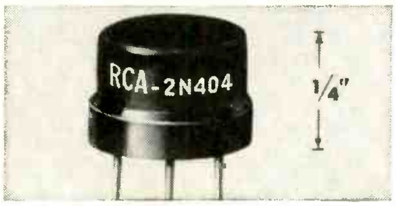
LMB, 1011 Venice Blvd., Los Angeles 15, Calif.

New Tubes & Semi-conductors

Among this month's releases are two transistors, an improved color image orthicon and a subminiature twin triode.

2N404

A germanium-alloy junction transistor of the p-n-p type featuring excellent stability and uniformity of characteristics. It is specifically designed for use in switching circuits of compact, medium-speed military and



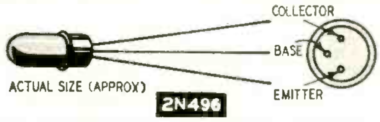
industrial electronic computers. The unit is made by RCA.

Maximum ratings for switching service use are:

V_{CB}		-25
V_{CE}		-24
V_{EB}		-12
I_C (ma)		-100
I_E (ma)		100
P_C (mw)	(at 25°C)	120
	(at 55°C)	35
	(at 71°C)	10

2N496

A hermetically sealed p-n-p, silicon surface alloy transistor intended for high-speed switching applications. The maximum frequency of oscillation is typically about 25 mc. This transistor,



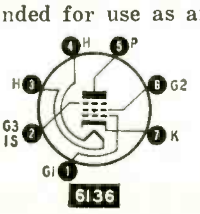
made by Philco, was originally known as the T1276. It is the electrical equivalent of the 2N355.

Tentative maximum ratings of the unit are:

V_{CB} or V_{CE}	-10
I_C (ma)	-50
P_{total} (mw) (at 25°C)	150
Junction temperature (°C)	140
Storage temperature (°C)	-65 to 140

6136

A premium version of the 6AU6, this tube is intended for use as an if or rf



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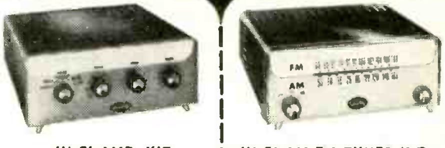

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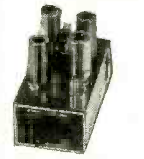

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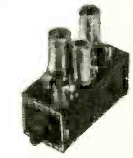

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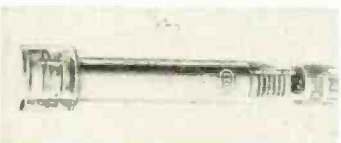
amplifier in high-gain wide-band circuits of vhf communications receivers. Sample 6136's are tested at the end of 1 hour, 100 hours and 500 hours to insure that they are within the established characteristics limits.

Maximum ratings of this RCA tube in class-A1 amplifier service are:

V_p	330
V_{g1} (pos bias value)	0
V_{g2}	165
V_{g3}	0
P_p (watts)	3.3
Peak heater–cathode voltage	
(htr neg with respect to cath)	100
(htr pos with respect to cath)	100

Color image orthicon

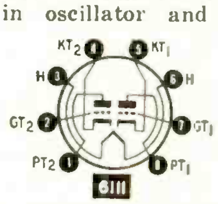
The RCA 7037 color image orthicon is an improved type that has much higher sensitivity and outperforms previous models. The tube's higher sensitivity to red, green and blue permits reducing the lighting level or lens aperture. Its increased ratio of blue to red sensitivity gives better balance between color channels with incandescent lighting.



The 7037 can be used in place of the 6474 in color TV cameras. No change in color filters is necessary because of the close similarity in the spectral response of the two types.

6111

A subminiature medium-mu twin triode with flexible leads. It is designed for use in oscillator and amplifier applications at frequencies up through the vhf region. It is made by RCA.



Maximum ratings as a Class A1 amplifier are:

V_p	165
V_{g1} (pos bias value)	0
(neg bias value)	55
P_p (watts)	1.1
Peak heater–cathode voltage	
(htr neg with respect to cath)	200
(htr pos with respect to cath)	200
Max grid-circuit resistance for cathode-bias operation (megohms)	1.2

Other types

A versatile subminiature silicon-junction diode, the 1N658 has been announced by Radio Receptor Co. Inc. The unit is designed for computer, communications, military, and moderate-power applications. Forward voltage drop is under 1 volt at 100 ma. Peak inverse rating is 120 volts. It will handle an average rectified current of 200 ma and has a power dissipation rating of 200 mw. END

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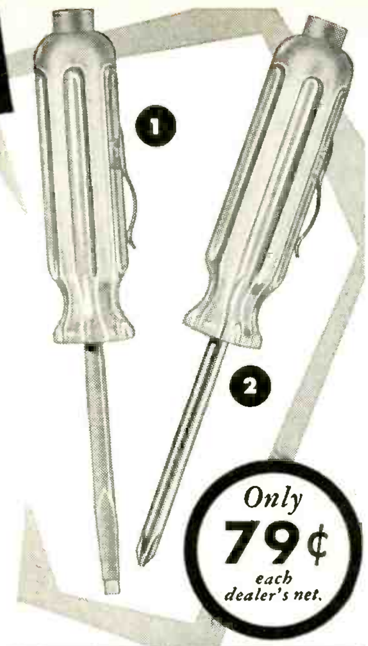

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Books

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When a busy engineer or technician needs detailed tube or transistor data, he needs it in a hurry. That is the reason for this handy manual. It is bound with 16 heavy metal rings to withstand hard use. The handbook gives full operating data, pin connections, etc. without need for turning the page. Tube sections list separately voltage amplifiers, converters, diodes, picture tubes, uhf types, phototubes, etc. Seldom-used tubes are listed apart from the more common types. Transistors and diodes receive the same detailed data under suitable headings.

Although essentially a tube and semiconductor handbook, related information is available. Included are use of tube testers, handling of kinescope tubes, resistance-coupling charts, color codes, symbols, etc.—*IQ*

ELEMENTS OF MAGNETIC TAPE RECORDING, by N. M. Haynes. Prentice-Hall Inc., Englewood Cliffs, N. J. 6 1/2 x 8 inches, 392 pages. $7.95.

The author is well known to older readers of this magazine from the mid-30's, when under the acrostic penname A. C. Shaney he conducted a Sound Engineering department in RADIO-CRAFT. He is one of the pioneers of magnetic recording and is now engineering vice president of the Amplifier Corporation of America. With this background he may be expected to have written a monumental work, and indeed has produced what musicologist Edward Tatnall Canby has called "almost a 'constitution' for the world of magnetic tape." The reader is likely to find more information on tape recording within the covers of this book than in any other work or collection of works on the subject he may have.

The book is divided into four sections. The first deals with theory and fundamentals; the second with principles and processes (recording, playback, erasing); the third with apparatus, operation and maintenance, and the fourth with circuitry.—*FS*

BASIC ELECTRICITY, by Rufus P. Turner. Rinehart & Co., Inc., 232 Madison Ave., New York 16, N. Y. 5 3/4 x 9 inches, 396 pages. $6.50.

This comprehensive volume is written for beginners. A wide field is covered for readers not ready to specialize in any particular branch of electricity. Each topic is clearly discussed: basic theory, transformers, motors, automa-

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tion, radio, industrial controls, etc.

The first chapters show what electricity is and what it does. From elementary charges, the book proceeds to practical dc circuits based on Ohm's and Kirchhoff's laws. Numerical exercises are worked out to give the reader confidence in circuit calculations. As the student's interest and knowledge grows, he advances to ac, polyphase lines, tubes and transistors. Other chapters cover electrical wiring, illumination, telephone fundamentals, and even the International Code appears. The final chapters are an introduction to electronics and measurements, including radio, phototubes and thyratrons and the oscilloscope.—*IQ*

PROCEEDINGS OF THE NATIONAL ELECTRONICS CONFERENCE, Vol. XII, 1956. National Electronics Conference, Inc., 84 East Randolph St., Chicago, Ill. 6 x 9 inches, 1095 pages. $5.

This latest volume contains nearly 120 papers covering a wide variety of advanced topics. Among the main sections are: instrumentation, measurements, network theory, solid state studies and automation. Many are specialized articles of interest to scientists and physicists.

ENGINEERING ELECTRONICS, by John D. Ryder. McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y. 6 x 9 inches, 666 pages. $9.50

This book is for senior college students and engineers who are concerned with the industrial and control aspects of electronics. Here they will find design data and operating characteristics of tubes and transistors; amplifier, oscillator and switching circuits; servomechanisms. The author presents a wide variety of topics aided by mathematical analysis.

Theory is coupled with application. Welding systems, rf heating, motor control, etc., are shown as examples of circuit theory in action.

ELECTRONIC COMPUTERS, Principles and Applications, edited by T. E. Ivall. Philosophical Library, New York. 172 pages. $10.

A nonmathematical treatment designed to give the reader a broad background picture of the principles and applications of digital and analog computers. Covers the fundamentals of basic circuitry and stresses the applications of computers to automation. Prepared especially for readers with a knowledge of basic electricity and electronics but also suited to business executives interested in applications or developmental work.

CLOSED CIRCUIT TV System Planning, by Morris A. Mayers and Rodney D. Chipp. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N.Y., 8½ x 11 inches, 250 pages. $10.

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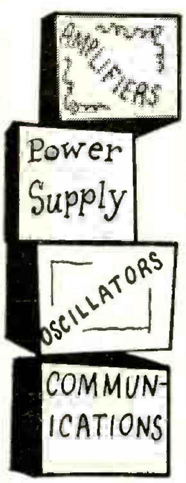

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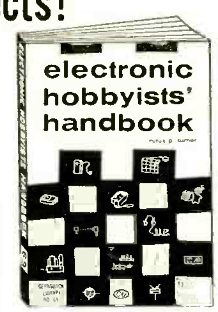

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closed-circuit TV are carefully presented. The text is divided into three parts. The first section shows how closed-circuit TV has been used in business for sales meetings, management training, fund raising, education, and industrial purposes such as production supervision.

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REPAIRING HI-FI SYSTEMS, **by David Fidelman. John F. Rider Publisher, Inc., 116 West 14 St., New York 11, N. Y. 5½ x 8½ inches, 203 pages. $3.90.**

This book introduces the radio technician to hi-fi repair and adjustment. It describes typical equipment needed for this work, such as distortion analyzers, wow meters, audio voltmeters and oscilloscopes. Very little theory appears, the author concentrating on techniques for testing, locating defects and servicing.

Amplifiers, pickups, tuners, record players and tape machines are discussed. The final chapter shows how simpler defects can often be located and cleared up without any test instruments.—*IQ*

ELEMENTS OF TAPE RECORDER CIRCUITS, **by Herman Burstein and Henry C. Pollak. Gernsback Library Inc., 154 W. 14 St., New York 11, N.Y. 8½ x 5½ inches, 223 pages. $2.90.**

Written for the technician and audiophile with an elementary knowledge of electronics and audio, this book shows clearly just what makes a tape recorder work. Such information is vital if you are to select a recorder to suit your own needs and even more important if you are to repair one properly.

Starting with an overall picture of what goes into a tape recording system, the text continues through a discussion of the characteristics of a high-quality recorder, equalization circuits, record-level indicators and minimizing hum and noise. Overall, an excellent way to build up your tape recorder know-how.—*LS*

FREQUENCY MODULATION RECEIVERS, **by J. D. Jones. Philosophical Library, Inc., 15 E. 40 St., New York 16, N. Y. 5½ x 8½ inches, 114 pages. $6.**

A good description of the principles and design theory of FM receivers, with numerical calculations by a British author. Each portion of the receiver—rf, converter, if, detector—is discussed separately. Calculations are worked out for gain, drift, impedance matching, tank design, etc. FM engineers and technicians need this book. Listeners who understand math and circuit theory will find it helpful and useful. END

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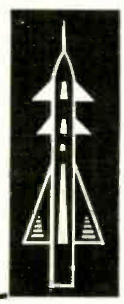

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FM specifications include grounded-grid triode low noise front end with triode mixer, double-tuned dual limiters with Foster-Seeley discriminator, less than 1% harmonic distortion, frequency response 20-20,000 cps ± ½ db, full 200 kc bandwidth and sensitivity of 2 microvolts for 30 db quieting with full limiting at one microvolt. AM specifications include 3 stages of AVC, 10 kc whistle filter, built-in ferrite loop antenna, less than 1% harmonic distortion, sensitivity of 5 microvolts, 8 kc bandwidth and frequency response 20-5000 cps ± 3 db.

The 5 controls of the KT-500 are FM Volume, AM Volume, FM Tuning, AM Tuning and 5-position Function Selector Switch. Tastefully styled with gold-brass escutcheon having dark maroon background plus matching maroon knobs with gold inserts. The Lafayette Stereo Tuner was designed with the builder in mind. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all parts and metal cover, a step-by-step instruction manual, schematic and pictorial diagrams. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 18 lbs.

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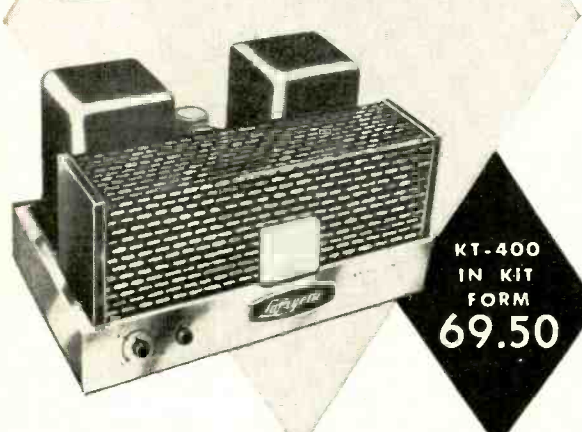

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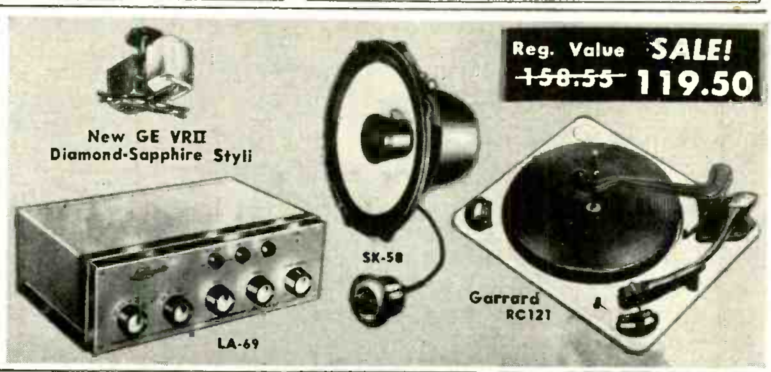

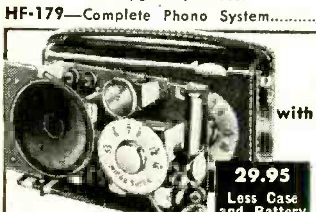

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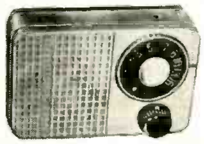

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Each GENIAC® comes as a self-contained course in computer design. All instructions are so simple that we have records of intelligent twelve-year-olds designing factoring machines and puzzle-solving circuits—while hundreds of schools and industrial training programs have incorporated our kits in their curricula.

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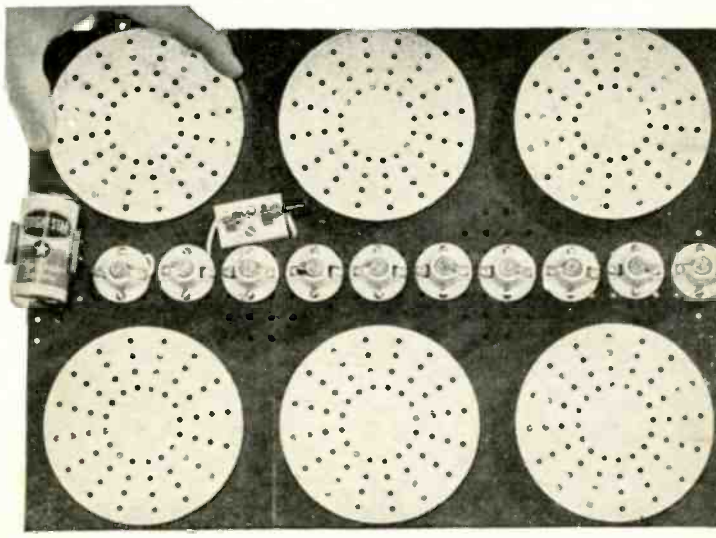

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Because of their durability and uniformity of response, dynamic microphones are almost universally used by recording studios. Electro-Voice dynamic microphones are a triumph of electro-acoustics in the recording, P.A. and general purpose fields. One of the many reasons for this is the Variable D principle which employs three distinct sound entrances, with acoustical filters; achieves flat response and excellent back cancellation while eliminating boominess caused by close talking—and susceptibility to shock. That's why those who want true fidelity, life-like recorded tape choose Electro-Voice dynamic microphones.

➊ E-V MODEL 664

Utilizing the revolutionary Variable D, this high-fidelity cardioid dynamic brings broadcast quality to tape recording and the P.A. and general purpose field. Proper placement of microphone stops unwanted sounds, gives accurate, natural pick-up of voice and music. Unprecedented ruggedness largely eliminates possibility of accidental damage.

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➋ E-V MODEL 636

This model brings style and quality to the recording and public address fields. Slim and trim—only 1⅛″ in diameter x 10¼″ long — it greatly reduces recording staging problems. Frequency response: 60 to 15,000 cps, essentially flat. Adjustable impedance. Gold or satin chrome finish. On-off switch standard equipment. Net weight: 15 oz. List price Chrome Finish: $72.50 (less stand).

➌ E-V MODEL 623

Excellent for both speech and music, its small, slim size makes it inconspicuous and easy to handle. Swivel mounting permits tilting microphone through a 57° arc toward the sound source. Acoustalloy diaphragm. Frequency response: 60 to 12,000 cps. Satin chrome finish. Net weight: 1 lb. List price: $57.00 (less stand).

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This is similar to Model 623 in performance characteristics but is traditionally styled. Frequency response: 60 to 11,000 cps. Satin chrome finish. Net weight: 1 lb. List price: $52.50.

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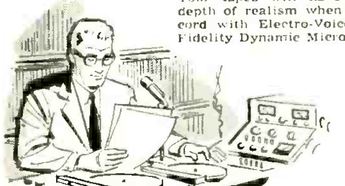

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1 To enter the contest, write a statement of 50 words or less telling how you think RCA's promotion of "National Television Servicemen's Week" benefits the independent TV service industry. The contest is open to all radio-television service dealers and their service employees, in the continental U. S., Alaska, and Hawaii, without any obligation on their part.

2 Your entry must be made on an official entry blank and must be submitted in your own name describing your own opinions in connection with "National Television Servicemen's Week"—March 24th to 29th, 1958. You may prepare your own entry blank, or you can ask your RCA Tube Distributor Salesman to help you prepare your entry blank. If your distributor salesman does help you, be sure to have him countersign your entry blank—he is also eligible for a prize if you win. Official entry blanks are available from your Authorized RCA Tube Distributor and from RCA Electron Tube Division advertisements. Only one entry per person is permitted.

3 Mail your entry, using adequate postage to: RCA Electron Tube Division, P.O. Box 551, New York 46, N. Y. *All entries must be postmarked on or before midnight, March* 15, 1958. No general correspondence should be sent to this address.

4 The entries will be judged by Advertising Distributors of America, Inc., an impartial, independent contest judging organization, on the basis of originality, sincerity, and aptness of thought. Decision of the judges is final. All entries become the property of Radio Corporation of America, and none will be returned. Entry in the contest constitutes permission to RCA to use your name and entry in any way it sees fit.

5 The contestants will be ranked in each region, in the order of the merit of their entries, as determined by the judges as provided above. They will be visited in person or phoned, in succession, sometime between the period of April 1, 1958 and April 30, 1958, by a "Mystery Shopper". The "Mystery Shopper" will ask a question about the product features of RCA Silverama Picture Tubes or RCA Receiving Tubes. The first service dealer or service technician in each region who answers the question correctly will be presented with the grand award. The next 3 dealers or their service employees in each region who answer the question correctly will be awarded one of the beautiful, new RCA Victor color TV sets. An additional 10 contestants in each region who answer the "Mystery Shopper" question correctly will receive one of the exquisite RCA Victor High Fidelity Sets. And 10 additional contestants in each region who answer the question correctly will receive an RCA Victor Transistor Radio. All contestants will receive a token of recognition.

6 The "Mystery Shopper" is the name applied to a group of impartial employees of Advertising Distributors of America, Inc., located throughout the nation. The "Mystery Shopper" will visit or phone contestants in the guise of a consumer, and will not divulge his or her identity unless the contestant supplies the correct answer to the question asked by the "Mystery Shopper".

7 Only one award will be made per person. Duplicate awards will be made in the event of a tie. This contest is subject to state and local regulation. Void if taxed, restricted or forbidden by law. A list of award winners may be obtained after April 30, 1958 by sending a stamped, self-addressed envelope to the address given above.

OFFICIAL ENTRY FORM

Mail to: C-39

RCA ELECTRON TUBE DIVISION
P.O. Box 551, New York 46, N. Y.

ALL ENTRIES MUST BE POSTMARKED ON OR BEFORE MIDNIGHT MARCH 15, 1958

Complete this statement in 50 words or less:

As a service dealer, this is how I think RCA's promotion of "National Television Servicemen's Week" benefits the independent TV service industry:

SIGNED ____________________
(Signature of Dealer or Technician)

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FIRM NAME

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